THE INFLUENCE ON RURAL COMMUNITIES OF INTERURBAN TRANSPORTATION SYSTEMS

VOLUME I
THE INFLUENCE ON RURAL COMMUNITIES OF INTERURBAN TRANSPORTATION SYSTEMS

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16. Abstract This research project, "The Influence on Rural Communities of Inter-Urban Transportation Systems," was one of five conducted under the general title, "Transportation to Fulfill Human Needs in a Rural/Urban Environment." The research is documented in two volumes: Volume I : The Influence on Rural Communities of Interurban Transportation Systems, and Volume II: Transportation and Community Development: A Manual for Small Communities. The first volume is the description of the study process and the findings of the various research phases during the project. This document would be of interest to professional planners in regional governments having small, rural communities within their jurisdiction. The report may aid in facilitating their interactions with representatives of smaller cities and enhance their appreciation of the uniqueness of those areas as reflected in their needs and issues.

The set of planning guides contained in Volume II would be of interest to the community representatives. The guides are designed for the layperson and are written in non-technical language. The purpose of the manual is to promote a more informed participation in the national, state, and regional decision-making process as it relates to transportation, and to provide the basis for initiating and continuing comprehensive local planning for small urban places (cities and towns with a population of 25,000 or less).

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EXECUTIVE SUMMARY

INTERURBAN TRANSPORTATION AND THE RURAL COMMUNITY

Transportation systems are, by definition, designed and constructed for the movement of goods and people from one place to another, but, as everyone knows, they affect much more than this. In fact, everyone expects them to accomplish, or help accomplish, other goals, or else they would not be built in the first place. It would be nice, in one way, if transportation were an end in itself. Then we could be concerned only about providing the most efficient and the safest means of getting from one point to another. Add to this a lack of social and environmental constraints and unlimited funds for developing new concepts, and we would have a world which every transportation engineer must dream about after a day spent preparing an environmental impact statement. Of course, not even the most frustrated transportation planner would want his dream to come true. The societal goals served by transportation systems are also his when he changes hats, and it is he, above most others, who is aware of the role transportation can play in accomplishing other ends.

That transportation is not an end in itself poses no real problem. The problem lies in the rational pursuit of the goals which transportation systems serve -- in determining priorities, in allocating resources, and in meeting a multitude of often conflicting expectations under changing conditions. This is what makes transportation policy a complex business. To choose one set of priorities is to acknowledge the restrictions of one's resources. To commit resources to one goal is to exclude other, perhaps equally desirable choices. To satisfy one set of expectations is to frustrate another set and to arouse still others. Above all, the expectations aroused, satisfied, or denied by a given transportation system will enter and then reenter the equations of policy-making as conditions change, defining and redefining what seems to be the rational way to accomplish the goals of greater social and economic well-being.

The present network of interurban highways is an obvious example of a system designed to serve a given transportation need and at the same time promote goals connected with the general welfare. In addition to simply moving people and goods between large urban areas, the system was also intended to serve the aims of national defense and to reduce social and economic costs through savings in time, money and lives. If these had remained its only goals, we could point to the present system as a model of efficiency in joining means and ends, and we would all be happy with minor adjustments and improvements in technical design and in the analytic tools developed to create the system. But, as we are all too aware when we watch the strains and stresses placed on cost/benefit analyses and the other procedures traditionally used to rationalize our choices, the accomplishment of the aims in the original policy has not been the end of a process. The unanticipated effects of the system itself, the changing economic and social conditions of the nation, and the expectations created by increased accessibility have forced us to reassess almost every aspect of the policies and programs which lie behind the present system.

THE EXPANDED ROLE OF THE TRANSPORTATION PLANNER

The changes in policy and accompanying legislation have explicitly imposed on the transportation planner a much wider responsibility than was assumed two decades ago; as a result, today he must play a variety of roles including those of the sociologist, the environmentalist, and the arbitration expert. He is expected not only to develop efficient transportation systems and to integrate these with the long-term goals of his society, but also to anticipate the future evolution of these same goals and develop ways of responding to changing conditions and new expectations. One only has to look through the conference proceedings and reports of the Transportation Research Board and other agencies over the last decade to recognize how fully that responsibility has been acknowledged and how thoroughly the expanded role of the transportation planner has been accepted. The breadth of the social, environmental and economic goals identified as major concerns may be illustrated by going back to some recommendations of the conference on "Transportation and Community Values" held by the Highway Research Board in 1969. Among basic social needs were listed such values as "personal identity and recognition," "(having) a voice in decision making," "a sense of community or belonging," "stability and security." Basic economic needs listed include "maintenance of economic stability of a community," and "growth, especially for the lower income and minority groups."[1] These categories illustrate just how broad the context of transportation decisions has become, and they also illustrate the difficulties we now face in relating such broad expectations to specific transportation decisions.

THE INTERURBAN SYSTEM AND NON-METROPOLITAN AREAS

Among the expectations we might have anticipated was that the interstate system would potentially benefit the areas which lie between the large urban centers. A natural result of the policy to upgrade the interurban system was to improve the accessibility of non-urban and non-metropolitan areas within the transportation corridors linking major cities. In the context of the decline of small urban places, many people perceived that improved accessibility would justify the large investment in interurban highways by creating new growth possibilities in rural America analogous to those once created by the railroads.

Just outside the small town of Smithville, Texas, located roughly equidistant from Austin, Houston and San Antonio, is a weathered blue and white sign which proclaims, "Welcome to Smithville, Heart of the Megalopolis." Erected some time ago by some local booster group, it seems today both humorous and pathetic. It is humorous because not even the most sanguine Smithville resident has probably ever taken the boast with full seriousness, and pathetic because it still represents the hopes aroused during the past two decades that towns like Smithville would not be among those "left behind." As they watched the spread of urban areas outward along the radii of transportation corridors, and as terms and phrases like "megalopolis" and "golden triangle" became household words, the residents of small towns quite naturally assessed their future in terms of their position in the new transportation network and in terms of the real and supposed benefits it could provide.

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[1] Creighton, Robert L., "Conference Summary," Transportation and Community Values, HRB Special Report No. 105, Highway Research Board, Washington, D. C., 1969.

Prior Studies to Assess Impact

Most of the previous studies are limited in that they concentrate on a narrowly-defined study area. In studies of small towns in rural areas the entire community has to be included in order to provide a true picture of the total effect. In such communities, with limited resources and few existing activities, an increase in the activities in one particular area may have a detrimental effect in other areas of the community.

Many of the previous studies fail to give a good description of the total transportation system and other important community characteristics both before and after the improvement. For this reason it is difficult to see which factors of the improvement are the most decisive and in what types of communities they will cause the specific effect predicted.

As a last major point, it may be added that the studies reviewed reveal little information about the time when an effect occurred relative to particular human decisions or physical changes. Public hearings, right of way designations, highway construction -- all are particular moments in a process and cannot be detached from the total cause/effect relationship.

REQUIREMENTS FOR FUTURE RESEARCH

In order to compensate for the limitations discussed above, an ideal study methodology will have to meet the following requirements;

(1) The study period must be long enough to include all the important changes in both the community and the transportation system.

(2) The study should be continuous over time to reveal the general trends in community development both before and after changes in the transportation system.

(3) The geographic limits of the study area must incorporate the entire community, including extraterritorial controls.

(4) The effects on the community examined must include all physical, social and economic factors of importance for characterizing the community and for measuring the community's potential for growth and development.

(5) The study of the transportation system must include all of the modes serving or influencing the community, and the study method must make it possible to determine what characteristics of the transportation system are of the greatest importance for community development.

The many weaknesses of the "before-and-after" and the "survey-control area" approaches would be overcome by employing a continuous long term study period. It would be necessary to make the study period continuous over the entire term, before, during, and following major changes in the intercity transportation system. This makes it possible to relate previous community conditions to later responses to change.

The major feature of this approach is the ability to relate the indicator (s) under study to previous changes both in the transportation system and in the community itself. As an overall approach, it should be suitable to any indicator capable of study, even though it is perhaps not feasible to use statistical analysis for all indicators. These may vary from directly measurable indicators, e.g., land value, to such less quantifiable indicators as the changes in community political and social structure. This general approach should make it possible to reveal the relationship between the effect in a community and the factors producing the effect. Consequently, for any case, it should be possible not only to describe what happened, but also to explain why it happened. Once the effects of transportation impact are more fully understood, it should be possible to develop more precise modeling techniques for those aspects of community change which can be related directly to changes in the transportation system.

ECONOMIC BASE AS AN INDICATOR OF ECONOMIC IMPACT[2]

One of the most important indicators of economic change in a community is change in the "economic base." The economic base of a community consists of those economic activities which produce goods or services that are consumed by residents or businesses in other areas. When the economic base of a community changes it will usually have a dramatic effect on all the economic activities in the community. This is caused by the strong relationship between economic base and total community income. When community income fluctuates, expenditures in retail sales and services will also change. Thus, the change in economic base activities can have a direct influence on the economic health of the entire community.

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[2]For more detailed information see Appendix I, Exhibits 2 and 3.

If the community has a strong economic base, then it is likely to have strong economic ties to other communities within the region. That is, it produces a good or service that is consumed in other places, and it is likely that other communities provide goods or services that are consumed in the community under study. The prospects for economic growth are much greater for the community that has a strong economic base (or the potential for one) than for the community with little or no economic base.

Employment in economic base activities is referred to as basic employment. Basic employment normally falls into the categories of farming, fishing, mining, manufacturing, and construction, but it may also include some people who work in service establishments that cater to non-community residents. Employment in a local manufacturing plant, feed lot, food processing plant, or tourist attraction would be considered basic employment if most of the products or services are sold to people from outside of the community.

Employment data is most often used as an indicator of economic base because it is relatively easy information to obtain. There are some drawbacks, however. Employment information will not reflect changes in productivity and may, in fact, indicate the opposite impact. Also, employment data does not compensate for differences in wage levels among industries. But, due to the limited resources usually available to conduct economic base studies in rural areas, an employment approach can be quite useful if the drawbacks are recognized and accounted for.

Manufacturing employment change seems to provide the most consistently reliable information on the relationship between change in transportation and change in economic base activities. Although manufacturing employment is only one type of economic base activity, it seems to be well suited for studying the impacts of transportation in rural areas.

A change in transportation, and thus accessibility, may alter the position of a city in the urban hierarchy. Manufacturing employment would be more susceptible to change in accessibility than farming or mining because it is not tied to a particular resource location. Manufacturing employment is less seasonal than economic base activities based on services provided to tourists and vacationers and therefore would be a better predictor of the long-term growth prospects of a community than service oriented economic base activities. Construction employment in small towns is normally a non-basic (local) activity and therefore would be an adequate measure of changes in economic base. Change in manufacturing employment, then, would appear to be the best measure of change in economic base in rural areas.

The research effort to determine the impact of transportation change on manufacturing employment revealed some interesting information. There appears to be a linear relationship between transportation change and manufacturing employment, but this relationship is different for different size cities. Also, while transportation may play a significant role in the decision to locate in a particular area, it is not perceived as particularly important by decision-makers.

The study shows that for rural towns of different sizes, different factors may assume more or less importance in influencing the growth of an economic base. Most outstanding of the examples is the importance of the nearest large population center or SMSA. Proximity to an SMSA is found to favor manufacturing growth in the larger rural towns while the reverse is true for smaller rural places (under 3,000). Likewise, the importance of rail is evident in that range of towns with a population of 701 - 3,000 while not differentially significant to manufacturing growth in the smaller or larger towns. Since studied rail service in larger towns is ubiquitous, this suggests the developmental importance of the rail factor. Whereas highway access is most critical to smaller rural town manufacturing gains, gains in the larger rural towns were most influenced by population. Population, as has been noted, is a consistently important variable and may, to a certain extent, represent the attractability of the service sector of the town.

In general, the impact of upgrading a highway seems to have had only a slightly more positive effect on towns near an interstate in Texas over what would have occurred along a parallel old U. S. highway. This result is attributable to the high quality transportation infrastructure which already existed throughout the area studied before improvements began. This is not to undermine the importance of major highways in contributing to the growth of manufacturing employment. In fact, access to a second major highway proved to be an extremely important contributing factor to manufacturing gains. The accessibility to highways was relatively more important to growth in the smaller towns.

A survey was conducted of business leaders who had moved their manufacturing concerns to a rural town after completion of a nearby interstate. The survey results indicated that transportation was a consistent, though not always most important, factor in the decision to relocate. Minimum lot size and land cost differentials were important factors in choosing a rural rather than an urban area. The most important factor in choosing a rural area was lower labor costs. In general, the survey results showed that larger businesses are more responsive to the degree of transportation access than are the smaller companies. The regional planner can use his knowledge about the relationship between transportation change and growth in economic base in two related ways. First, the regional planner will be able to assess the potential economic effects that a proposed transportation change will have on communities in the region. Second, the knowledge of potential impacts can facilitate the choice among alternate routes within an intercity transportation corridor by making it easier to determine how to maximize economic growth in the region through the placement of a transportation facility. Once a corridor has been determined, the choice of a particular route is often decided on the basis of cost, i.e., the cost of constructing the facility, not the cost or benefit of the economic impact on communities within the corridor. The inclusion of impacts on the economic base of small communities should make the decision to locate a particular facility more responsive to community desires for economic growth.

The Value of Case Study

While no general model can be evaluated from such a case study as every community has its own characteristics in terms of resources, traditions, economy, and so on, and each is served by a transportation system with specific development characteristics, the land value model from this case study could possibly be refined and expanded to a general descriptive model in a later phase of the overall research effort.

The purpose of the case study phase is not only to evaluate the descriptive model, but also to identify appropriate techniques to be used in similar studies. This identification may be considered to be as important as evaluating the model itself. Consequently, it is also a study of what information is generally desired, what information is generally available in rural communities, and what adjustments in study techniques are necessary given the available information.

The descriptive model in this case study phase will be given the form of a function. The dependent variable will be land value; the independent variables will be the different factors causing land value to vary: use, location, access, and so on. In addition, a specific technique will be used for evaluating the regression model to be analyzed. Before the regression models are set up an available program package for statistical analysis will be used to find the most significant factors in the data set and the interaction between them. Thus the model potentially should explain why and how land value varies from one parcel to another. Because of the human factor involved in all land evaluation, depending on the individual seller or buyer, such a mathematical model is not expected to be anything but a general expression for what an objective value of a specific piece of land should be, based on real life observations in a specific area.

A substantial data base was gathered in this study, and it is readily available for further analysis. Further research on this data base might include sensitivity analysis of the predictor variables and more complete analysis of the spatial variation within the community. The stored information may be analyzed to reveal possible differences in the variation in land values between zones, land use categories, location along the interurban highway versus other locations, and land ownership.

In further research major emphasis of the land value studies should be given to three subjects:

1. Further refinement of the techniques to describe quantitative and qualitative predictor variables already included in the analysis.
2. Development of a technique to separate the value of land and improvements or possibly to classify the quality of the improvement.
3. Development of a technique to include economic, political, social and ownership characteristics in the analysis.

On a state or nation-wide level, an effort should be made to create a data bank where all gathered information can be stored and made available for research teams and governmental agencies. The first step would be to develop general methodologies for data gathering and establish structures for the data bases in order to assure comparability between the different studies. Ideally this will facilitate future research efforts and provide sufficient data to enhance other programs such as land use planning and policy development.

Perceived Environmental Utility Under Alternative Transportation Systems

This section presents a framework for analyzing how residents of urban urban environments themselves perceive and evaluate transportation alternatives. A two phase design was described. In the first phase, a procedure was developed for eliciting the components which residents conceive as comprising their environment under a transportation system. For this, Kelly's Personal Construct Theory and Repertory Grid procedures were used. An example was given of the elicitation of the components which describe the environments of small town residents.

The second phase was more complex. It was hypothesized that, in a sample population, there might be groups who would (a) be homogeneous according to a very wide range of non-traditional socioeconomic and activity variables and (b) evaluate the components of their kind of environment in the same way under alternative transportation systems. Accordingly, the conceptual framework was extended to define statistically homogeneous groups, using income, occupation, age, and many different kinds of travel behaviors. This framework was successfully tested with the definition of four homogeneous groups in a case study small town. Finally, the INDSCAL model was employed to determine whether each homogeneous group does evaluate the components of their kind of environment under alternative transportation systems in a distinctive way. For the kinds of homogeneous groups in the case study town it was found that they do not. Each group evaluates transportation systems along similar dimensions, but individual differences within groups are so great that some members derive maximum utility from one alternative and some from another. Thus, other kinds of interest groups which support or oppose transportation innovations are drawn from different socioeconomic and activity groupings. The conceptual framework of this paper demonstrates how such interest groups are derived.

CITIZEN PARTICIPATION

Citizen participation is based on certain ideals that have deep historical roots. The implementation of these ideals is not without problems and challenges. The concepts of representation, organizing for action, conflict, and power have taken on added meanings and call for rational reform. Legislative processes in organizational structures have been challenged, as are some of the traditional ways of solving societal problems. The challenge is to be innovative in the democratic and planning process, so that desirable social change may be accomplished and the spirit of community participation strengthened.

The purpose of this part of the study was to consider these various aspects of citizen participation. Since the subject is wide ranging and lengthy, having a substantial literature extant, this chapter must necessarily be of an overview and illustrative type. The intent is to provide the reader with a sufficient feeling and background for the issues of citizen participation and some of the methods or procedures which may be adopted to assist in this process. The references cited throughout the chapter are illustrative of the literature available and are recommended for those readers who wish to pursue the topic further.

The Problem of Citizen Participation in Small Communities

It might be assumed that small communities would represent the ideal case for full citizen participation. In communities under 10,000, especially, an individual who has lived in town for any length of time is likely to know or have at least a "passing acquaintance" with a great percentage of the other residents. The tradition of the town-meeting in some regions and the variety of voluntary associations usually present in small towns accustom the resident to participation in some form of the decision-making process--setting goals, debating alternatives, and implementing solutions to local problems. Given the opportunities for contact between residents and for most citizens to become involved in an immediate way with the decision-making process, one might expect that it would be relatively easy to get "meaningful input" from a broad spectrum of the community on a particular issue and that the mechanisms for developing community consensus would already be "built in".

There are, however, social characteristics of small towns in general which may often work as inhibitors of genuine citizen participation.

The "I have to live here" syndrome. The smallness of a community creates the necessity as well as the opportunity for mutual contact among citizens. That necessity often creates a reticence to publicly express opinions and reveal attitudes that would create controversy or simply expose an individual to the disapproval of his fellow citizens. The desire not to antagonize others too often creates an apparent consensus when none in fact exists.

The distrust of the political process. In many small towns, there is an ingrained distrust of both external authority and the local leadership. An attitude of helplessness, and hence of cynicism, in regard to extra-local authority is wide-spread in small communities. The small town resident feels himself remote from the decision-makers whose actions affect his life. He often feels incapable of understanding the rationale behind a great many policies and decisions, and he does not see any meaningful way that he can contribute to a process apparently designed not to accomodate him.

His view of the local political leadership is often equally distrustful. He alludes to the existence of a ruling elite (the "boys downtown," "the folks at city hall"), and he assumes that its members will act only in their own interest. It might be suggested here that "ruling elites" often exist (or are thought to exist) because of the typical political process in many small communities. The desire to minimize conflict results in the minimization of issues on the local level, which in turn diminishes the political activity and participation in the electoral process.

These two social features will often be encountered in small communities, posing a dilemma for the planner who is genuinely interested in promoting citizen participation. If he chooses traditional tools for obtaining citizen participation (i.e., public meetings, citizen committees, etc.), he is less likely to elicit a set of responses indicative of the full spectrum of citizen attitudes than to discover an apparent but often specious consensus. On the other hand, if he uses means more apt to identify genuine attitudes, his information may well be useless as a measure of what can be expected in terms of actual community reaction.

RURAL COMMUNITY INVOLVEMENT IN TRANSPORTATION

The aim of this report has been to call attention to some of the sources of expectation and resentment which small town residents perceive as a result of the implementation of a major transportation facility in the immediate vicinity of their community. Although acutely aware of the benefits which may result from such transportation programs as the Interstate system, citizens of small communities remain sceptical of the intentions of planners and administrators. Ironically, the tangible benefits of past policies and programs have often helped fuel that scepticism. While on the one hand there has seemed to be a policy designed to help benefit small communities, on the other hand there has been an apparent disregard for the problems which are peculiar to the same small communities. To many residents of small towns, policies which are said to be designed for their interest seem only half-heartedly so.

To aid in achieving more involvement in transportation decision making a set of manuals were devised and field tested. The manuals were prepared from the perspective of the layperson and intended for their use. The manual is found in Volume II of this report. A discussion of their evolution and evaluation are included in this report, Volume I.

Recommendations

Given the unique nature of transportation impact on small towns and the concomitant planning needs of such communities, the following recommendations are offered in pursuit of a specific program for future interurban transportation policy.

1. That a basic transportation plan for each small community within a designated interurban corridor be developed concurrently with the transportation corridor system plan. This would formalize the link between the community and the sponsoring agency and provide a mechanism for making both parties aware of mutual problems. It would also provide the community with an introduction to basic planning and implementation techniques.

2. That a formal update of the original plan be conducted on a five-year basis. In addition, a continuing link between the community and the sponsoring transportation agency would allow the community to request assistance in evaluating their transportation plan in light of unanticipated developments.
3. That the sponsoring agency advise a community likely to be impacted by an interurban facility of particular planning services available from other regional and state agencies. This would insure that the community be fully aware of the range of information required to develop an adequate transportation plan. The sponsoring agency could serve initially to coordinate the community's planning activity.
4. That the criteria used to determine compensation for losses as the result of the impact of a change in transportation facilities be reexamined in regard to the problems of small towns. While it is beyond the scope of this paper to discuss assistance programs in detail, it does seem clear from our own research that current assistance policy is a major source of resentment.

PREFACE

BACKGROUND

This document is one in a series developed as an outgrowth of research sponsored by the U. S. Department of Transportation, Office of University Research, through the Council for Advanced Transportation Studies, The University of Texas at Austin. The topic of this research project, "The Influence on Rural Communities of Interurban Transportation Systems," was one of five conducted under the general title, "Transportation to Fulfill Human Needs in a Rural/Urban Environment." The overall objective of this project was to investigate the nature of interurban transportation influence on small "rural" communities (below 25,000 in population) and to assess the relationship between changes in the interurban system and the potential for growth and development of small communities.

The project consisted of four basic stages:

(1) a review and analysis of transportation impact studies leading to the identification and investigation of areas deemed important to rural communities and intercity transportation systems,

(2) an investigation of high probability areas of impact to ascertain data availability and appropriateness of various methodological concepts in studying transportation impacts on rural communities,

(3) a detailed case study of selected rural communities in terms of their response, real and perceived, to changes in their intercity transportation systems and accessibility, and

(4) the development and field testing of a set of transportation planning guides designed for use by the layperson in the rural community and the regional planner.

The research is documented in two volumes:

Volume I: The Influence on Rural Communities of Interurban Transportation Systems, and

Volume II: Transportation and Community Development: A Manual for Small Communities.

The first volume is the description of the study process and the findings of the various research phases during the project. This document would be of interest to professional planners in regional governments having small, rural communities within their jurisdiction. The report may aid in facilitating their interactions with representatives of smaller cities and enhance their appreciation of the uniqueness of those areas as reflected in their needs and issues.

The set of planning guides contained in Volume II would be of interest to the community representatives. The guides are designed for the layperson and are written in non-technical language. The purpose of the manual is twofold:

(1) to promote a more informed participation in the national, state, and regional decision-making process as it relates to transportation, and

(2) to provide the basis for initiating and continuing comprehensive local planning for small urban places (cities and towns with a population of 25,000 or less).

The MANUAL is divided into an executive summary and seven chapters, each individually bound and designed for use separately or in conjunction with others. The seven chapters are:

Chapter I. The Transportation Planning Process,

Chapter II. Transportation Impact,

Chapter III. Goals and Objectives,

Chapter IV. Community Inventory,

Chapter V. Development of Alternatives and Preliminary Assessment,

Chapter VI. Evaluation, and

Chapter VII. Glossary and Bibliography.

The purpose of this Volume is to present several of the major activities conducted during the study. The Volume consists of five chapters and extensive appendices of more detailed and technical descriptions of the research methodology.

Chapter I - Interurban Transportation Policy and the Rural Community is a perspective of the small rural community and issues relating to the external planner. A review of prior impact studies is included with recommendations for further studies of similar purpose.

A major issue in the small community is economic impact of transportation systems. Chapter II entitled "Economic Base as an Indicator of Economic Impact" is a discussion of the research performed in this area, findings, and recommendations.

To ascertain a better appreciation between perceived and real impacts as presented in our survey of rural community residents, a study entitled "Perceived Environmental Utility Under Alternative Transportation Systems" was conducted (Chapter III).

Chapter IV presents an assessment of citizen participation and its role in small rural communities.

The final chapter is entitled "Rural Community Involvement in Transportation" and presents the framework for developing the planning manual. The evaluation (field testing) process is documented and summary recommendations are made.

The exhibits contained in these appendices are essential to understanding the nature of the research and may be of value to state and regional transportation planners working with and for the small communities in the rural U. S.

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I. INTERURBAN TRANSPORTATION POLICY AND THE RURAL COMMUNITY

INTRODUCTION

Transportation systems are, by definition, designed and constructed for the movement of goods and people from one place to another, but, as everyone knows, they affect much more than this. In fact, everyone expects them to accomplish, or help accomplish, other goals, or else they would not be built in the first place. It would be nice, in one way, if transportation were an end in itself. Then we could be concerned only about providing the most efficient and the safest means of getting from one point to another. Add to this a lack of social and environmental constraints and unlimited funds for developing new concepts, and we would have a world which every transportation engineer must dream about after a day spent preparing an environmental impact statement. Of course, not even the most frustrated transportation planner would want his dream to come true. The societal goals served by transportation systems are also his when he changes hats, and it is he, above most others, who is aware of the role transportation can play in accomplishing other ends.

That transportation is not an end in itself poses no real problem. The problem lies in the rational pursuit of the goals which transportation systems serve -- in determining priorities, in allocating resources, and in meeting a multitude of often conflicting expectations under changing conditions. This is what makes transportation policy a complex business. To choose one set of priorities is to acknowledge the restrictions of one's resources. To commit resources to one goal is to exclude other, perhaps equally desirable choices. To satisfy one set of expectations is to frustrate another set and to arouse still others. Above all, the expectations aroused, satisfied, or denied by a given transportation system will enter and then reenter the equations of policy-making as conditions change, defining and redefining what seems to be the rational way to accomplish the goals of greater social and economic well-being.

The present network of interurban highways is an obvious example of a system designed to serve a given transportation need and at the same time promote goals connected with the general welfare. In addition to simply moving people and goods between large urban areas, the system was also intended to serve the aims of national defense and to reduce social and economic costs through savings in time, money and lives. If these had remained its only goals, we could point to the present system as a model of efficiency in joining means and ends, and we would all be happy with minor adjustments and improvements in technical design and in the analytic tools developed to create the system. But, as we are all too aware when we watch the strains and stresses placed on cost/benefit analyses and the other procedures traditionally used to rationalize our choices, the accomplishment of the aims in the original policy has not been the end of a process. The unanticipated effects of the system itself, the changing economic and social conditions of the nation, and the expectations created by increased accessibility have forced us to reassess almost every aspect of the policies and programs which lie behind the present system.

THE EXPANDED ROLE OF THE TRANSPORTATION PLANNER

The changes in policy and accompanying legislation have explicitly imposed on the transportation planner a much wider responsibility than was assumed two decades ago; as a result, today he must play a variety of roles including those of the sociologist, the environmentalist, and the arbitration expert. He is expected not only to develop efficient transportation systems and to integrate these with the long-term goals of his society, but also to anticipate the future evolution of these same goals and develop ways of responding to changing conditions and new expectations. One only has to look through the conference proceedings and reports of the Transportation Research Board and other agencies over the last decade to recognize how fully that responsibility has been acknowledged and how thoroughly the expanded role of the transportation planner has been accepted. The breadth of the social, environmental and economic goals identified as major concerns may be illustrated by going back to some recommendations of the conference on "Transportation and Community Values" held by the Highway Research Board in 1969. Among basic social needs were listed such values as "personal identity and recognition," "(having) a voice in decision making," "a sense of community or belonging," "stability and security." Basic economic needs listed include "maintenance of economic stability of a community," and "growth, especially for the lower income and minority groups."[1] These categories illustrate just how broad the context of transportation decisions has become, and they also illustrate the difficulties we now face in relating such broad expectations to specific transportation decisions.

THE INTERURBAN SYSTEM AND NON-METROPOLITAN AREAS

Among the expectations we might have anticipated was that the interstate system would potentially benefit the areas which lie between the large urban centers. A natural result of the policy to upgrade the interurban system was to improve the accessibility of non-urban and non-metropolitan areas within the transportation corridors linking major cities. In the context of the decline of small urban places, many people perceived that improved accessibility would justify the large investment in interurban highways by creating new growth possibilities in rural America analogous to those once created by the railroads.

Just outside the small town of Smithville, Texas, located roughly equidistant from Austin, Houston and San Antonio, is a weathered blue and white sign which proclaims, "Welcome to Smithville, Heart of the Megalopolis." Erected some time ago by some local booster group, it seems today both humorous and pathetic. It is humorous because not even the most sanguine Smithville resident has probably ever taken the boast with full seriousness, and pathetic because it still represents the hopes aroused during the past two decades that towns like Smithville would not be among those "left behind." As they watched the spread of urban areas outward along the radii of transportation corridors, and as terms and phrases like "megalopolis" and "golden triangle" became household words, the residents of small towns quite naturally assessed their future in terms of their position in the new transportation network and in terms of the real and supposed benefits it could provide.

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[1] Creighton, Robert L., "Conference Summary," Transportation and Community Values, HRB Special Report No. 105, Highway Research Board, Washington, D. C., 1969.

It might be argued that these expectations were not justified by the original policy to upgrade this system, but to do so would be to ignore both political realities and concomitant policies. Highways were seen by policy makers as potential sources of economic redevelopment, as witnessed by the decisions concerning Appalachia and the Connecticut Turnpike. Whatever the intentions behind the many impact studies commissioned by Federal and State agencies, the general results were an increasing focus on non-user, or community, benefit and the justification of public expenditure for highways in terms of long-range benefits to all the areas served. Although no explicit promises may have been made to towns like Smithville, there can be no question that some of the responsibility for their expectations rests with those who plan and construct transportation facilities and that future decisions must acknowledge that responsibility.

As the major component of the interurban system, the Interstate network, nears completion, we can look back with that unique tool, hindsight, and reassess what was done and what might have been done to promote the kind of goals now so widely acknowledged to be in the province of planning transportation systems. With particular reference to rural areas, we might ask what the experience of the vast improvement of highways tells us about the planning of future transportation systems, of whatever kind, with the hope that we can adequately meet the responsibilities that such planning will entail.

RESENTMENTS IN THE RURAL COMMUNITY

In the course of a recent case study of social impact on a rural community which seemed to have benefited from the construction of a portion of the Interstate system, we were involved with interviewing a wide spectrum of the citizenry. Since for several years prior to the study the town had pursued a relatively successful growth policy closely tied to the development of the freeway, the resentments expressed against State and Federal agencies and the divisions within the community over the benefits and disbenefits of the highway came initially as a surprise to the interview team. The often expressed view that "they (external agencies) do not care what we think and will do nothing for us" seemed to contradict the benefits widely attributed by the same people to the freeway: "Closer family ties" (because of increased access to family members who lived outside the community), "more jobs for local residents because of new industry" and "greater personal freedom" were among the benefits attributed to the highway.

ANALYSIS OF PREVIOUS STUDIES[2]

Most impact studies in rural areas concentrate on impact from highway improvement. Even though the private automobile is the major mode of transportation today, the consequences of changes in air, rail or bus service in rural areas need further investigation. The studies show clearly that highway improvement has a significant impact, and usually a positive impact, on the areas along the facility, but consequences of reduction in transportation service, as has been the case in most areas with rail service during the last two decades.

The previous highway impact studies provide a great deal of information, but their limitations should be noted. Many studies are directed more towards describing an impact, and the magnitude of the impact, than toward examining the cause/effect relationship. These studies are of value in showing the benefits of public investment in highway improvement, and they justify the spending of public funds in terms of "non-highway user" cost/benefit. However, they are of less value as a tool for highway or community planners since they cannot be used to predict the future impact of changes in the highway system on a particular community. All of the studies support general observations about the development of adjacent land, the increase in business activity and increasing land values close to the new facility, but few of them are designed to reveal the impact on the community as a whole.

The fact that each community has its own characteristic in terms of economic and human resources, geographical location, etc., makes it difficult to use the highway impact observed in one community to forecast the effect of

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[2]Skorpa, Lidvard, Richard Dodge, C. Michael Walton, and John Huddleston, "Transportation Impact Studies: A Review with Emphasis on Rural Areas," Research Report #2, Council for Advanced Transportation Studies, University of Texas at Austin, October 1974.

highway improvement in another community. A forecast would be possible only where general community characteristics are included in the analysis, but unfortunately this is not usually the case.

In addition to these general limitations, previous highway impact studies are subject to criticism on more specific grounds, depending upon the particular methodology used in the research. Consequently, it is important to examine the advantages and limitations inherent in each of five categories of study methodology before recommending a strategy for future research.

METHODOLOGY

The Before and After Technique

This technique is the most commonly used; it is used either singly or in combination with other techniques in all studies dealing with changes in highway facilities. The main advantages of this approach are, first, that it is simple to apply and, second, that it is easy to understand. The technique measures the value of some of the characteristics of an area before and then after the highway improvement; the difference is said to be the effect of the improvement. Consequently, the only quantity measured is the change in value between one time period and another. The greatest disadvantage is very obvious: this technique cannot relate the measured effect to any specific cause. Since in most cases there will be a span of 3-5 years between the before and the after period, many factors other than highway improvement are likely to influence the study area. Thus, this technique cannot determine whether an effect is, or is not, caused by the road improvement. In an attempt to isolate highway effect, the survey-control area technique is often used with the before-after technique. However, as will be shown in the next section, the survey-control area technique is not itself a sufficient way of revealing the scope of the highway impact.

Most studies are conducted in the after period. This may cause difficulties in determining or measuring the nature of the study area in the before period. The only way to avoid this shortcoming is to select an area where the necessary information on the before period is available, thus considerably limiting the number of areas which may be studied. Even assuming that sufficient information from the study area is available, there still remains a major disadvantage to the before and after technique. For each characteristic to be measured, only one value can be assigned for each of the two time periods. The before period, theoretically, has only one defined limit, usually the date on which construction of the improvement was begun; the after period is also defined by narrow limits, usually the period between completion of the highway facility and the date of the study itself. In practice the average length of the before period is approximately only two years; the length of the after period usually varies from two to four years. (In reality, the length of the "before" period is undefinable because it is not known when knowledge of a proposed highway improvement begins to influence the development of an area.)

Figure 1, p. 9, shows the possible pattern of a single response, in this case land value, to changes in the highway system. As can be seen, the before-after technique reveals no information about the trend in the before or the after period. The measured effect of the improvement will be the same regardless of the trend during the time preceeding the change in the highway facility. It is reasonable to say that the effect of the improvement is greater in cases where an existing "downward" trend is reversed than in the cases where the trend is already "upward," even though the measured effect in terms of a value for community response is the same. Consequently, it would be more logical to measure the effect in terms of the difference between the response to actual transportation improvement and a projection of the before-trend (assuming that no improvement had occurred). This situation is represented in Figure 2, p. 10. The total community impact over a time period would be the area between the two curves. Different phases in the improvement planning and implementation process may have different effects on community response (also indicated in Figure 2). What the general shape of such a curve would be, assuming that the effect caused by the highway system development could be isolated for each period, is not known.

It is assumed that general public knowledge of the project, purchase of right of way and so on, will have an influence on the community response, even if not of the same magnitude as the actual construction of the improvement. Since events other than construction usually fall outside the scope of the before and the after study periods, their effect cannot be determined.

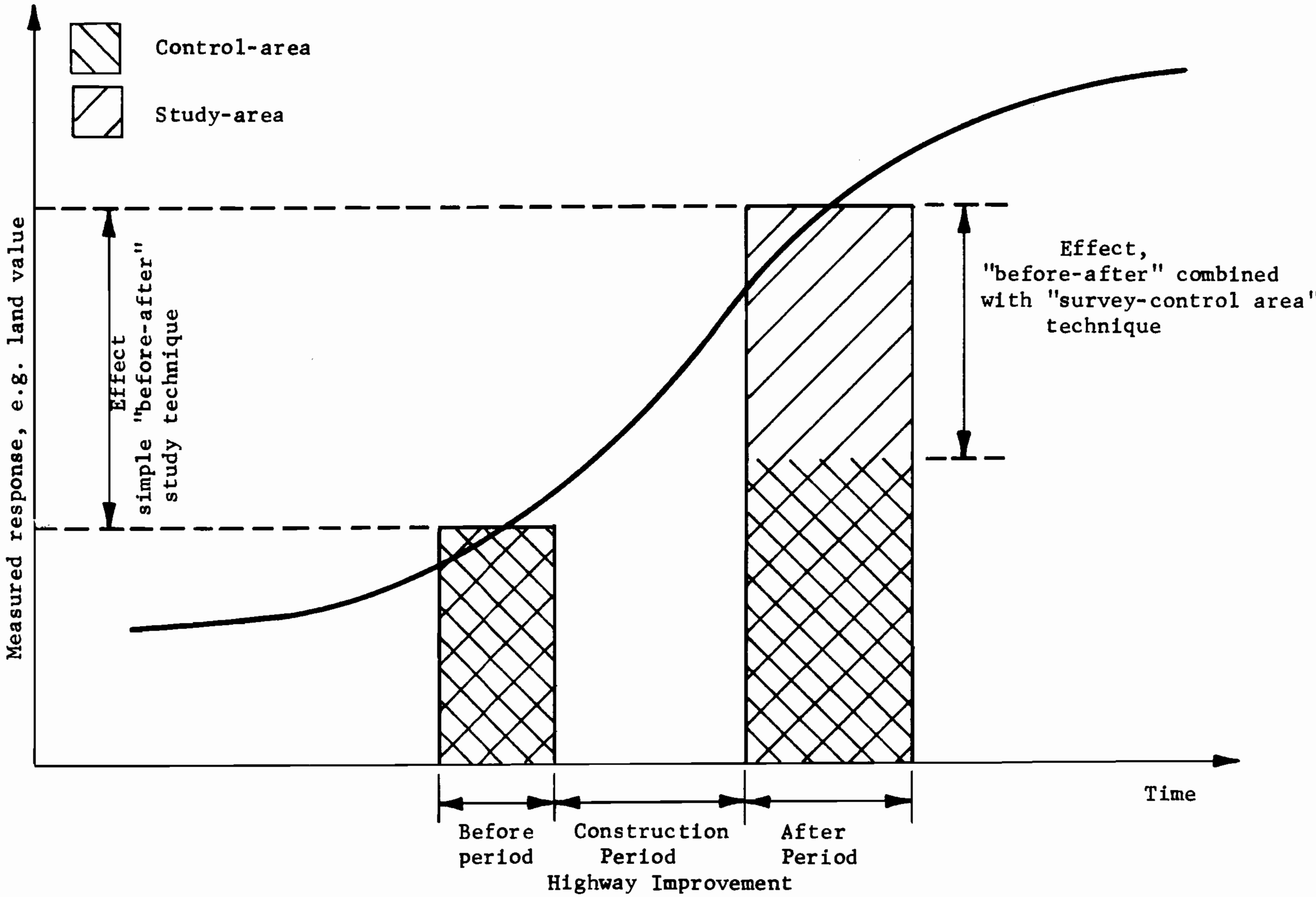


Figure 1. Before-after study technique.

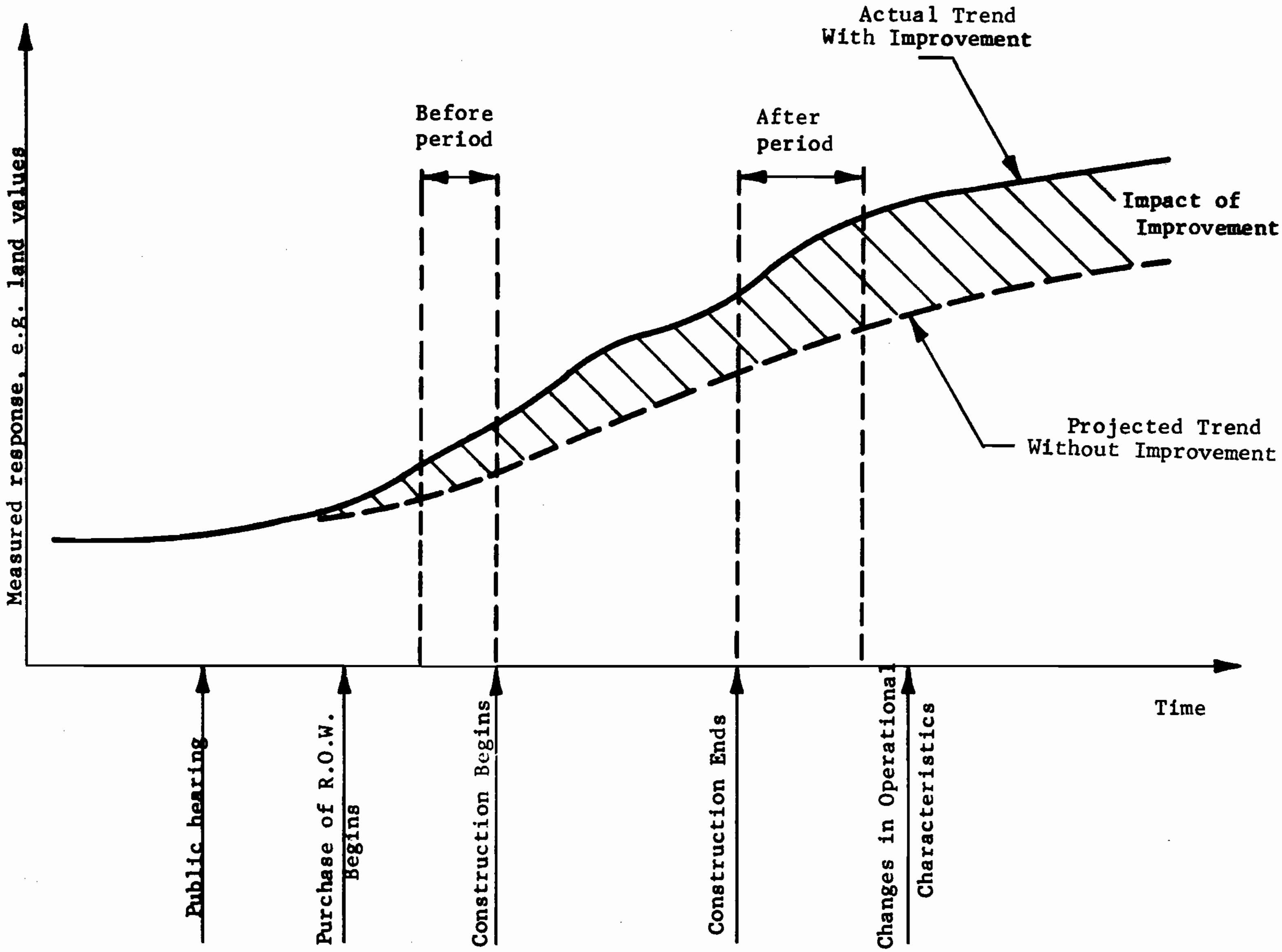


Figure 2. Possible effect of different phases in highway improvement.

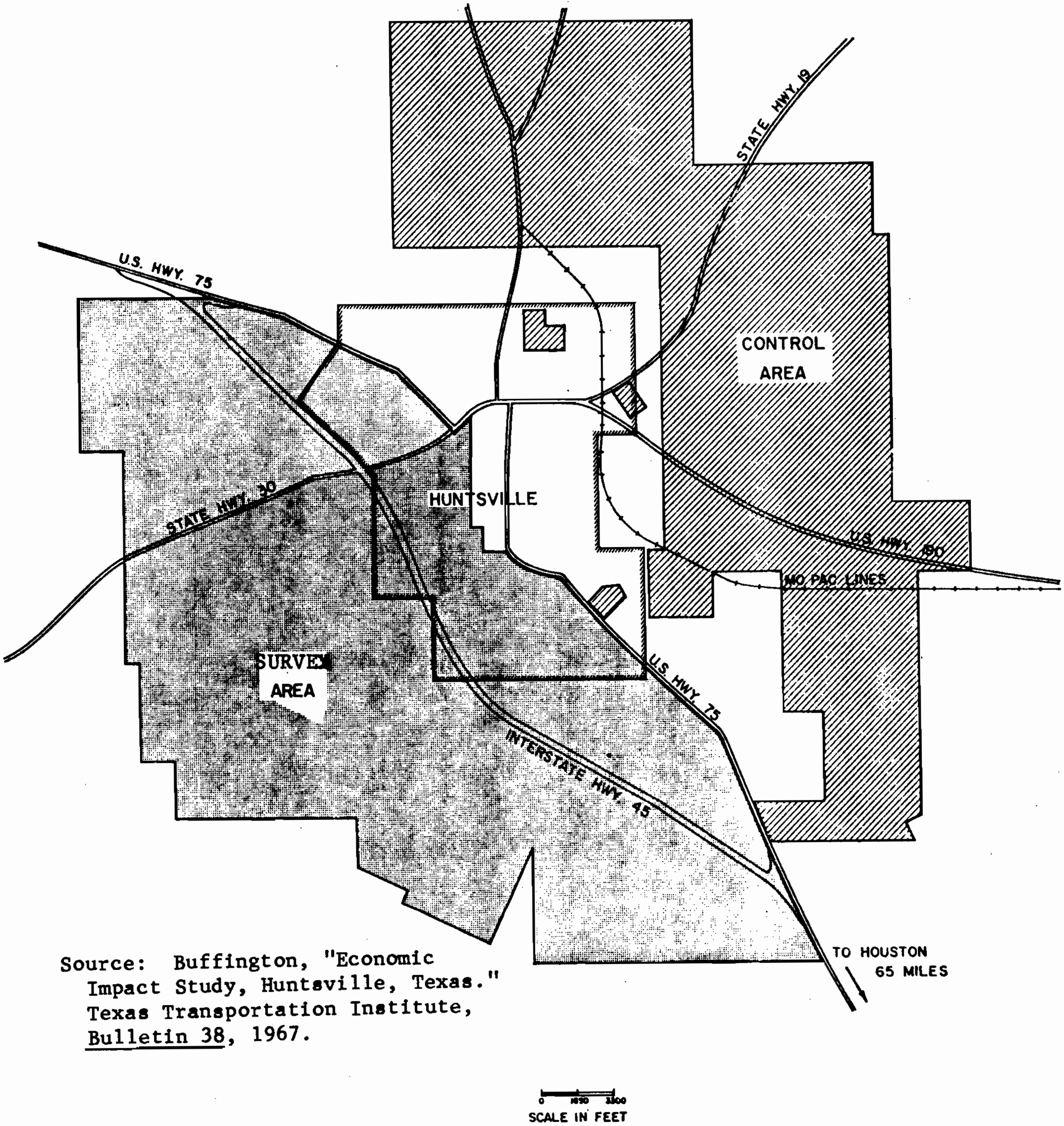
The Survey-Control Area Technique

This is the most common technique used to isolate highway impact. It has been frequently used to study the effect on land values in an area adjacent to a new highway facility (the survey area). To separate the effect of non-highway related factors from those related to the highway, a control area, similar to the survey area, is selected. This control area is ideally chosen far enough from the highway to have been unaffected by the highway facility.

In theory, the survey area and the control area would have to be exactly alike in all respects during the period just prior to the highway improvement. Also, the factors affecting development in the two areas should be the same, except for the highway improvement. These requirements are hard to meet, as the spatial limits or distribution of the highway impact are not known in advance, and it is difficult to gather information relating to all non-highway related factors. For example, certain social groups frequently control certain areas of the community, and thus economic activity may be linked to a limited area, and land development may be strongly influenced by the local power-structure. For these and other reasons, it may not be possible to find an ideal control area.

In practice, the survey-control area approach does not give any information about the spatial distribution of the impact unless the survey area is divided into sectors, bands, etc. Usually, this has not been done. Figure 3, p. 12, shows survey and control areas as selected in an actual study. It is obvious that the effect of the different factors will not be evenly distributed over the two areas. When the average value for each area is used, the character of this spatial distribution is lost, and thus the interpretation of any results of the study would be extremely limited.

The same figure also illustrates that these two areas, as chosen, could not be used to describe the effect of changes in the total transportation system if the changes were more extensive than merely the construction of the bypass route. Changes in rail or air service and alterations in local traffic conditions could affect the survey area and the control area differently, making it impossible to measure the total effect of changes in the transportation system.



Source: Buffington, "Economic Impact Study, Huntsville, Texas." Texas Transportation Institute, Bulletin 38, 1967.

A map showing the relationship of the study and control areas to Huntsville and the transportation facilities in 1964.

Figure 3. Example of selected survey and control areas.

While the survey-control area approach has offered an apparently scientific way to determine impact in a limited survey area, providing the requirements for the selection of a control area can be met, the method cannot be used to study the effect on the entire community. The community effect will include the effect in both the survey and the control areas; consequently, the "zero" effect in the control area, as well as all degrees of effect up to the maximum in the areas adjacent to the new highway facility, are of interest. This is illustrated in Figure 4, p. 14. The average community effect depends on both magnitude and spatial distribution of the effect on the entire community area.

In a small community it probably would be difficult to find any control area not influenced by major changes in the transportation system. A new facility will possibly cause new activities to be established, but it might also cause already established activities to move from their old locations to sites closer to the new facility. Thus, because of limited resources and the relatively small number of activities in a community, it is likely that there will be a shift in the spatial distribution of activities affecting the entire area. This is illustrated in Figure 5, p. 15. According to the assumptions of the survey-control area technique, the highway impact is measured as the change in the survey area minus the change in the control area. As a result, any negative effect in the control area will actually contribute to an increase in the total measured highway impact. Such a situation may occur frequently in small communities where major changes in the transportation system will cause businesses to move, resulting in both positive and negative effects in the area as indicated on Figure 5.

Thus, although the survey-control area approach is designed to correct for the limitations of the simple before-and-after study, in practice and in theory it has not been wholly successful. The problems involve finding a suitable control area, identical to the survey area in all respects <u>except</u> for the change in the highway facility, and isolating the impact on the survey area from the impact on the control area. The multitude of highway and non-highway related factors which are involved in the changes to be measured create a more complicated situation than the assumptions of the survey-control area method would account for.

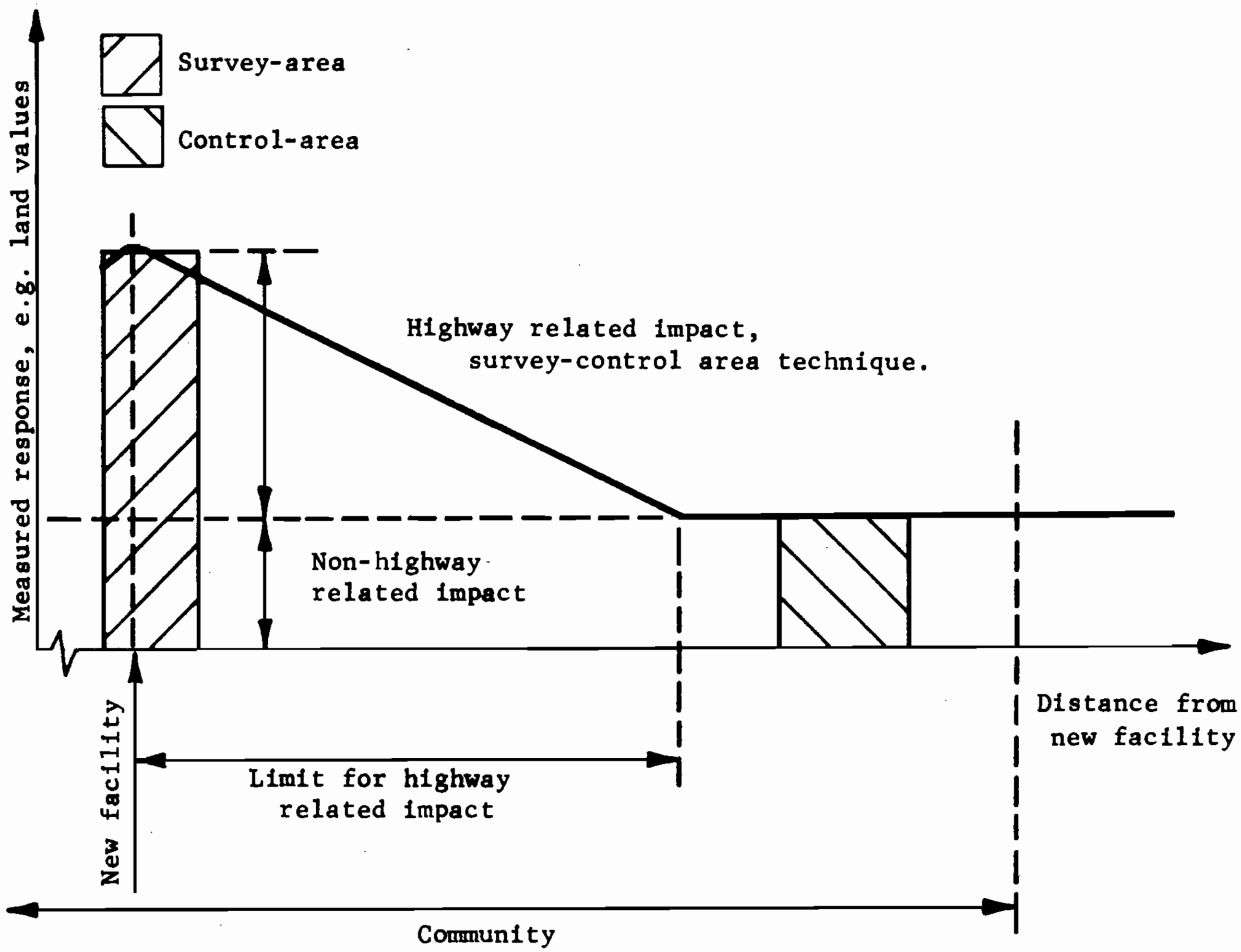


Figure 4. Survey-control area study technique.

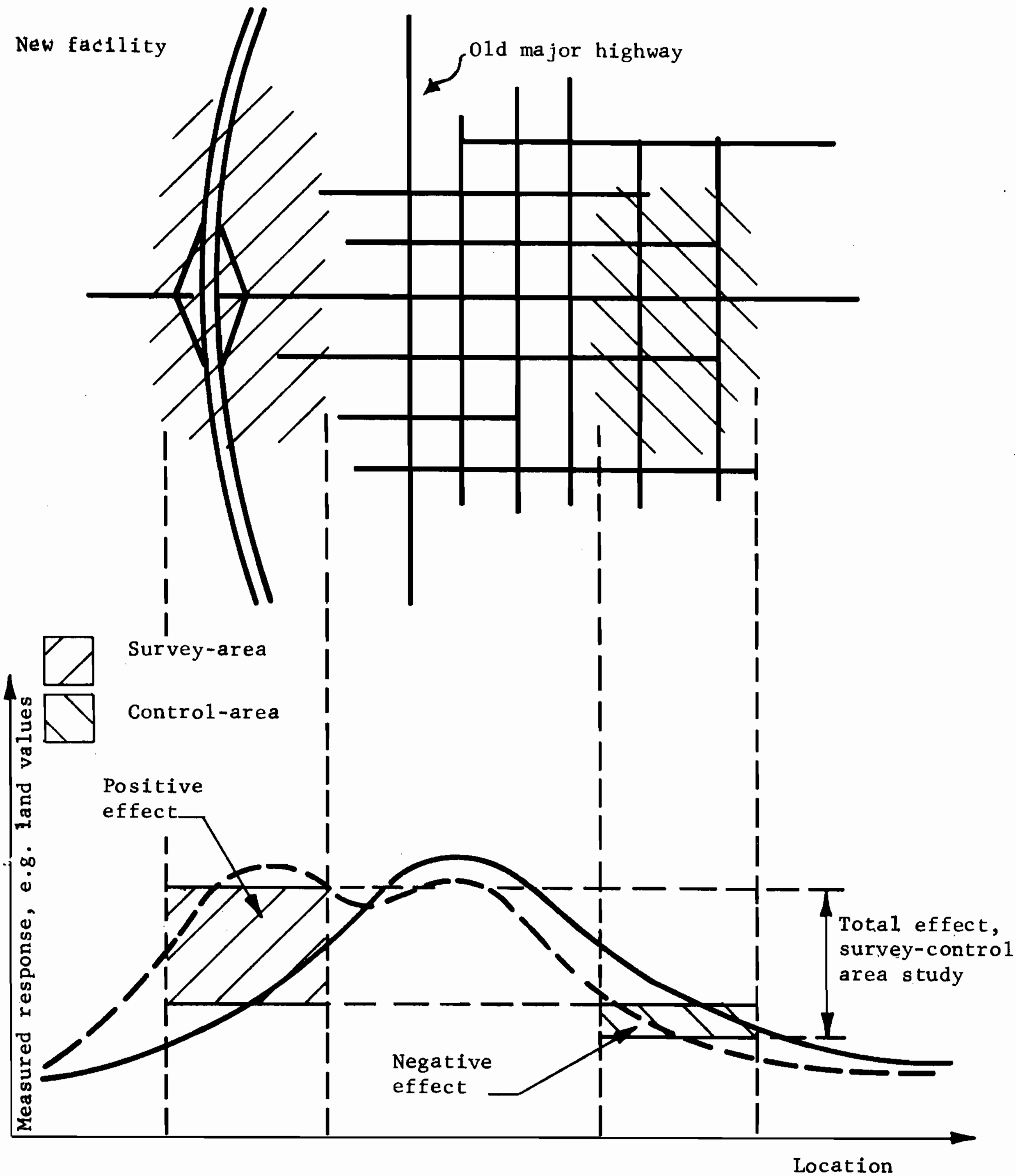


Figure 5. Spatial distribution of highway impact.

Multiple Regression Analysis

This technique requires more information about the non-highway related factors than the other techniques, and it has in most cases been used when appropriate control areas could not be found. In this method the highway impact is isolated by examining both highway-related and non-highway-related factors. Consequently, the technique is not strictly limited to the analysis of highway impact, and it may also be used to analyze the complex cause/effect relationship in a more complete manner than do the previously described approaches. In practice, however, it has not been possible to include all relevant factors because of the lack of general knowledge about how to determine relevancy or how to quantify qualitative characteristics. At the same time, it is not always possible to gather sufficient data on those factors whose significance is known. However, these limitations do not apply to the methodology as such but rather to its present state of development.

The dependent variable in the regression equation is the specific area effect to be studied, e.g., land development or land value; the independent variables are all the relevant factors contributing to any part of the effect to be measured. By ordinary regression analysis, the best regression model can be found. The degree to which the included variables can explain the effect and an expression for the model's accuracy can be found.

In order to get a meaningful expression for the effect, all of the factors included in the regression model must be represented quantitatively. This creates great problems because many factors are qualitative, and no technique to give them a meaningful quantitative representation has yet been evaluated. This problem should be overcome, however, as more knowledge about the different factors involved in highway impact is acquired through future research.

Multiple regression analysis may be used together with a refined before and after approach to reveal information about changes in some community characteristic, e.g., land value, due to changes in both the transportation system and other aspects of the community.

It is important to be aware of the limitations connected to a regression model, especially since in most cases the model may seem to be general in character. The "best regression model" is entirely an empirical equation based on a given set of data, and it is not known whether the model can describe the effect when the range of any factor is extended beyond that in the data set previously analyzed. As "time" usually will be one factor in the model, it cannot be used for prediction of future impact unless certain assumptions about the future are made.

Case Studies

The case study approach deals with rather detailed analysis of specific events which have taken place. Such events may be as simple as the decision to construct a new industrial plant in a given location or as complicated as the whole set of events involved in the construction of a new transportation facility. The case study can be an intensive examination of the entire situation in one specific area. Consequently, although detailed knowledge about the cause/effect relationship in the specific case may be obtained, the findings are not claimed to be general.

The value of a case study lies in the possibilities for detailed analysis, and thereby in providing experience on which broader studies of more general character can be based. Since general studies have to cover a wide spectrum of different cases, it is important to identify the most significant factors, to determine what information is available, and to establish the most efficient way of data processing and analysis.

Other Techniques

Techniques other than those discussed above have been used, but to very little extent. The major reason for this lies probably in the degree of complexity of the models and in the subjectivity of their assumptions.

One of these techniques is the "projected land use - value relationship approach." This technique is used for examining changes in land value, and it tries to take account of the close interaction between land use and land value as well as the acceleration or deceleration in land development. Realizing that land use may change in any case, highway improvement or not, the after situation cannot be directly compared to the before situation. To get a correct picture of the impact, the situation after highway improvement will have to be compared with a hypothetical projection of the before situation. Thus the researcher will have to make some general assumptions or do a thorough job of projecting land use development as it might have occurred supposing that no highway improvement took place. Because of the lack of sufficient information about trends in land use development in the before period, the projections often will have to depend on personal judgement and subjective assumptions. Personal judgement will also always be involved in determining land values in connection with the projected land use.

The projected land use - value relationship approach may be valuable in connection with other techniques. The projected land use may serve as a check on the appropriateness of control areas selected, or as a check on the actual highway impact affecting land use in an area close to a new highway facility.

A similar technique for evaluating the differences in impact on business activity in different locations is the "neutral road approach." Since the neutral facility cannot be physically constructed, it is a hypothesized road which can handle future traffic without causing any change in existing trends in land use development or business growth. The basic reason for adopting this approach is the necessity for retaining a perspective on over-all possibilities for area business volume in the future. It is expected that alternative highway locations will result in different predicted business volumes. The measurable effect is not the variation of each alternative from the neutral road, but the differences among the variations, which theoretically should be the result of facility location and design.

MAJOR SHORTCOMINGS OF PREVIOUS STUDIES

This discussion of the most commonly used methodologies in the previous transportation impact studies has revealed several shortcomings which should be observed when planning comprehensive impact studies. The comments should, however, be seen in connection with the actual study planned, and, consequently, simpler methodologies might be used for studies of limited character.

Most of the previous studies are limited in that they concentrate on a narrowly-defined study area. In studies of small towns in rural areas the entire community has to be included in order to provide a true picture of the total effect. In such communities, with limited resources and few existing activities, an increase in the activities in one particular area may have a detrimental effect in other areas of the community.

Today, the private automobile is the most common mode of transportation in the United States. In spite of this, an impact study should include in its analysis any transportation mode available in the community during the time period under consideration. Again, small communities may be very sensitive to, e.g., changes in railway services simply because in many cases they owed their initial development to rail transportation.

Many of the previous studies fail to give a good description of the total transportation system and other important community characteristics both before and after the improvement. For this reason it is difficult to see which factors of the improvement are the most decisive and in what types of communities they will cause the specific effect predicted.

As a last major point, it may be added that the studies reviewed reveal little information about the time when an effect occurred relative to particular human decisions or physical changes. Public hearings, right of way designations, highway construction -- all are particular moments in a process and cannot be detached from the total cause/effect relationship.

REQUIREMENTS FOR FUTURE RESEARCH

In order to compensate for the limitations discussed above, an ideal study methodology will have to meet the following requirements:

(1) The study period must be long enough to include all the important changes in both the community and the transportation system.

(2) The study should be continuous over time to reveal the general trends in community development both before and after changes in the transportation system.

(3) The geographic limits of the study area must incorporate the entire community, including extraterritorial controls.

(4) The effects on the community examined must include all physical, social and economic factors of importance for characterizing the community and for measuring the community's potential for growth and development.

(5) The study of the transportation system must include all of the modes serving or influencing the community, and the study method must make it possible to determine what characteristics of the transportation system are of the greatest importance for community development.

The many weaknesses of the "before-and-after" and the "survey-control area" approaches would be overcome by employing a continuous long term study period. It would be necessary to make the study period continuous over the entire term, before, during, and following major changes in the intercity transportation system. This makes it possible to relate previous community conditions to later responses to change. Figure 6, p. 21, shows briefly the proposed technique.

The major feature of this approach is the ability to relate the indicator (s) under study to previous changes both in the transportation system and in the community itself. As an overall approach, it should be suitable to any indicator capable of study, even though it is perhaps not feasible to use statistical analysis for all indicators. These may vary from directly measurable indicators, e.g., land value, to such less quantifiable indicators as the changes in community political and social structure. This general approach should make it possible to reveal the relationship between the effect in a community and the factors producing the effect. Consequently, for any case, it should be possible not only to describe what happened, but also to explain why it happened. Once the effects of transportation impact are more fully understood, it should be possible to develop more precise modeling techniques for those aspects of community change which can be related directly to changes in the transportation system.

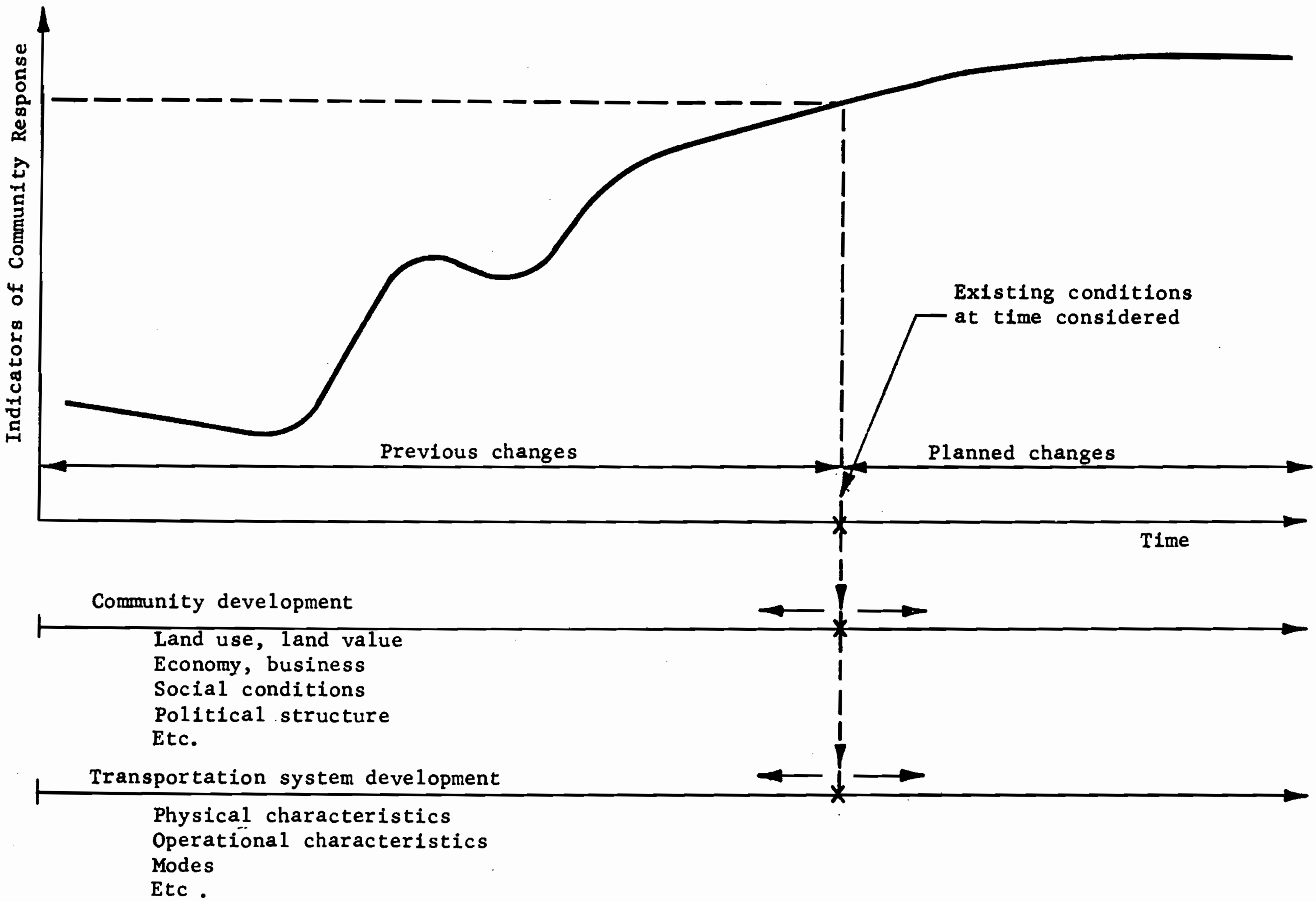


Figure 6. Continuous study approach.

CHAPTER II. ECONOMIC BASE AS AN INDICATOR OF ECONOMIC IMPACT

II. ECONOMIC BASE AS AN INDICATOR OF ECONOMIC IMPACT[1]

One of the most important indicators of economic change in a community is change in the "economic base." The economic base of a community consists of those economic activities which produce goods or services that are consumed by residents or businesses in other areas. When the economic base of a community changes it will usually have a dramatic effect on all the economic activities in the community. This is caused by the strong relationship between economic base and total community income. When community income fluctuates, expenditures in retail sales and services will also change. Thus, the change in economic base activities can have a direct influence on the economic health of the entire community.

If the community has a strong economic base, then it is likely to have strong economic ties to other communities within the region. That is, it produces a good or service that is consumed in other places, and it is likely that other communities provide goods or services that are consumed in the community under study. The prospects for economic growth are much greater for the community that has a strong economic base (or the potential for one) than for the community with little or no economic base.

Employment in economic base activities is referred to as basic employment. Basic employment normally falls into the categories of farming, fishing, mining, manufacturing, and construction, but it may also include some people who work in service establishments that cater to non-community residents. Employment in a local manufacturing plant, feed lot, food processing plant, or tourist attraction would be considered basic employment if most of the products or services are sold to people from outside of the community.

Employment data is most often used as an indicator of economic base because it is relatively easy information to obtain. There are some drawbacks, however. Employment information will not reflect changes in productivity and may, in fact, indicate the opposite impact. Also, employment data does not compensate for differences in wage levels among industries.

[1]For more detailed information see Appendix I, Exhibits 2 and 3.

But, due to the limited resources usually available to conduct economic base studies in rural areas, an employment approach can be quite useful if the drawbacks are recognized and accounted for.

Manufacturing employment change seems to provide the most consistently reliable information on the relationship between change in transportation and change in economic base activities. Although manufacturing employment is only one type of economic base activity, it seems to be well suited for studying the impacts of transportation in rural areas.

A change in transportation, and thus accessibility, may alter the position of a city in the urban hierarchy. Manufacturing employment would be more susceptible to change in accessibility than farming or mining because it is not tied to a particular resource location. Manufacturing employment is less seasonal than economic base activities based on services provided to tourists and vacationers and therefore would be a better predictor of the long-term growth prospects of a community than service oriented economic base activities. Construction employment in small towns is normally a non-basic (local) activity and therefore would be an adequate measure of changes in economic base. Change in manufacturing employment, then, would appear to be the best measure of change in economic base in rural areas.

RESULTS

The research effort to determine the impact of transportation change on manufacturing employment revealed some interesting information. There appears to be a linear relationship between transportation change and manufacturing employment, but this relationship is different for different size cities. Also, while transportation may play a significant role in the decision to locate in a particular area, it is not perceived as particularly important by decision-makers.

The study shows that for rural towns of different sizes, different factors may assume more or less importance in influencing the growth of an economic base. Most outstanding of the examples is the importance of the nearest large population center or SMSA. Proximity to an SMSA is found to favor manufacturing growth in the larger rural towns while the reverse is true for smaller rural places (under 3,000). Likewise, the importance of rail is evident in that range of towns with a population of 701 - 3,000 while not differentially significant to manufacturing growth in the smaller or larger towns. Since studied rail service in larger towns is ubiquitous, this suggests the developmental importance of the rail factor. Whereas highway access is most critical to smaller rural town manufacturing gains, gains in the larger rural towns were most influenced by population. Population, as has been noted, is a consistently important variable and may, to a certain extent, represent the attractability of the service sector of the town.

In general, the impact of upgrading a highway seems to have had only a slightly more positive effect on towns near an interstate in Texas over what would have occurred along a parallel old U. S. highway. This result is attributable to the high quality transportation infrastructure which already existed throughout the area studied before improvements began. This is not to undermine the importance of major highways in contributing to the growth of manufacturing employment. In fact, access to a second major highway proved to be an extremely important contributing factor to manufacturing gains. The accessibility to highways was relatively more important to growth in the smaller towns.

A survey was conducted of business leaders who had moved their manufacturing concerns to a rural town after completion of a nearby interstate. The survey results indicated that transportation was a consistent, though not always most important, factor in the decision to relocate. Minimum lot size and land cost differentials were important factors in choosing a rural rather than an urban area. The most important factor in choosing a rural area was lower labor costs. In general, the survey results showed that larger businesses are more responsive to the degree of transportation access than are the smaller companies. The regional planner can use his knowledge about the relationship between transportation change and growth in economic base in two related ways. First, the regional planner will be able to assess the potential economic effects that a proposed transportation change will have on communities in the region. Second, the knowledge of potential impacts can facilitate the choice among alternate routes within an intercity transportation corridor by making it easier to determine how to maximize economic growth in the region through the placement of a transportation facility. Once a corridor has been determined, the choice of a particular route is often decided on the basis of cost, i.e., the cost of constructing the facility, not the cost or benefit of the economic impact on communities within the corridor. The inclusion of impacts on the economic base of small communities should make the decision to locate a particular facility more responsive to community desires for economic growth.

TRANSPORTATION IMPACTS AND MANUFACTURING

Approaches to evaluating economic impacts of transportation improvements may generally concern themselves with one of three areas of impact: (1) selected interchanges, (2) the transport corridor, or (3) the network and/or system. Economic changes are changes which occur in a determined spatial structure. At the interchange level, impacts on land values and land use may constitute a new spatial organization albeit on a very small and perhaps temporary scale. Highway impacts at this level are well documented and are generally comprised of commercial starts.[2] Furthermore, in a study of rural interchanges along interstate highways in Pennsylvania, Sauerlender (1966) noted that almost no industrial development occurred on land contiguous to the interchange but rather in or near towns in the vicinity.[3]

Examination of transportation corridors in their entirety has involved essentially the same variables as interchange analysis but includes a specified area on both sides of the route to be studied. This approach has been utilized in urban or developed areas to predict relocation of residential and commercial land uses.[4]

Approaches to manufacturing location on a regional scale have been, for the most part, based on traditional location theory, although the role of the transportation system has largely remained an unintegrated variable at least

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[2]See, for example, Lidvard Skorpa, et al., Transportation Impact Studies: A Review with Emphasis on Rural Areas, The Council for Advanced Transportation Studies, The University of Texas at Austin, October 1974.

[3]Owen H. Sauerlender, Robert B. Donaldson, Jr., and Robert Twardk, Factors That Influence Economic Development at Non-Urban Interchange Locations, Research Publication Number 48, Institute for Research on Land and Water Resources, Pennsylvania State University, 1966.

[4]Skorpa, et al., op. cit.

in empirical studies in the U. S.[5] The technique most often applied is essentially a short-term, before-and-after, documentation of plant starts or relocations on a given transportation route on the one hand, and a survey of locational preferences on the other. Such approaches have tended to underscore but not quantify the directive forces of transportation forms and point to other important variables in location choice within a limited geographic area. In a predominantly urban context, Bone and Wohl (1959) studied the relocations of industries in the Boston area subsequent to the completion of a 25 mile segment of Route 128.[6] Although perhaps influenced by many other contributing factors they found a significant shift of industries in the Boston area, specifically from the central city to locations on the new highway. Through survey studies they determined the four most important factors considered in relocation were (1) land for expansion, (2) availability of labor, (3) employee accessibility, and (4) commercial accessibility. Voorhees (1970), in his study of the growth of manufacturing in ten large cities in the U. S., also found "available land" as the most important variable.[7] Accessibility was also noted. Breese (1954), however, looked at transportation as one of many factors in a comparative analysis of plant locations of a partly rural county in New Jersey and concluded that the transportation system was the primary influence on industrial plant location and that taxes, utilities, etc., were only of marginal importance.[8] This conclusion was based primarily on the coincidence of plants and networks and on the homogeneity of the other comparative factors throughout the county.

The coincidence of manufacturing location and transportation change was also noted by Rhodes (1960), who found that of all the manufacturing concerns

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[5]Work has been done for developing countries, although application of findings may be of doubtful use in the U. S. See, for example, B. J. L. Berry, An Inductive Approach to the Regionalization of Economic Development, University of Chicago, Department of Geography, Research Report 62, 1960.

[6]A. J. Bone and Martin Wohl, "Massachusetts Route 128 Impact Study," Bulletin 227, Highway Research Board (1959), pp. 21-49.

[7]Alan M. Voorhees, "Urban Growth Characteristics," in A Geography of Urban Places, by Robert Putnam, Frank Taylor and Philip G. Kettle, (Eds.), London: Methuen Publications,

[8]Gerald Breese, Industrial Site Selection, The Bureau of Urban Research, Princeton University, 1954.

that located in Indiana between 1957 and 1960, 44 percent located within a distance of 22 miles from the Indiana Turnpike.[9] In Alameda County, California, following the construction of the Eastshore Freeway, 43 percent of the total new industrial development occurred within an area "most subject to highway influence," comprising only 9 percent of the acreage of the county.[10] Industrial expansions along the New York State Thruway have also been noted.[11]

As to predominantly rural areas, Burch (1956) noted the overall benefits derived from secondary road improvements in North Carolina and suggested the improved network accounted in part for the fact that at that time 25 percent of the new industries locating in North Carolina were locating in rural areas.[12]

Hansen (1971) found a significant correspondence between rural counties classified as "consistent fast gainers" in population and proximity to an Interstate Highway or other limited access divided highway, although he emphasizes the concommitant influence of nearness to an Standard Metropolitan Statistical Area.[13]

In terms of location preferences and the importance of transportation, Kiley (1964) did a survey of 4,000 firms in the United States which had changed, expanded or located during 1955-56 to determine the most important factors in the location decision.[14] Thirteen location factors were tested

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[9]Farwell Rhodes, "Toll Factors for the Indiana Turnpike," Traffic Quarterly, Vol. 14, No. 1, (January, 1960), pp. 26-35.

[10]Highways and Economic and Social Changes, U. S. Department of Commerce, Office of Research and Development, November 1964, p. 54.

[11]Ibid., p. 54

[12]James S. Burch, "The Secondary Road Program in North Carolina," Bulletin 147, Highway Research Board (1956), 27 pp.

[13]Niles Hansen, The Future of Nonmetropolitan America, Lexington, Massachusetts: D. C. Heath and Company, 1973, pp. 25-28.

[14]Edward Kiley, "Highways as a Factor in Industrial Location," Highway Research Record Number 75, Highway Research Board, 1964, pp. 48-52.

in the survey. Access to good highways was ranked as the first in importance in 11 of 22 manufacturing S.I.C. classifications, and access to rail service was ranked fifth overall.

Greenhut also found transportation, in terms of transport type and cost, to be an important factor in the location of several manufacturing concerns in Alabama.[15] There is also evidence that for some firms a combination of modes is an important influence. Bowersox (1960) interviewed six manufacturing industries in Michigan to determine the importance of accessibility to a major highway in the location decision and found it to be an increasingly important variable since most of the firms were relying more heavily on motor transport.[16] Although only one of the firms set specific standards for a highway facility to be considered, none would consider locations which did not offer "adequate" highway facilities.

If transportation serves to organize areas, and attract industry as well, then conversely the lack of sufficient transport facilities has been blamed for the lack or loss of manufacturing base. In March of 1965 the Appalachia Redevelopment Act was passed, the major portion of expenditures being earmarked for the construction of a major highway network linking the depressed region internally and with more prosperous areas. The underlying premise for highway funds was that the lack of economic development had been to some extent the result of inadequate accessibility of areas in the intra- and interregional transportation system. It is significant that between 1965 and 1969 46 percent of the 1,149 new industrial plants locating in the Appalachia region located within 10 minutes of an interstate or development highway.[17]

The thrust of these studies was at the least to document location and relocation in light of improvements to a transport network, and at most to

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[15] Melvin Greenhut, Plant Location in Theory and Practice, Chapel Hill: North Carolina University Press, 1956.

[16] Donald S. Bowersox, "The Influence of Highways on Selections of Six Industrial Locations," Bulletin 268, Highway Research Board (1960), pp. 13-28.

[17] Carl W. Hale and Joe Walters, "Appalachian Regional Development and the Distribution of Highway Benefits," Growth and Change, Vol. 5, No, 1, (February, 1971), pp. 3-11.

suggest some of the influences on the location decision. Statements on the spatial impacts of this process, however, have been limited. Bone and Wohl noted in passing the outshift of industries from Boston to locations on Route 128. The trend to "decentralize" in Chicago was also observed by Reinemann (1960).[18] He found that between 1946 and 1954, of all the relocations of manufacturing concerns, 16 percent moved from the inner city to the outermost sections and 14 percent moved out of the metropolitan area altogether to locate in nearby small towns. However, causative factors and transportation linkages were not analyzed. Decentralizing tendencies are also noted in a number of studies undertaken for the Department of Commerce, Bureau of Public Roads, but again with no specific inferences to a larger spatial order.[19]

INFRASTRUCTURE AND GROWTH

Certain studies further suggest the applicability of approaching transportation impacts from a hierarchical perspective. Garrison points out that an important result of transportation innovation has been the process of specialization:

> Unifying large territories politically, relieving congestion, opening new economic areas, and other motivating factors in transportation developments were all worth-while because they introduced efficiencies in the form of specialization: armies could specialize, governments specialize, farmers and manufacturers could act as specialized production agents, and routes themselves were specialized as efficient carriers. Individuals and groups of individuals specialized at places to serve larger areas.[20]

This seems to be supported by empirical studies in rural areas. Stroup (1959) studied the effects of highway improvement in six rural counties in Kentucky

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[18]Martin Reinemann, "The Pattern and Distribution of Manufacturing in the Chicago Area," Economic Geography, Vol. 36, No. 2, (April 1960), pp. 139-144.

[19]Highways and Economics and Social Changes, op. cit., pp. 58-60.

[20]William L. Garrison, et al., Studies of Highway Development and Geographic Change, Seattle: University of Washington Press, 1959, p. 5.

and found an increasing tendency for business to consolidate and centralize.[21] Stores once found in the "open country" tended to relocate in towns and at interchanges and he also found some specialization in the goods offered in each town over a relatively short period of time. C. C. Zimmerman (1938) found a similar concentration in his study of rural areas of Canada.[22] Kolb and Polson (1933) noted the areal interdependence of growth in their study of rural towns in Wisconsin, with larger centers growing rapidly, having absorbed many of the functions of smaller towns.[23]

A study was undertaken by Hale and Walters (1971) to predict economic benefits from an overview of the regional infrastructure of Appalachia.[24] They suggest that the non-Appalachian cities in the "immediate environs" of Appalachia have become more economically linked to the extended Appalachia region than the Appalachian cities, and "since these non-Appalachian cities are already better linked to the rest of the nation than the Appalachian cities, it is likely that a preponderance of the benefits associated with the ARC (Appalachia Redevelopment Commission) highway development program will accrue to the non-Appalachian cities . . ."[25] Their methodology was to develop essentially a growth potential matrix which incorporated (1) an index of accessibility and (2) an index of economic potential (EP). For 35 cities, some of which are contiguous to the Appalachia region, accessibility was determined by travel times among towns and the EP was derived from a gravity model. Increases in accessibility were denoted by reduced travel times between cities (from 1955 to 1972) and the EP was derived on a per capita interaction based on the formula

$$EP_i = (P_i/\frac{1}{n}) + \sum_{j=1}^{n} P_j/d_{ij}$$

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[21] Robert H. Stroup and Louis A. Vargha, "Economic Impact of Secondary Road Improvements," Highway Research Record Number 16, Highway Research Board, 1963, pp. 1-13.

[22] C. C. Zimmerman, The Changing Community, New York; Harper, 1938.

[23] Garrison, et al., op. cit., p. 12.

[24] Hale and Walters, op. cit.

[25] Ibid., p. 4.

where "i" refers to the city being analyzed; there are j=1 . . . n other cities, and "d_{ij}" refers to the economic distance (travel time) between city "i" and each of the other cities. Their conclusion is that the peripheral non-Appalachia cities will benefit more from the highway program and although empirical data on manufacturing is not presented, short term population data is used to indicate the validity of their hypothesis. An empirical analysis of manufacturing location also using the gravity concept, although not including transportation as an explicit consideration, is that of Duncan (1959). Duncan gathered data on percent of labor force employed in manufacturing industries for 100 non-metropolitan SEA's in the U. S. for 1950.[26] Locating the nearest metro center, she grouped the population into totals for concentric bands with radii of 150 miles and divided the population total by the distance from the metro center to the midpoint of each successive band to arrive at a population "potential" index. Using the populating potential and a control variable which represented "degree of urbanization" in a regression analysis, she found that the percentage of total labor force involved in manufacturing employment varied inversely with distance from a metro and directly with the population potential.

However, using data aggregated to the county level, a Department of Transportation report (1974) classified the counties of nine planning regions in Iowa as "central place" or "hinterland" counties and comparing manufacturing employment growth from 1960-1970 suggested a more rapid relative growth of manufacturing employment in the hinterland counties.[27]

A recent attempt was also made to adapt a simulation model to evaluating proposed changes to the transportation network. Putnam (1973) describes a model used to predict changes in the spatial distribution of economic and demographic activity in light of transportation alterations in the northeast

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[26] Beverly Duncan, "Population Distribution and Manufacturing Activity: The Non-Metropolitan U. S. in 1950," Papers and Proceedings, Regional Science Association, No. 5, 1959, pp. 95-103.

[27] Engineering Research Institute, Iowa State University, Integrated Analysis of Small Cities Intercity Transportation to Facilitate the Achievement of Regional Urban Goals, prepared for the U. S. Department of Transportation, June 1974.

corridor of the U. S.[28] The model measures economic activity by (1) employment totals (both basic and non-basic) and (2) personal income. The model begins with a large scale econometric model which sets "control totals" for a smaller interregional input-output which in turn sets control totals for an intersectoral area model. Transportation as a variable is measured in terms of accessibility in a rather different way from gravity models. It is a function of impedance, i.e., (1) the costs involved in obtaining inputs for production and (2) the costs of transport to market. The region involved in this model is extremely large, and the model has been only partially tested. A similar model by Amano was developed, but its major concentration was on traffic generation and land use impacts.[29]

Little empirical analysis has been done, however, on the "function" of manufacturing in the hierarchy approach. Central place studies have been devoted almost exclusively to retain goods and services. Manufacturing has been assumed to be largely an urban activity given the increased concentration and growth of fast growing industries in urban centers over the last century. This concentration has been largely attributed to the benefits of external agglomeration effects. Agglomeration effects are those forces which reduce costs of production and/or increase market outlets due to proximity to other industries and/or the market. These advantages accrue to a given industry when, for example, it locates near an auxiliary industry from which it purchases a service. The sharing of that service among many industries tends to reduce its cost. There are institutional agglomerative advantages as well. The availability of capital in urban centers, tax adjustments and low interest rates are inducements of an agglomeration. Greenhut suggests that "these agglomerating advantages are the governing factors in location whenever transportation and labor differentials at alternative sites are relatively slight."[30]

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[28] S. H. Putman, "Developing and Testing an Interregional Model," Regional Studies, Vol. 4, No. 4 (December, 1970), pp. 473-490.

[29] K. Amano and F. Masahisa, "A Long Run Economic Effect Analysis of Alternative Regional and National Transportation Facility Plans," Journal of Regional Science, Vol. 10, No. 3 (December 1970), pp. 297-323.

[30] Greenhut, op. cit., p. 11.

Hansen criticizes traditional location theory for not illuminating sufficiently the extent of the impact of agglomeration:

> It should be emphasized that the advantages of larger urban areas cannot be simply explained by the traditional economic base approach because it really never came to grips with the dynamics of the process by which an area amasses overhead capital and by which it acquires new export bases. Similarly, classical location theory, including central place theory, relied too heavily on static analyses . . . [31]

More recent data, while not unqualified support for a reversal of this trend suggest the viability and growth of certain kinds of manufacturing in rural areas. Nationally, rural and partly rural counties, with only a tenth of the manufacturing jobs in 1960, accounted for about a fifth of the gain in manufacturing workers in the 1960-70 decade.[32] (See Figure 7) Between 1960 and 1970 the nonmetropolitan South actually outstripped the metropolitan South in absolute manufacturing employment gains.[33] Furthermore, Duncan's study (1960) of the correlation of city size and 14 manufacturing SIC classifications in cities in the U. S. suggests some degree of hierarchical arrangement which appears strongest in the South.[34]

The growth of the manufacturing function in some rural towns and not others is accounted for by a variety of factors, not all of which are included in this model. There may be personal preference factors, production or marketing factors which lie beyond the scope of this type of analysis. Within the context of urban hierarchy, however, the basic premise employed is the relationship between functional organization and spatial distribution when the "functions" are defined as basic (export) economic activities. The importance of the role of the basic sector in stimulating the secular growth

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[31] Hansen, op. cit., p. 8.

[32] U. S. Department of Agriculture, The Economic and Social Condition of Rural American in the 1970's, prepared for the Senate Committee on Government Operations, 1971, p. 55.

[33] Niles Hansen, Factors Determining the Location of Industrial Activity in Metropolitan and Nonmetropolitan Areas, Discussion Paper Number 50, Center for Economic Development, The University of Texas at Austin, July 1972, pp. 17-20.

[34] Dudley Otis Duncan, et al., Metropolis and Region. Baltimore: Johns Hopkins Press, 1960, pp. 65-75.

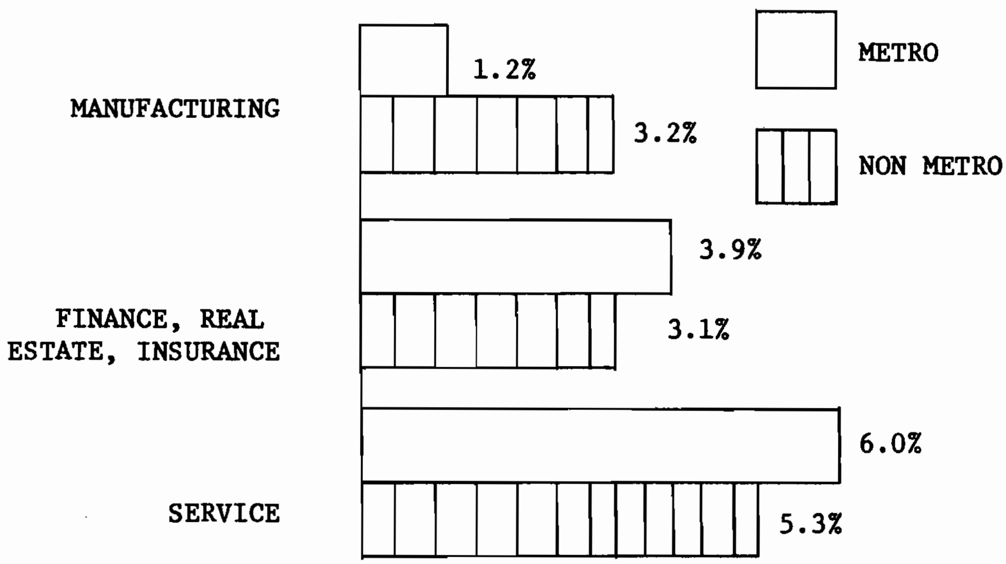

Figure 7. Employment gains for some industry groups 1960-1970

of areas has been suggested by Hoyt (1969) who found strong correlations between manufacturing gains and population growth in predominantly urban areas in the nation as a whole.[35] Likewise, Thomas (1969) has described the dynamics of regional growth as a function of the development of its basic sector.[36] This development encourages service sector growth as well as increased quality of service which in turn attracts more industry. Garrison (1972) notes the positive multiplier effect of the location of basic industry on rural towns in a study undertaken in Kentucky.[37] For the purpose of this study, all manufacturing concerns are considered to be essentially basic industries.

The variables used in this type of analysis then are essentially based on an assumption of interrelatedness between each rural town and its nearest SMSA and/or next larger town. Distance being measured in terms of miles.

Accessibility to U. S. Highways and the Interstate System is measured in terms of travel time from each town. This notion of accessibility differs considerably from many accessibility measures. It measures accessibility to key networks of the transportation system itself. It is, to that extent, an absolute measure of accessibility to the infrastructure, not a relative index such as many regional accessibility indices which incorporate accessibility as a function of linkage to all other centers in a closed system. This is not inconsistent with the concept of urban hierarchy and along with the other variables will tend to aid in isolating statistically the impacts of the improved network.

The role of transportation in the regional context has been generally described as one of "integrating" rural communities. Various methods of

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[35]Homer Hoyt, "The Importance of Manufacturing in Basic Employment," Land Economics, Vol. XLV, No. 3 (August, 1969), pp. 344-358.

[36]Morgan Thomas, "Regional Economic Growth: Some Conceptual Aspects," Land Economics, Vol. XLV, No. 1 (February, 1969), pp. 43-51.

[37]Charles Garrison, "The Impact of New Industry: An Application of the Economic Base Multiplier to Small Rural Areas," Land Economics, Vol. XLVIII, No. 4 (November, 1972), pp. 329-337.

providing indices of economic integration are examined in this section and applications to real-world situations are noted.

These areas are of crucial concern to the stability and growth of rural towns. They essentially provide indices of socio-economic integration as a function of transportation and thus may prove valuable in evaluating the influences of existing and proposed transportation infrastructure in a regional scheme. The resulting indices form a set of characteristics of the towns in a rural area which in turn may be used to establish certain investment priorities or strategies within the region to attain regional goals.

The need for developing transportation planning strategies in rural areas stems from many diverse issues including (1) the need to manage growth and sprawl; (2) the desire to advocate rural economic stability; and (3) the lack of comprehensive planning on a regional scale. The first two issues are in many ways complementary. It is on the political level that growth planning becomes a polarized (growth vs. no-growth) issue, with the result usually being over-industrialized metropoli and underutilized resources in rural towns. The issues which this condition raises have not been delineated fully, in part due to the lack of ability of "rural America" to organize its own united interest group. The case must be pleaded by diverse organizations or by towns themselves on a town by town basis. As an example, one issue of the inequities involved in the lack of planned growth is the rural educational system. Funded by the rural community, the rural school often produces students who are then forced to go to cities to find work, where their services and income do not benefit their rural education system one bit.

Of the first two issues noted above, growth management and rural economic growth, the one that is by far the most politically acceptable is rural economic growth. Yet it is growth management for which effective, useful programs have been researched, planned and even implemented on a regional scale. For example, "phased" or "staged" investment in public utilities expansion and/or transportation links have been utilized in the twin cities development framework and in the Green River Area Development District. The problem in the case of rural economic development is that while everyone agrees with it, few have become involved in the mechanics of it.

Approaching development strageties for rural towns must start with an evaluation of the development potential of the towns involved. Not all rural towns are alike in their resource characteristics, their transportation characteristics nor geographic characteristics. The combination of these characteristics tend to determine the range of economic functions which can be supported in a given town. Thus, studies have shown definite correlations between the range of economic functions in rural towns (the kinds of products and services available) and the towns' distance from large central cities.[38]

In planning for the development of rural towns, then, one must be able to make reasonably accurate judgements as to the combinations of its resource, transportation and geographic characteristics. The process of making that judgement will in essence describe the development potential of the town which, in turn, will also suggest the developmental needs of the town.

There are generally three classes of models used to evaluate characteristics and assign development potentials: (1) gravity models (based on population trends), (2) hierarchy models (based on population plus distance from other towns), and (3) mixed models such as simulation models which incorporate a mix of characteristics to include transportation access, population, and distance from other towns.

LAND VALUE MODELING IN RURAL COMMUNITIES[39]

This study attempts to review and experiment with appropriate modeling techniques for describing and explaining variation in land values within small rural communities affected by changes in the interurban transportation systems which serve them.

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[38] B.J.L. Berry, "Strategies, Models, and Economic Theories of Development in Rural Regions," U. S. Department of Agriculture, Economic Report 128, 1967.

[39] For more detailed information see Appendix I, Exhibit 4.

The study has three objectives:

1. to describe the variation in land value in one community over a twenty-year period;
2. to develop appropriate indices and modeling techniques which could have general application to other small communities; and
3. to identify the areas where further research and evaluation are required.

Transportation planning requires an understanding of how changes in an existing system will affect a community. The effect on land values is important not only because of its direct bearing on a community's fiscal structure and economic development, but also because of the psychological weight which people attach to an externally induced change in property values.

LAND VALUE AS AN INDIRECT INDICATOR OF IMPACTS

Land values are to some extent affected directly by changes in the transportation system. Indirectly, however, they will reflect the many facets of impact on the community. Even though the impact on a specific community characteristic is not of economic character, the impact might have measurable economic consequences. Land value might be an indicator of non-economic impact also. For example, if one aspect of the social impact is increased housing segregation, this will have an influence on the distribution of land values within the residential land use category. As the total community impact is the sum of different types of impact in different locations, land value as an indicator might be used to describe both individual parcels and the entire community.

Indication of Overall Effect

The total land value in a community generally will reflect the economic characteristics of the area. Expressed in terms of dollars per capita or units per area at different times, it might be used to describe the changes which have occurred or the vitality of the community relative to that of other communities. Changes relative to the general land value trend in the area might indicate whether the community is doing "better" or "worse" than the rest of the region. When land use changes to a "better" use, e.g., from agricultural to industrial or commercial, this is generally reflected in land values. Thus a change from an agricultural economic base to an industrial or manufacturing base possibly caused by changes in transportation system can result in an increase in total land values in the area. In other cases, the increase may be localized, or there may even be a net decrease in land values in the community as a whole.

Indication of Spatial Effect

When new transportation facilities are constructed, more land is usually opened for development, thus increasing the supply. If there is no change in demand, or if demand for certain land use categories is merely transferred from one area to another, land values may actually decrease or, in net terms, remain unchanged. In studying individual parcels or neighborhoods, one may assume that changes in land use and land values may reveal the spatial distribution of the total effect. Local changes in both land use and intensity together will determine the growth pattern in the community.

For example, highway-related commercial activities seem to depend upon a location close to the highways with good visibility and accessibility. If the highway facility changes location, these activities will also have to change location. In small communities this consequently means a transfer of an existing activity. Thus, by comparing changes of land values for different categories of land use, the effect of the transportation system change on each land use category may be revealed. The spatial distribution of each land use category will reflect this land use category's dependence upon accessibility to and the quality of the transportation system.

Indication of Social Effect

Changes in social conditions in the community will also be reflected in land values. Shifting social status in a neighborhood may cause land values to decrease or increase. Such a change in social conditions might be a consequence of changes in overall economic structure in the community which again might be an impact from the change in the transportation system. Disruption of a neighborhood, dislocation and so on may cause a shift in residential location of social groups, and thereby influence land values.

DIRECT EFFECTS ON THE COMMUNITY TAX BASE OF CHANGES IN LAND VALUES

It should be expected that changes in land values would have a direct bearing on the annual total tax revenue. However, this is not always the case. Two factors determine whether a change in land values will affect tax revenue: the tax rate and frequency of re-assessment.

As long as the tax rate is lower than the legal maximum tax rate, the total tax revenue is mainly determined by the needs of the budget. Total revenue has to balance total expenditures, and this consideration will determine the amount needed from taxes on local real estate. Both tax rate and total assessed land values might in this case be subject to political manipulation and have no influence at all on the final total tax revenue. In the case of maximum legal tax rates, on the other hand, the total income from local property taxes will be directly proportional to the total assessed property values within the community. Any change in total assessed land values thus may influence the tax income and the economic viability of the community, depending on whether the assessed values are adjusted in order to reflect the real market values.

Right-of-way for railroads is subject to local taxes, but no taxes are paid for land when acquired for public roads. This may be a considerable part of a city, frequently ranging from 20 to 25 percent of the total area. Almost any kind of improvement of the transportation system includes additional taking of right-of-way for the facility. Thus less land is taxed, and, in the case of maximum legal tax rates, the result is a reduction in total tax revenue, unless otherwise compensated for. Perhaps the most frequently used way of compensating for this loss is to extend the community limits, and thus add taxable land.

In some cases the local government has to pay a part of or the entire cost for purchase of right-of-way as needed for improvement of the transportation system. In order to have a net economic gain (when only expenses of right-of-way and loss of revenue from real estate are considered), the increase in annual taxes has to be equal to or greater than the annual amortization of the expenses of right-of-way purchase. It should be noted that the entire purchase of right-of-way has to be finished some years before the main increase in value of the adjacent properties takes place and before there can be an increase in tax revenue caused by the impact of the improvement of the facility.

The intent of this brief discussion has been to show that there is no given answer as to whether or not changes in the real land values, caused by a change in the transportation system, have a direct effect upon local tax revenue. Taxation of real estate is to a high degree a question of local policy and of the need for revenues from taxation. If taxation is based on the real value of the land at a given time, then any fluctuation in land values will be reflected in the tax incomes. However, taxation policies can also be used to stimulate or force a desired land use pattern and are, therefore, not exclusively a way of providing revenues for public expenditures in the community.

LIMITATIONS

Time Lag Between Transportation Change and Change in Indicator

There is always some uncertainty as to the elapsed time between changes in the transportation system and consequent changes in selected measures of impact (in this case, land value). Further uncertainty is introduced when questions are raised as to which stage(s) of the process of improving transportation facilities stimulate(s) changes in the indicators of impact.

To oversome these difficulties, the study will be continuous in time over the entire 19 year study period. Each property transaction will be related to elapsed time after major decisions or actions in community or transportation development. Thus, the continuous trend in land values over the study period will be examined. Figure 8 shows the continuous study approach.

Separating Overall Trends from Transportation-Induced Changes

To properly identify the net effects of transportation changes on the indicator (land value), some notion must be derived of the general trend of the indicator in the absence of transportation changes. Then such factors as land use and population growth would be predicted for the "do nothing" situation and entered in the model. The total impact from any actual change in the transportation system on land values could then be measured as the difference between the areas under the "change" and "no change" curves for land value. This is illustrated in Figure 9.

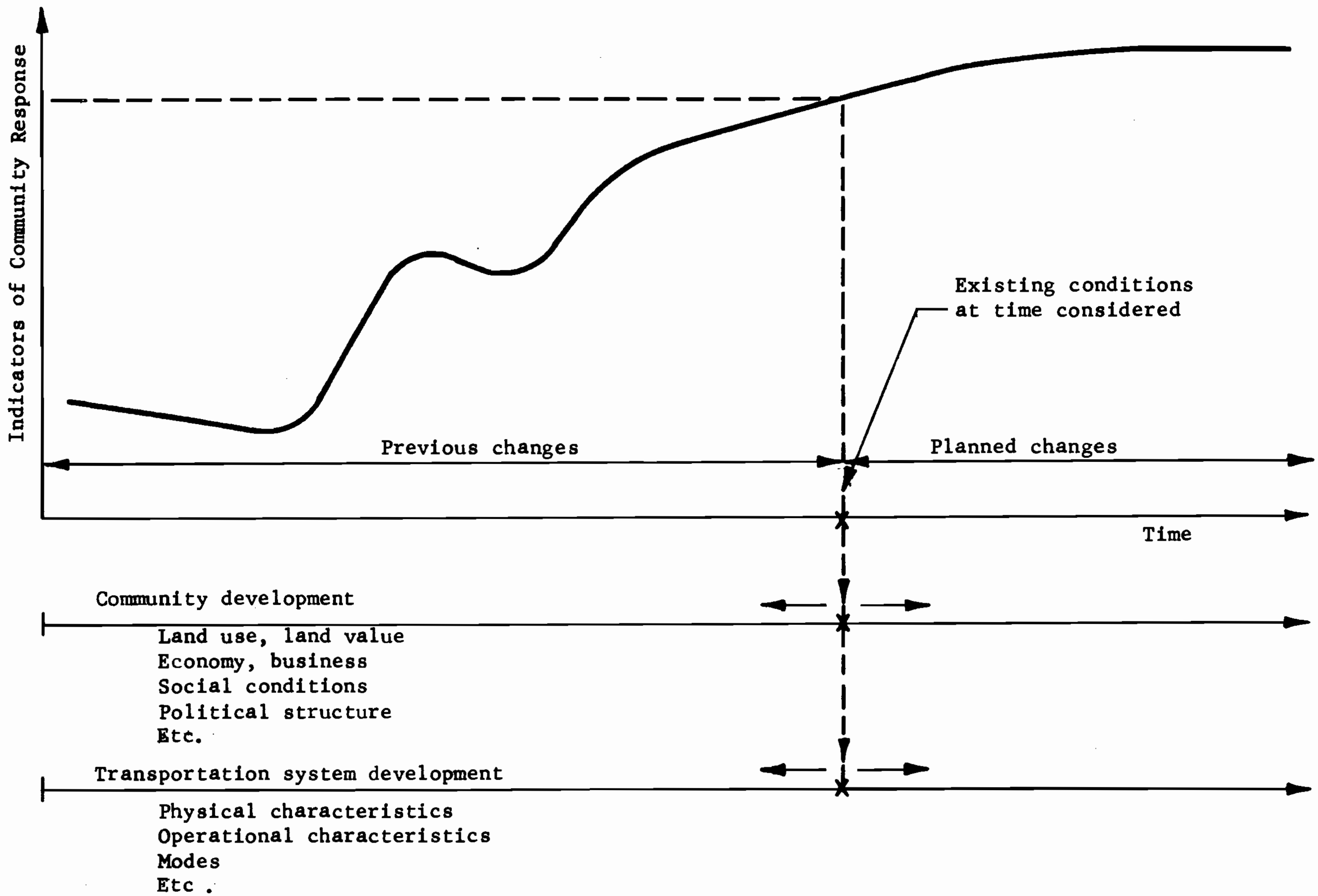

Figure 8. Continuous-study approach.

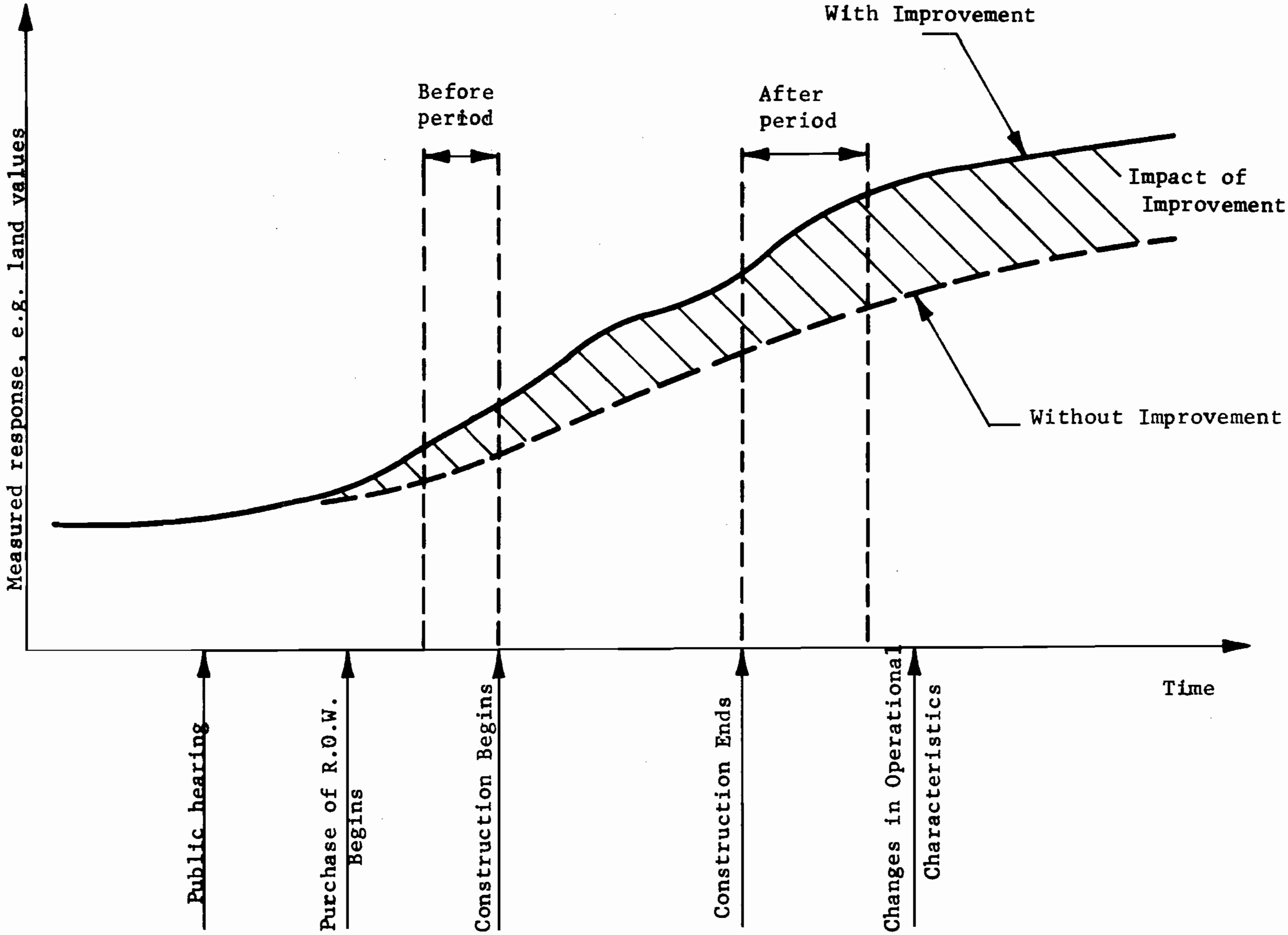

Figure 9. Possible effect of different phases in highway improvement.

Both areas which are adjacent to new transportation facilities and thus likely to be greatly impacted and areas which are further removed and likely to be less or little impacted must be included in a study examining land values. In the present work, the study area includes not only the incorporated city, but also the areas adjacent to the community potentially influenced by the changes in transportation system. This area is shown in Figure 10.

Limitations Inherent in Choice of Measures of Land Value

The choice of method in measuring land values introduces limitations. Consequently, each of the two methods -- appraisal and market value -- has its own advantages and disadvantages in comparison with the other.

Appraisal Method. Appraised value through tax records can be obtained for most land parcels in a study area over long time periods. Appraisals might be taken as a measure of real value since appraisers take time, location, and other factors into consideration. However, there is one major fallacy in this approach. The appraised land value reflects the appraiser's evaluation of how a piece of property differs from a supposedly comparable property and how these differences influence the market value. An appraisal is an estimate based on assumptions about the very determinants of land value which this study seeks to define. Appraised land values thus would bias the statistical analysis designed to determine the actual cause/effect relationship.

Furthermore, appraisals in an area may not be arrived at in a uniform manner. In some instances appraisals may be more subject to the personal whim of the appraiser, political influence, or a need to increase tax revenues than to actual land value trends.

Market Value Method. For this reason only market values from actual transactions will be used in the analysis. Thus, the data will not be influenced by any presumption about which factors are important or how they influence land values. Unfortunately the sales will reflect factors which

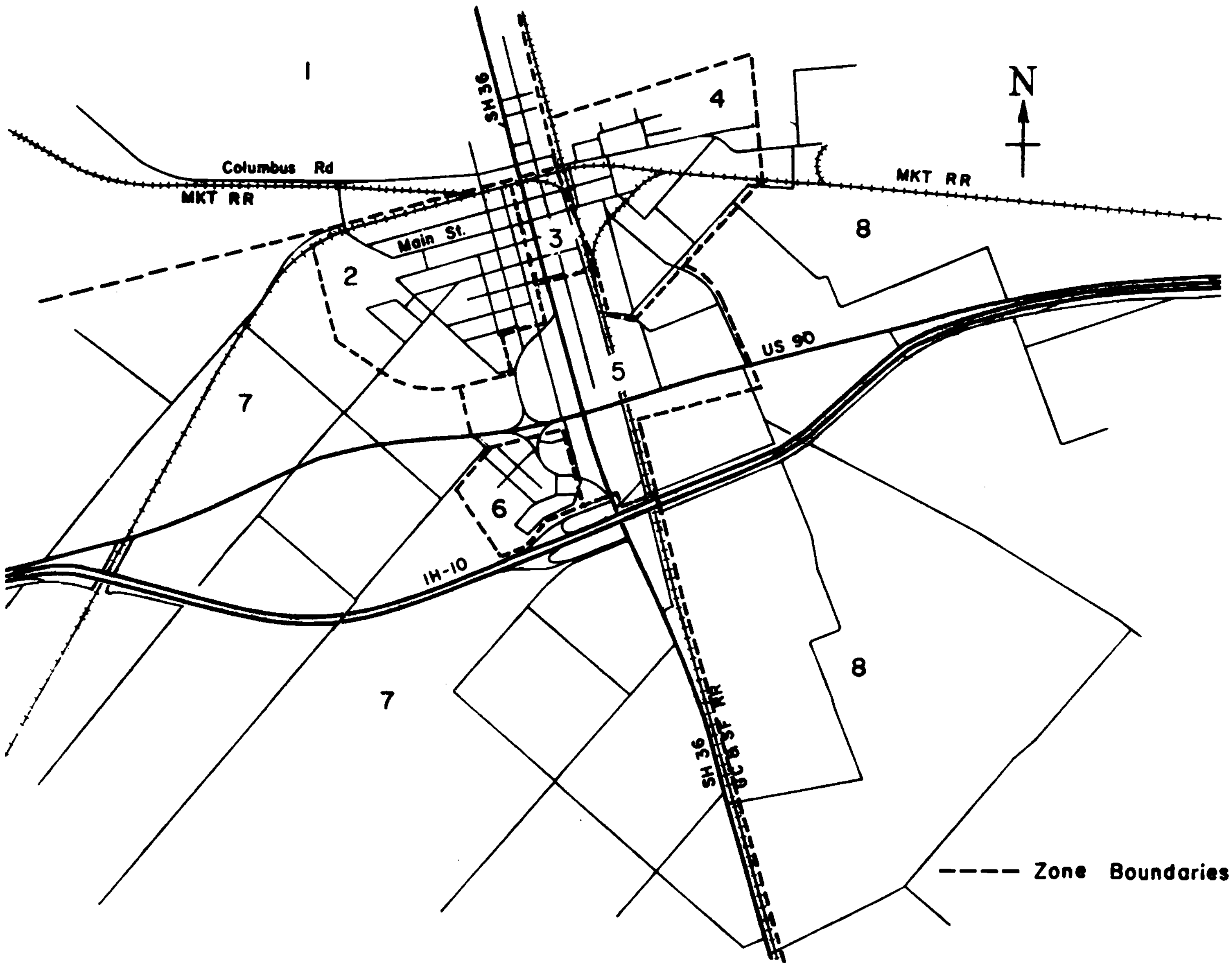

Figure 10. Study area, Sealy, Texas.

are irrelevant in this study, like family-relationship between buyer and seller, forced sales and so on, where the actual sales price is not the actual market value.[40]

There are further limitations to the use of market value from actual sales as a measure of land value. In a study area, only a portion of the properties will be sold during the study period. This raises the question: Do sale prices reflect the overall trend of land value?

There is some reason to believe that transportation improvements cause certain types of properties to be sold more frequently than others in an area, at least in the short run. In areas adjacent to new facilities, parcels susceptible to an immediate change in land use and parcels which are vacant or have limited improvements would be sold more quickly.[41]

Further, not all records of land transactions will include the sale price. In the present study the only readily available source of market land values was the record of title policies from Bellville Abstract and Title Company. The information recorded included the names of the buyer and seller, price, date of transaction, and, in most cases, the size of parcel and the subdivision in which it was located. Not all of the transactions

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[40]As other discussions of impact on land value indicate, the "true value" of all land within an impacted area is difficult to determine or even define. (See, e.g., the discussion by Paul Zickefoose in "Economic Survey of Raton, New Mexico," New Mexico State Highway Department, Bulletin 37, May, 1968, pp. 39-40.) In choosing to base the measurement of land value on sales data alone, one must ignore the fact that land which is not sold also has a value. Sales prices may cause either under-estimates or over-estimates of property values, depending on the economic situation. For example, if only the marginally effected properties in an area change hands, sales prices can under-represent true value; on the other hand, if only the most viable are sold, sales prices can exaggerate average property values.

Nevertheless, since land value is a function of supply and demand, sales prices are indicators of a real market situation for land in a given category. Thus it may be said that although sales price is not an adequate indicator of "latent" or "unrealized" value, it does serve as a description of the actual market at a given time.

[41]William G. Adkins, "Land Value Impacts of Expressways in Dallas, Houston, and San Antonio, Texas," Highway Research Board, Bulletin 227, p. 63.

recorded in the owners' title policies could be used as it was not possible to determine the exact location of all property or the value of some of the other characteristics needed. Consequently the sample is chosen according to the information available, and not according to any sampling technique. This fact will tend to reduce the reliability of the model to be developed, as the social and economic characteristics of seller or buyer may influence who takes out an owner's title insurance policy.

One other difficulty arises from distinguishing between the value of improvements on a sale property and the value which is attributable to the land itself (i.e., its location). Adkins proposes that the purchase price for a parcel which will undergo a change in land use requiring a different type of improvement than was present before the sale will be equal to the land value of the parcel less clearance costs of old improvements plus the salvage value of the old improvements. This complicates the choice of which measure, land value or total market value, should be used as a means of comparing property transactions throughout an area.[42] Where data is available it almost certainly will be in terms of total purchase price. Attempts to separate out value of improvements will be based on assumptions of unknown accuracy and may well influence results from any statistical analysis. The relative proportion between value for land and improvement may vary widely.

In this study total market value was used as an indicator of impact. Further, information was collected which allowed a split of the data set into parcels which were improved or unimproved at the time of sale.

It is assumed that there is an overall relationship between land value and market value, as more money may be used for improvement and structures the more valuable is the land. This assumption is supported by findings from a study on Route 128 around Boston.[43] This study found that, as an overall picture, the value of both land and buildings increased at an approximate equal rate over the study period. The findings from the study are shown in Figure 11.

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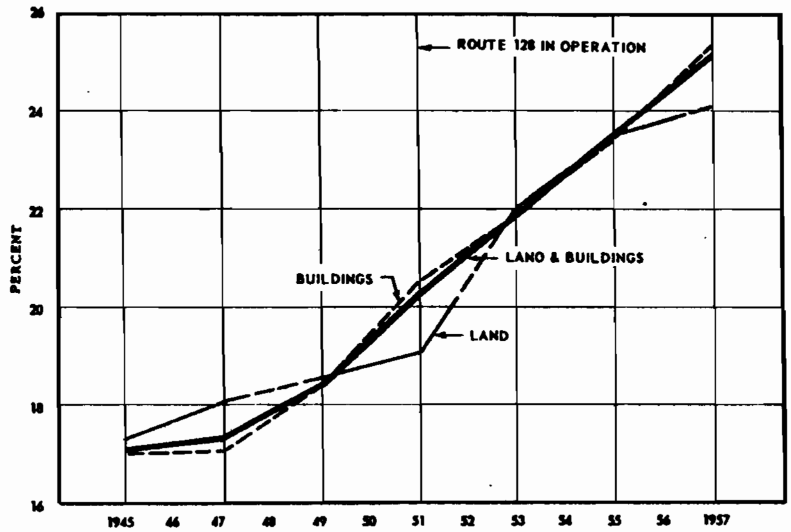
[42] Adkins, op. cit., pp. 63-65.

[43] A. J. Bone and Martin Wohl, "Massachusetts Route 128 Impact Study," Highway Research Board, Bulletin 227, pp. 21-49.



Assessed values in the adjacent Band Area of Lexington expressed as a percentage of assessed values in the entire town.

Figure 11. Variation in assessed values for land and for buildings in an area adjacent to a new highway facility.

(Source: Bone, A. J. and Wohl, M.: "Massachusetts Route 128 Impact Study," HRT - Bulletin 227, pp. 21-49, 1959).

The information gathered in Sealy makes it possible to study the relationship between unit market value ($/acre) for improved and unimproved parcels in the community. By plotting land value for improved and unimproved parcels with common characteristics, it is possible to see a clear general trend. The result is plotted in Figure 12. The common characteristics include both spatial distribution, social conditions, parcel characteristics, and time of sale. As can be seen from the figure, unit values for unimproved parcels were generally in the range of 20 percent of the corresponding value for improved parcels. As both land and improvements have experienced the same changes in value due to changes in other factors, they do not have to be analyzed separately.

DATA REQUIREMENTS

A study of land values similar to the type outlined in this research requires the collection, storage, and manipulation of a large amount of data with a consequent large expenditure of time and money. In addition to the effort of getting raw data, procedures will have to be developed to store data and to retrieve it and manipulate it to acquire meaningful results. In the following description of the methodologies employed in this research two sophisticated computer programs are discussed: STEP 01 regression analysis, and AID (Automatic Interaction Detection). One other program, SYSTEM 2000, is discussed in a following section. Any programming packages will be fairly expensive to purchase and will require access to computers for their use.

Implicit in any modeling effort is a trade-off between expense and accuracy. Predictions of a dependent variable, in this case land value, should be increasingly accurate as more dependent variables are added to the predictor equations. The effort to identify relevant predictor variables and to obtain values for each case (property transactions) will involve increasing expense in data collection, storage, and in the analysis.

Further, in any analysis of such a complicated phenomena as changes in land value there will be a problem in identifying relevant factors and controlling for intercorrelation among predictor variables.

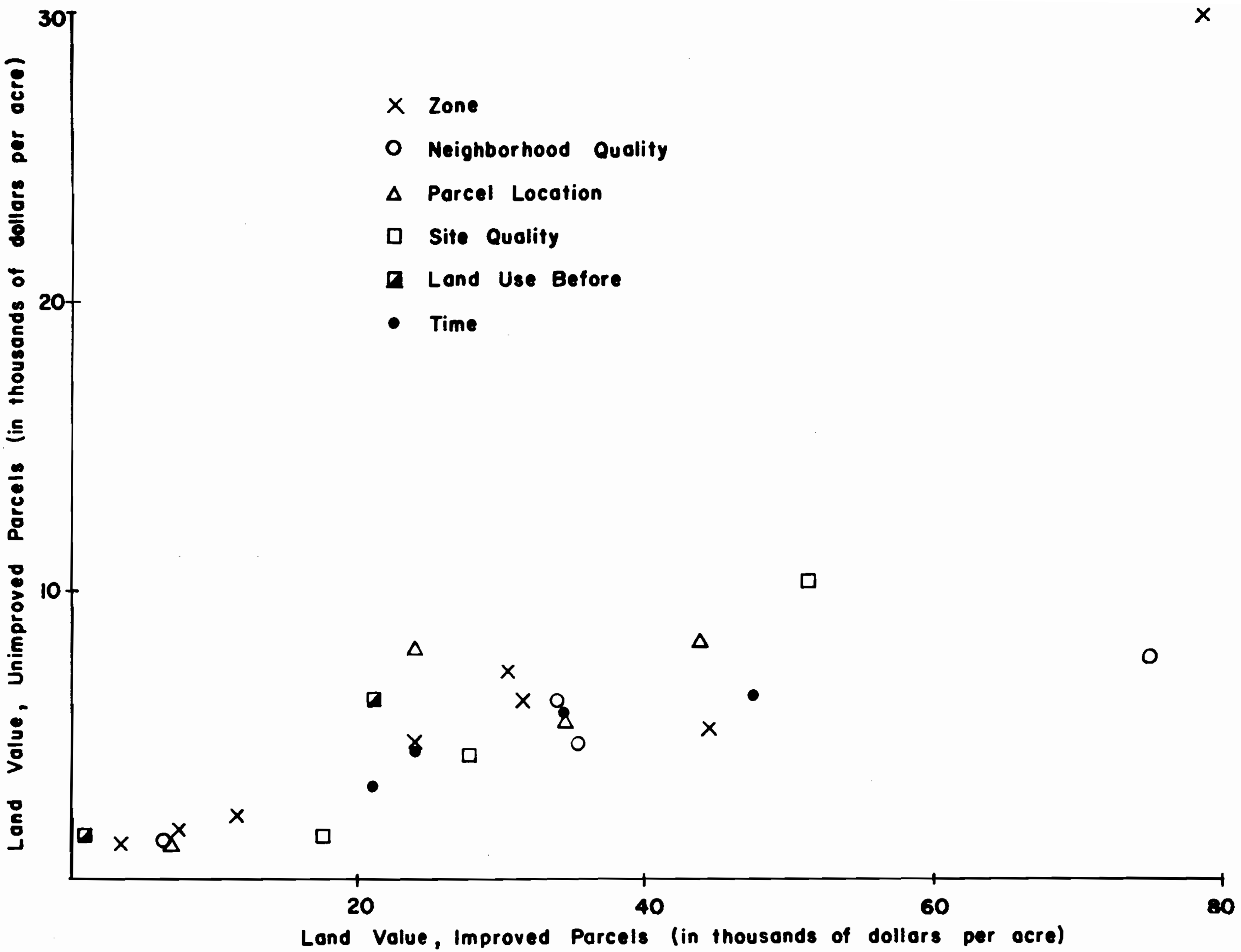


Figure 12. Comparison of land values for improved and unimproved parcels, Sealy.

Applying Results from the Case Study to Other Cases

In addition, factors which may be identified as meaningful predictors in one area may not be relevant in predicting land values in another area while a variable not even examined in the first area may be relevant in the second.

The present study reduces an initial set of 21 variables (for each of 611 property transactions - a data set of almost 13,000 items) to a predictor equation of 10 variables. It was proposed that this would reduce the data requirements for future studies to these 10 variables. In light of the above comments about likely differences among different areas as to the interrelation of land values and proposed predictor variables, this may not be the case. In fact some variables, such as a bus service index and accessibility to public transit facilities, were proposed then dropped from the model prior to the statistical analysis as these factors had not varied during the study period. This lack of variance may not be true for other communities.

Land Value and Social Attitudes

Land value may give us some ideas about likely changes in land use and economic activities in an area, but it tells us nothing about the attitudes of a community's residents towards these anticipated changes. A new freeway may raise residential land values in a small community and increase accessibility to a nearby metropolitan area. A likely effect will be to attract new residents with relatively high incomes to the area, people who will commute to jobs in the central city of the metropolitan area. But will this produce resentments in older, poorer, longer-term residents who may feel that the newcomers have no real stake in preserving the community in its present semi-rural character? A further phase of the research proposes a method for assessing community attitudes in response to transportation-induced changes.

The Value of the Study and Further Research

While no general model can be evaluated from such a case study, as every community has its own characteristics in terms of resources, traditions, economy, and so on, and each is served by a transportation system with specific development characteristics, the land value model from this case study could possibly be refined and expanded to a general descriptive model in a later phase of the overall research effort.

The purpose of the case study phase is not only to evaluate the descriptive model, but also to identify appropriate techniques to be used in similar studies. This identification may be considered to be as important as evaluating the model itself. Consequently, it is also a study of what information is generally desired, what information is generally available in rural communities, and what adjustments in study techniques are necessary, given the available information.

The descriptive model in this case study phase will be given the form of a function. The dependent variable will be land value; the independent variables will be the different factors causing land value to vary: use, location, access, and so on. In addition, a specific technique will be used for evaluating the regression model to be analyzed. Before the regression models are set up an available program package for statistical analysis will be used to find the most significant factors in the data set and the interaction between them. Thus the model potentially should explain why and how land value varies from one parcel to another. Because of the human factor involved in all land evaluation, depending on the individual seller or buyer, such a mathematical model is not expected to be anything but a general expression for what an objective value of a specific piece of land should be, based on real life observations in a specific area.

A substantial data base was gathered in this study, and it is readily available for further analysis. Further research on this data base might include sensitivity analysis of the predictor variables and more complete analysis of the spatial variation within the community. The stored information may be analyzed to reveal possible differences in the variation in land values between zones, land use categories, location along the interurban highway versus other locations, and land ownership.

In further research major emphasis of the land value studies should be given to three subjects:

1. Further refinement of the techniques to describe quantitative and qualitative predictor variables already included in the analysis.
2. Development of a technique to separate the value of land and improvements or possibly to classify the quality of the improvement.

3. Development of a technique to include economic, political, social and ownership characteristics in the analysis.

On a state or nation-wide level, an effort should be made to create a data bank where all gathered information can be stored and made available for research teams and governmental agencies. The first step would be to develop general methodologies for data gathering and establish structures for the data bases in order to assure comparability between the different studies. Ideally this will facilitate future research efforts and provide sufficient data to enhance other programs such as land use planning and policy development.

CHAPTER III. PERCEIVED ENVIRONMENTAL UTILITY UNDER ALTERNATIVE TRANSPORTATION SYSTEMS: A FRAMEWORK FOR ANALYSIS*

*The work was performed by Dr. Pat Burnett, Associate Professor of Geography, University of Oklahoma, formerly of the University of Texas at Austin. This chapter represents work Dr. Burnett performed as a segment of the work plan regarding the influence of Interurban Transportation Systems on the Rural Community. This chapter is taken from Research Report 35, Council for Advanced Transportation Studies, March 1976.

III. PERCEIVED ENVIRONMENTAL UTILITY UNDER ALTERNATIVE TRANSPORTATION SYSTEMS: A FRAMEWORK FOR ANALYSIS

Transportation planning is marked by a concern about citizen involvement in the process. This is manifested by the plethora of studies on highway and expressway controversies.[1] It is also evident in attempts to create opportunities for citizen participation[2] and to examine the social consequences of road construction.[3] The concern

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[1] Amir, S., "Highway Location and Public Opposition." Environment and Behavior, 4 (1972), 413-436; J. E. Burkhardt, "Community Reactions to Anticipated Freeways: Fears and Actual Effects," Highway Research Record, No. 470 (1973), 22-31; G. Fellman, "Neighborhood Protest of an Urban Highway," Journal of the American Institute of Planners, 35 (1969), 118-122; A. Gonen, "The Spadina Expressway Conflict in Toronto: Decision and Opposition," Discussed Paper No. 5, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970; A. J. Mumphrey, "The New Orleans Riverfront Expressway Controversy: An Analytical Account," Discussion Paper No. 1, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970; A. J. Mumphrey, "A Monte Carlo Simulation of Highway Planning and Citizen Opposition: The Pennsylvania Planning Opposition Simulation," Discussion Paper No. 9, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1971; J. H. Schermer, "Interest Group Impact Assessment in Transportation Planning." Traffic Quarterly, 39 (1975), 29-49; J. E. Seley, "Development of a Sophisticated Opposition: The Lower Manhattan Expressway Issue," Discussion Paper No. 2, Research on Conflict in Locational Decisions, Department of Regional Science. University of Pennsylvania, 1970.

[2] Fretzsche, D. J., "Consumer Response Information - A Potential Tool for Regulatory Decisionmakers," Transportation Journal, 14 (1974), 22-26; M. L. Manheim, et al. Community Values in Highway Location and Design: A Procedural Guide: Final Report. Cambridge, Mass.: The M.I.T. Urban Systems Laboratory, 1971; C. Ryan, et al., "A Review of the Public Hearing Process as a Means of Obtaining Citizens' Views and Values," Highway Research Record, No. 467 (1974), 24-25.

[3] Kaplan, Gans and Kahn, Social Characteristics of Neighborhoods as Indicators of the Effects of Highway Improvements. San Francisco: Marshall Kaplan, Gans and Kahn, 1972; D. Nasatir, The Social Consequences of BARTS Environmental Impact: Some Preliminary Considerations and Hypotheses. Berkeley, California: University of California at Berkeley, 1974.

with citizen involvement occurs at all scales of analysis, from the metropolitan area[4] to the small urban community.[5]

It has often been noted that, in response to transportation plans, private individuals are most concerned about the protection, conservation, and enhancement of their physical and social space.[6] However, little work has been done on how individuals themselves perceive the effects on their environment of new routes or other kinds of transportation innovation, such as transit services or airports. The emphasis in this report is therefore on developing an analytical framework for examining residents' perceptions of their environmental utility under different transportation alternatives. The analytical framework is intended for application at any scale; the usefulness of the framework, however, is demonstrated through a case study of a small urban community.

The analytical framework is two-phase in design. First, a methodology is briefly outlined for defining the general attributes of the perceived environment of a class of urban residents, for example, small town residents or residents in neighborhoods within a city. Then a conceptual framework is developed for delineating homogeneous population groups within an example of such an environment and for measuring each group's differential cognition and evaluation of the effects of transportation alternatives.

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[4] Sloan, A. K. Citizen Participation in Transportation Planning: The Boston Experience. Cambridge, Mass: Ballinger, 1974.

[5] Hunter, G. C., "Rural Communities and Inter-Urban Transportation Systems: A Study of the Stages of Interaction," Master's Thesis, Department of Architecture, The University of Texas at Austin, 1974.

[6] Himman, J., "Controversial Facility-Complex Programs: Coalitions, Side-Payments, Social Decisions," Discussion Paper No. 8, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970.

DEFINING THE GENERAL ATTRIBUTES OF THE PERCEIVED ENVIRONMENT

Proposed alterations in transportation affect the behavior of residents in the vicinity. Conceptually, each person can be viewed as having an individual activity space containing a unique set of n elements or places to which he/she attaches some utility.[7] Following Harrison and Sarre, each element i can be viewed as defined by a number of constructs, m_i ($i = 1, \ldots, n$), that is, meanings which the individual ascribes to the place.[8] Constructs are subjectively percieved characteristics of all the places a person uses or values in his/her activity space under a transportation system. However, constructs may also be conceived as bipolar scales (e.g., near, far) describing all the elements which make up the percieved environment for the individual.

Although each person will have a unique set of elements and constructs comprising his/her own activity space, it is plausible to argue that similarities will exist in the systems of individuals in similar locations and with similar backgrounds - for example, residents of small towns or residents within metropolitan neighborhoods. Thus, to study the effects of transportation proposals on perceived environments, the constructs defining places in the environment must first be elicited.

For a class of urban residents of interest, Kelly's Personal Construct Theory and related procedures may be used, together with their extensions by Bannister; Bannister and Mair; Bonnarius; Epting,

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[7] Brown, L. and E. G. Moore, "The Intra-Urban Migration Process: A Perspective," Geografiska Annaler, 52, Series B. (1970), 1-13; F. E. Horton and D. R. Reynolds, "The Investigation of Individual Action Spaces: A Progress Report." Proceedings of the Association of American Geographers, 1 (1969), 70-74.

[8] Harrison, J. and P. Sarre, "Personal Construct Theory in the Measurement of Environmental Images: Problems and Methods," Environment and Behavior, 3 (1971), 351-374.

Suchman and Nickerson; and Slater.[9] The procedures employ a small sample of the population of interest but provide a rigorous method whereby the constructs of places in activity spaces can be suggested by residents rather than researchers.

To illustrate the use of the theory and the procedure for one general class of urban residents, we can take the elicitation of the constructs which define places for small town residents. (The population sizes of the towns range from 2,000 to 20,000). Since the details of this survey have been described elsewhere only a brief outline is required here.[10] First, a sample of small town residents was drawn: in this case 31 freshmen University students were selected to demonstrate the procedures involved. Each respondent listed all the places he/she used or valued about his/her home town, that is, all the elements of his/her activity space. Examples of listed elements are home, church, and corner store. Although each respondent listed a different set of places, there is no reason to believe that overall the lists did not provide a representative sample of places used by small town residents in general.

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[9] Kelly, G. A. The Psychology of Personal Constructs. New York: W. W. Norton, 1955; D. Bannister, "Personal Construct Theory: A Summary and Experimental Paradigm," Acta Psychologica, 20 (1962), 104-120; D. Bannister and J. M. M. Mair, The Evaluation of Personal Constructs. London: Academic Press, 1963; J. C. J. Bonnarius, "Research in the Personal Construct Theory of George A. Kelly: Role Construct Repertory Test and Basic Theory," in B. A. Mahr (Ed.) Progress in Experimental Personality Research. New York: Academic Press, 1965, pp. 1-46; F. R. Epting, D. I. Suchman, and G. J. Nickerson, "An Evaluation of Elicitation Procedures for Personal Constructs," British Journal of Psychology, 62 (1971), 513-517; P. Slater, "Theory and Techniques of the Repertory Grid," British Journal of Psychiatry, 115 (1969), 1287-1296; P. Slater, Notes on INGRID 72. London: Institute of Psychiatry.

[10] Burnett, K. P., et al. Transportation-Related Constructs of Activity Spaces of Small Town Residents, Research Report 18, Council for Advanced Transportation Studies, The University of Texas at Austin, 1974.

Next the triadic comparison method was utilized to elicit all the constructs defining all the elements on each respondent's list. Sets of three elements on the list were presented at random to each respondent; each time two elements considered similar were placed together and the third contrasting element was placed apart. The reason for the similarity and contrast between places was asked; this yielded descriptions such as "secure" and "insecure," that is, the contrasting poles of the construct or characteristic defining the triad of places. Triads were presented to every respondent until no new constructs were elicited. Thus, overall, the cognitive meanings ascribed to the range of places listed within small towns were elicited from all the respondents.

The triadic comparison procedure obviously can be yield a very large number of constructs or environmental descriptions even with a small sample. Slater's algorithm INGRID was developed to present such information in a more parsimonious form.[11] To utilize the algorithm, repertory grids must be constructed for each respondent: in our sample case, these took the form of the matrix outlined in Figure 13, where rows represent the preferred poles of the respondent's constructs, columns represent the elements of his or her activity space, and the entry in cell ij is the rating of how much of the preferred characteristic each element possessed (the ratings ranged from 1, most or top-scoring, to 7, least). The INGRID algorithm is a modified principal components analysis of each respondent's grid, such that clusters of preferred construct poles, or attributes, result. This leads to the extraction of the essential definitive substance of respondents' perceptions of their environment--for example, 38 constructs elicited from three subjects were reduced to only eight environmental components in the case study. In addition, 17 components occurred more than once for different respondents. These are listed in Table 1 and indicate communalities in the perception of small town environments. Although there are obvious problems of small sample size and aggregation, these 17 components were taken as

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[11] Slater, Notes . . ., op cit.

Preferred Pole of Construct	Element (Place) in Town																	
	Home 1	School 2	Church 3	Weekend Shop 4	Supermarket 5	Hangout 6	.	.	.	.	.	.	.	.	.	Coffee House 22	Coke Street 23	Bakery 24
1 Affectionate	1	4	3	7	4	1	.	.	.	.	.	.	.	.	.	3	7	7
2 Calm	5	5	6	4	6	3	.	.	.	.	.	.	.	.	.	2	6	7
3 Private	4	5	4	4	7	2	.	.	.	.	.	.	.	.	.	2	5	7
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.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
13 Exciting	4	2	6	2	1	1	.	.	.	.	.	.	.	.	.	2	6	6
14 Educational	3	2	6	2	1	1	.	.	.	.	.	.	.	.	.	3	6	7

Figure 13. **Example of a repertory grid.**

TABLE 1.

COMPONENTS DEFINING THE PERCEIVED ENVIRONMENT

FOR SMALL TOWN RESIDENTS

1. Preservation of family ties and friendships
2. Enjoyable outdoor recreation with others
3. Personal freedom
4. Country-western activities
5. Access to sophisticated entertainment
6. Restraints on behavior because everyone knows you
7. Challenge, excitement, adventure
8. Informal relationships
9. Access to luxuries of life
10. Pressure to achieve
11. Peace, tranquillity
12. Relaxation
13. Routine activities
14. Attractive rural surroundings
15. Intellectual stimulation
16. Accessibility to people and places
17. Personal privacy

bundles of constructs defining the perceived environment of small town residents. Components like those in Table 1 can readily be seen to provide adjectives which can be used in semantic differentials or other forms to rate the environment.

The foregoing has illustrated an analytical framework for defining a general kind of residential environment as it is perceived by its inhabitants. We now turn to a methodology for delineating population groups within an example of such a residential environment and for measuring each group's differential cognition and evaluation of the effects of transportation alternatives.

THE DELINEATION OF HOMOGENEOUS POPULATION GROUPS

Conceptualization

Within a general kind of residential environment (small towns, metropolitan neighborhoods) we may consider a population distribution at time t. Let there be a spatially random sample of m households drawn from this population. Then we may expect some number y of household clusters to be defined where the clusters will be homogeneous, at least in terms of (1) socio-economic status (broadly defined), stage in life cycle, and ethnicity and (2) their activity patterns. Such groups may also have distinctive cognitions and evaluations of the attributes of their perceived environment under alternative transportation systems. These expectations follow from Burnett and the well-known work by Berry and others on urban factorial ecology.[12] It also draws on work by Brail and Chapin

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[12] Burnett, K. P., "Decision Processes and Innovations: A Transportation Example," Economic Geography, 51 (1975), 278-289 B. J. L. Berry (Ed.) Comparative Factorial Ecology (Special Edition) Economic Geography, 47, Supplement (1971); B. J. L. Berry and P. Rees, "The Factorial Ecology of Calcutta," American Journal of Sociology (1969), 445-491; L. S. Bourne and R. A. Murdie, "Interrelationships of Social and Physical Space in the City: A Multivariate Analysis of Metropolitan Toronto," Canadian Geographer, 16 (1972), 211-229.

which demonstrates correlation of activity patterns with the demographic characteristics of urban residents.[13] Finally, there is some evidence that environmental cognition and evaluation varies with socio-economic status.[14]

Given an extended set of variables describing both the socio-economic characteristics and activity patterns of the sample, y internally similar household clusters may first be defined using factor analysis and a grouping algorithm; each cluster's cognition and evaluation of its environment under alternative transport systems can then later be probed. The initial formation of household clusters may first be demonstrated for a case study situation.

The Case Study Population Groups

Given that the general perceived environment of small towns was described above, one small town, Sealy, Texas, was selected for analysis. This town had a population of 2685 in the 1970 Census. Within the area, a 3 per cent sample of households was drawn for home interviews to determine household socio-economic characteristics and travel habits. Since there was no listing of households by address to provide a sampling frame, block fronts on a street map were numbered and then selected using a table of random numbers. As many households on a selected blockfront were contacted as possible, producing a spatially random clustered sample. One callback per household was used. Interviews were carried out with one respondent in each household during August, 1974, until 80 completed returns were compiled: two were later deleted owing to response inaccuracies. A map of the sampled households is shown in Figure 14. Subsequent analysis of the data in the questionnaires showed that the sample obtained

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[13] Brail, R. K. and F. S. Chapin, "Activity Patterns of Urban Residents," Environment and Behavior, 5 (1973), 163-190.

[14] Horton and Reynolds, "The Investigation . . .," op cit.; R. J. Johnston, "Activity Spaces and Residential Preferences: Some Tests of the Hypotheses of Sectoral Maps," Economic Geography, 48 (1972), 199-211.

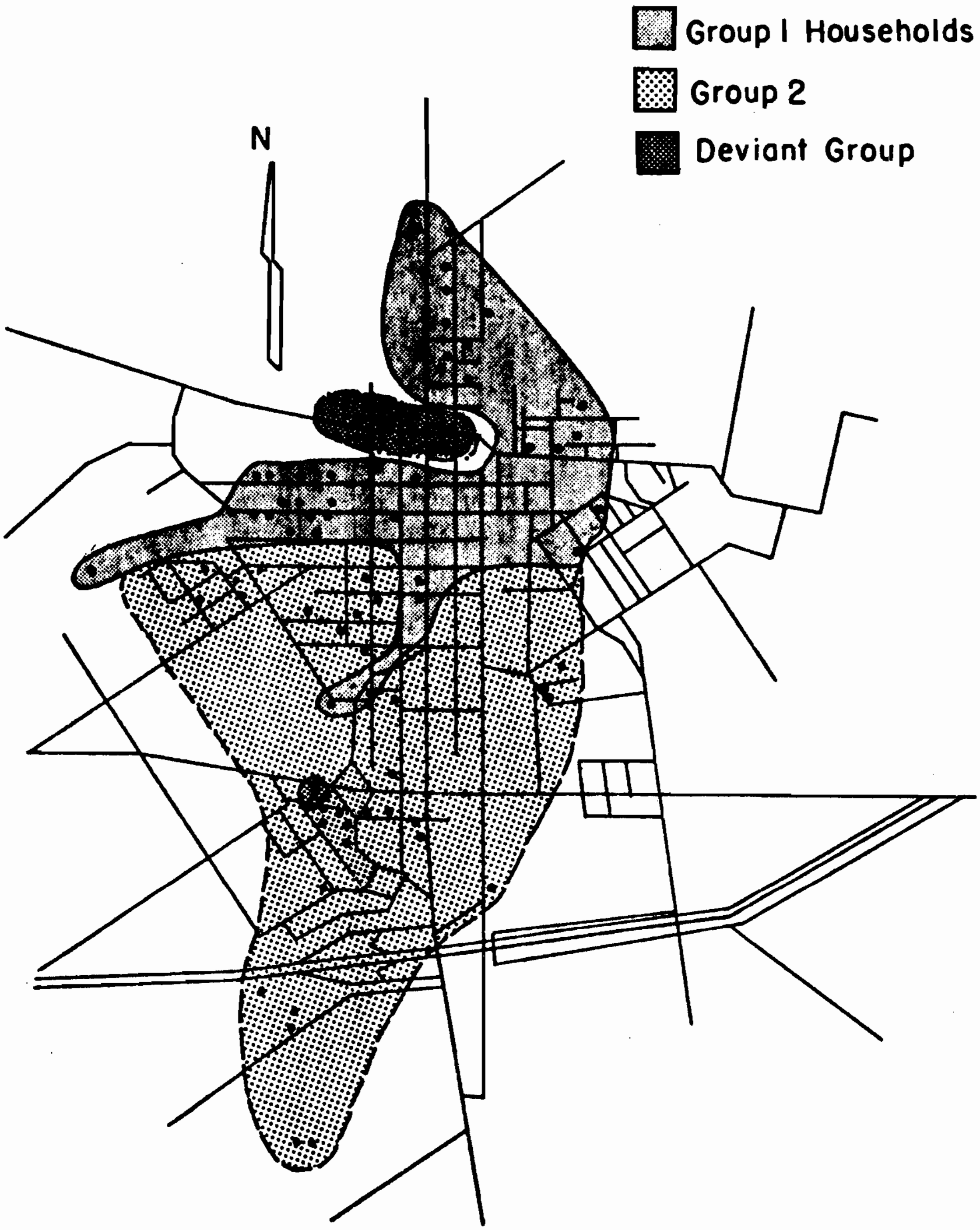

Figure 14. Locations and kinds of households in Sealy, Texas.

in this way was reasonably representative of different strata in the town's population (Table 2).

Information was collected on 58 variables describing household socio-economic characteristics and travel habits. These variables comprise the S and A sets of Table 3. To find the basic dimensions which might differentiate households into clusters, a principal components analysis with varimax rotation to simple structure was performed on the 78 household by 58 variable matrix.[15] Since some of the variables were categorical (for example, religion of respondent), they were treated as dummies, with each category assigned a number.

The analysis produced sixteen factors with eigenvalues greater than one; these may be treated as basic factors differentiating households (Table 4).[16] The well-known life cycle phase and income/ethnicity factors appeared with loadings on the component variables that were readily interpretable. For example, as the life cycle phase factor increases, number of residents in household decline and age of respondent and life stage of household increase. A third socio-economic factor also appears, namely, familiarity with the town; this increases both as the year the respondent first moved into Sealy increases and as his/her total length of residence there increases.

The remaining 13 basic factors were those underlying household travel behavior and were more difficult to interpret. Some examples may be taken, however. Indoor recreation (Factor 7, Table 4) increases as the place of recreation changes and as the time taken to get there decreases. However, indoor recreation also increases as frequency of visit decreases, perhaps indicating that as travel time decreases, more time is spent at the recreation center and fewer

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[15] The program used for the factor analysis was Veldman's "Factor," a special program written for the CDC 6600 system at the University of Texas at Austin. (Donald J. Veldman, VSTAT User Manual. University of Texas at Austin, 1974, p. 28).

[16] Rummel, R. J., "Understanding Factor Analysis," Journal of Conflict Resolution, 40 (1967), 440-480.

TABLE 2. PROPORTION OF 1970 POPULATION AND 1974 SAMPLE IN DIFFERENT STRATA.

	Percent Foreign Born	Females 16 Years & Older- Percent in Labor Force	Employed Persons- Percent in Manu-facturing	Percent Negro & Other Races	Percent 18-64 Years	Percent 65 Years & Older	Males Over 14 Years- Percent Married	Females Over 14 Years- Percent Married	Persons 18 Years & Older- Percent Male
Population (1970)	3.8	23	4	9	68	25	30	42	40
Sample	3.7	21	6	7	63	26	32	38	37

Source: General Social and Economic characteristics of Sealy, Texas PC(1) - C45, L.S. Department of Commerce, Social and Economics Statistics Administration, Bureau of the Census, issued April 1972, Table 16.

TABLE 3. VARIABLES USED IN THE FACTOR ANALYSIS

3A S (SOCIO-ECONOMIC) SET

1	Year respondent first moved to Sealy
2	Total length of residence in Sealy of respondent
3	Number of persons permanently resident in household
4*	Occupation of respondent
5	Years of schooling of respondent
6	Number of cars in household
7*	Country or origin of respondent
8	Number of rooms in dwelling
9	Age of respondent
10*	Religion of respondent
11	Total weekly income of household ($ US)
12	Number of bathrooms in dwelling
13*	Sex of respondent
14*	Racial descent of respondent
15*	Place of employment of respondent
16**	Life stage of household

* Dummy variable

** Categories based on the ages of the household head and spouse, and ages of children, if any.

TABLE 3. VARIABLES USED IN THE FACTOR ANALYSIS (cont.)

3B A (ACTIVITY) SET

17*	Place usually shopped for groceries
18	Frequency of groceries shopping
19	Time to place for groceries
20*	Place usually shopped for clothing
21	Frequency of clothing shopping
22	Time to place for clothing
23*	Place used to shop for a car
24	Frequency of shopping for a car
25	Time to place for a car
26*	Place used for banking
27	Frequency of banking
28	Time to place for banking
29*	Place used for hairdressing
30	Frequency of hairdressing
31	Time to place for hairdressing
32*	Place used for doctor
33	Frequency of doctor's visits
34	Time to place for doctor
35*	Place used for indoor recreation
36	Frequency of indoor recreation
37	Time to place for indoor recreation
38*	Place usually used to see close relatives
39	Frequency of visiting relatives
40	Time to relatives' place

(cont.)

TABLE 3. VARIABLES USED IN THE FACTOR ANALYSIS (cont.)

3B A (ACTIVITY) SET

41*	Place usually used for a movie
42	Frequency of seeing movie
43	Time to place of movie
44*	Place usually used for a restaurant
45	Frequency of using restaurant
46	Time to restaurant
47*	Place usually used as library
48	Frequency of use of library
49	Time to library
50*	Place usually used to see friends
51	Frequency of visiting friends
52	Time to place of friends
53*	Place used to take visitors out
54	Frequency of taking visitors out
55	Time to place to take visitors out
56*	Place usually used for distant relatives
57	Frequency of visiting distant relatives
58	Time to place of distant relatives

TABLE 4. FACTORS WITH EIGENVALUES GREATER THAN ONE.

Factor	% Var.	Variables and loadings (in parenthesis)
1. Life cycle phase	4.85	3(-.67); 9(.64); 16(.74)
2. Ethnicity/Income	5.27	8(.74); 12(.80); 14(.56); 29(.57); 30(.52)
3. Familiarity with town	4.34	1(.91); 2(.90)
4. Non-family socializing	5.77	40(.72); 41(.76)
5. Banking opportunities	5.45	27(-.87); 28(-.85)
6. Occupation trips	4.39	4(-.78); 15(-.70); 30(-.51); 31(-.55)
7. Indoor recreation	4.41	35(-.60); 36(-.90); 37(-.89)
8. Infrequent types of trips	6.73	23(.55); 48(.60); 54(.50); 57(.62); 58(.77)
9. Socializing with friends	5.28	50(-.70); 51(-.85); 52(-.83)
10. Opportunities for doctor's visits	2.77	32(.78)
11. Grocery shopping opportunities	3.74	18(-.75); 19(-.70)
12. Choice of quality professional care	3.25	5(.53); 32(-.57)
13. Car purchase opportunities	2.98	24(.68); 25(.73)
14. Intellectual companionship	3.18	49(.72); 50(.74)
15. Opportunity for private indoor activities	5.90	45(.-.81); 56(-.84); 47(-.74)
16. Opportunities for clothing purchases	2.70	22(.74)

trips are made. In contrast, for speciality goods like car purchasing (Factor 13, Table 4), as the time to the place of purchase increases, so does the frequency of the trip. This may well be because larger towns further away from Sealy offer a better array of automobiles and other speciality goods from which to shop. A final example of a less easily interpretable factor may be taken, that of opportunity for private indoor activities (Factor 15, Table 4). This opportunity increases as the frequency of using a restaurant decreases, and as the place used for a library changes. However, it also increases as the time to a restaurant decreases. This apparent anomoly may be explained by the fact that restaurants far from Sealy are preferred, compared with the limited facilities available in Sealy itself.

All 16 factors are interpretable as exemplified, so scores for each household on each factor were computed. The algorithm CONGRUP was then used to cluster households with like scores on the 16 factors.[17] As well as using constraints on the similarity of factor scores in forming household clusters, CONGRUP also employs a well-known "contiguity" constraint: that is, households have to be contiguous to each other to be included in a group. Accordingly, CONGRUP delineated four main clusters of neighboring households, with two major groupings of 43 and 29 members respectively, and two deviant minor groupings of four and two members (Figure 14). The number of component groupings was subjectively chosen, but the appearance of two major groupings conforms with Hunter's delineation of two major kinds of households in Sealy in the late 60's and early 70's.[18] Thus, the sample clusterings appear to reflect the general community makeup of the area. To the north is a zone of older housing with residents of older age and lower socio-economic status; this area also contains the ethnic ghetto of the town. To the south and the west, the residents are more youthful, have lived in Sealy for

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17 The program CONGRUP was adapted to the CDC 6600 system at the University of Texas at Austin by Dr. R. Briggs, Department of Geography. It is based on Ward (1963).

18 Hunter "Rural Communities . . . ," op cit.

a less lengthy period, and are generally of higher socio-economic status (Figure 14). Given a manner in which homogeneous groupings of the population can be defined, we may now turn our attention to a method of analysis of their cognition and evaluation of environmental attributes under alternative transport systems.

THE DIFFERENTIAL COGNITION AND EVALUATION OF THE ENVIRONMENT UNDER ALTERNATIVE TRANSPORT SYSTEMS

Conceptualization

The first part of the report delineates the components (bundles of constructs) which define the residential environment for a class of urban dwellers. Different population groups may perceive their environment as desirably or adversely affected by alterations in the transportation systems of an urban area. For example, one group could perceive the attribute of small towns "preservation of family ties and relationships" (Table 1) as severely disrupted by an inter-state highway.

To conceive how members of various groups rate their environments under different transportation alternatives, we may envisage a matrix of the kind shown in Figure 15. In this figure, the r rows represent components of the residential environment elicited by the Personal Construct Theory and Repertory Grid methodologies; the columns represent different possible alternative transportation strategies for an urban area. An entry in the cell of the matrix represents how much a group member perceives an urban area component to be affected by the transportation system, ranging from 1, extremely favorably, to 7, extremely unfavorably. The matrix thus represents the application of 7 point rating scales to evaluate the quality of the urban environment under alternative transportation systems. If it is desired to investigate the effects of environmental components not elicited from the residents themselves (for example, town growth in the case of the small town residents of Table 1), these components can be added as extra rows. The stress in this report, however, is on evaluating the urban environment from the resident's point of view. Consequently,

Environmental Component	Transportation System Alternative: Before Freeway 1	After Freeway 2	With Dial-a-bus 3	With Train 4
1. Accessibility to friends	7	1	4	4
2. Peace, tranquility	1	7	3	5
3. Preservation of friendship	6	3	4	4
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
r Personal freedom	7	2	3	3

Figure 15. Group member's evaluation of the effects of alternative transportation strategies on his/her residential environment.

the rows of the matrix of Figure 15 are viewed as composed entirely, or mostly, of residents' elicited perceptions of urban area attributes.

The matrices for the members of a homogeneous population group may be manipulated using the INDSCAL model to summarize the group's cognition and evaluation of the effects of transportation alternatives on their urban environment.[19] The input to the INDSCAL model is a similarities matrix for each person of a group. Accordingly, a matrix like Figure 15 for each group member has to be preprocessed so that similarities between each possible pair of transportation systems can be measured. There are various methods of doing this, for example, by using the program DISTAN after ratings across the n stimuli (transportation systems) have been standardized to zero mean and unit standard deviation.[20] Or, alternatively, following Nicholaidis, the scores for a transportation system can be conceived as represented by a vector [21]

$$X^i_{jt} = (X_{j1}, X_{j2}, \ldots, X_{jr})$$

in a space of the r environmental attributes of Figure 3, where i = a group member, j = the transportation system, and t is an environmental component. The perceived similarity of any pair of transportation systems by a group member is then given by

$$S^i_{jk} = \sum_{t=1}^{r} \left[X^i_{jt} - X^i_{kt}\right]^2 \quad j, k = 1 \ldots n \text{ (number of transportation systems).} \qquad (1)$$

Where the ratings data have been collected from illeducated, semi-illiterate respondents, less refined methods of deriving similarities may be justified: for example, the use of the absolute differences

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[19] Shepard, R. N., A. K. Romney and S. B. Nerlove (Eds.) Multidimensional Scaling. Volume 1: Theory. New York: Seminar Press, 1972.

[20] Green, P. E. and V. R. Rao. Applied Multidimensional Scaling. New York: Holt, Rinehart and Winston, 1972.

[21] Nicholaidis, G. C., "Quantification of the Comfort Variable," Transportation Research, 9 (1975), 55-66.

between each pair of systems in their total or average scores over all environmental components. Formally, using the same notation as above, this becomes

$$S^{i}_{jk} = \left| \left(\sum_{t=1}^{r} X^{i}_{jt} \right) - \left(\sum_{t=1}^{r} X^{i}_{kt} \right) \right|, \; j, k=1 \ldots n \quad (2)$$

in the former case and

$$S^{i}_{jk} = \frac{\left| \sum_{t=1}^{r} X^{i}_{jt} - \sum_{t=1}^{r} X^{i}_{kt} \right|}{r} \quad (3)$$

in the latter case.

The similarities between transportation systems have been calculated according to the systems' evaluated effects on a relatively large number of components of the urban residential environment. The application of INDSCAL enables the identification of the few most important latent, subjective scales which 'lie behind' each group member's evaluation of the effects of the transportation systems on their environment. Following Carroll, assume that there exists a set of a few important but latent environmental scales which generate group members' similarities judgements.[22] Let there be p such scales. Assume further that all the latent scales are common to the households in a homogeneous group. Then the p scales represent the most important dimensions of the group's evaluation space, and x_{jd} ($j = 1 \ldots n$, $d = 1 \ldots p$) represents the value of each of the transportation alternatives on each of the important environmental dimensions in the group evaluation space.

Assuming that the latent scales are common to all the households in a cluster seems a very strong homogeneity assumption. However, under the INDSCAL model, any household, i, has a unique set of weights $W_i = (W_{i1}, W_{i2}, W_{i3}, \ldots, W_{ip})$ which it attaches to each of the

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22 Carroll, J. D., "Individual Differences and Multidimensional Scaling", in R. M. Shepard, A. K. Romney, and S. B. Nerlove (Eds.) Multidimensional . . ., op cit., pp. 105-155.

p scales. Theoretically, any of the W_i can equal 0 and thus some group members can attach no importance to some environmental dimensions. However, it is anticipated that within a homeogeneous cluster of households, none of the weights will equal zero (that is, households will share a common set of important dimensions to evaluate transportation alternatives). Nonetheless, there may be inter-household differences in weights, reflecting realistic inter-household differences in the importance attached to the basic dimensions used to evaluate the environment.

The INDSCAL model also permits the calculation of the utility of each transportation system as far as the environment is concerned for each group member. This is given by

$$U_{ij} = \sum_{d=1}^{p} W_{id} \cdot x_{jd} \tag{4}$$

where U_{ij} is the environmental utility of the j^{th} transportation strategy for household i, W_{id} is the household's weight or importance attached to dimension d, and x_{jd} is the position of the transportation strategy on the dimension (this is similar to Nicholaidis' derivation of utilities for modal attributes). It will be of concern to note whether all households in a group find that the same transportation system alternative maximizes their environmental utility, that is, whether they form an environmental interest group.

Many other sources contain further details of the INDSCAL model.[23] However, sufficient of its details have been presented to provide the conceptual framework for the analysis of this report. The manner in which the INDSCAL model is actually fit to (dis)similarities matrices, like those of each household in a cluster here, is also presented in the noted sources. It remains to demonstrate how the environmental effects of different transportation alternatives could be measured.

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23. Ibid., Green and Rao, Applied . . ., op cit.,Nicholaidis, "Quantification . . .," op cit.

The Case Study: Respondents' Environmental Cognition and Evaluation

In 1974 the residents of the case study town either had experience of, or were exposed to, debate about six alternative transportation systems. They had experience of a period prior to the opening of an interstate highway in 1968 and after it; there were also discussions of the addition of an AMTRAK train stop in the town, the upgrading or the downgrading of country bus services in terms of scheduling and destination, and the addition of a local intrastate airstrip.[24]

Accordingly, every member of the four groups in the town rated the 17 elicited components of their residential environment (Table 1) under each transportation alternative, from 1, most advantageously affected, to 7, most disadvantageously affected. This produced a matrix for each sampled household of the kind shown in Figure 16. In addition, each respondent similarly rated the effects of the transportation facilities on six other components of their community. These components were suggested as important by Hunter after perusal of the local town newspaper and included[25]

(a) the attractiveness of the town to industry,
(b) the attractiveness of the town to retailing and office use,
(c) the respondent's household income,
(d) the community income,
(e) neighborhood land values, and
(f) population growth.

This produced a 23 x 6 matrix of ratings for each member of each of the four household groups in the town. It should be noted that each respondent was asked to use all the numbers between 1 and 7 where possible in rating, but that most of the small town residents were ill-educated and had considerable trouble filling out a matrix of the type shown in Figure 16.

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24. Hunter, "Rural Communities . . .", op cit.

25 Ibid.

Environmental Component	Transportation System Alternative					
	Before Interstate Highway	After Interstate Highway	Present Facilities Plus Train Stop	Improved Bus Services	No Bus Services	Local Intrastate Airstrip
	1	2	3	4	5	6
1. Preservation of family ties	1	6	4	4	6	2
2. Outdoor recreation	3	1	3	3	5	2
3. Personal freedom	7	3	3	3	6	2
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
17. Personal privacy	7	2	3	3	6	1

Figure 16. Group member's evaluation of the effects of alternative transportation strategies on his/her residential environment in Sealy.

The simplest method of preprocessing the data for INDSCAL analysis was therefore used. For each member of each homogeneous population group a similarities matrix was prepared. The similarities measure used was the difference between the average component scores for each pair of transportation systems (Equation 3). This yielded a six by six matrix of similarities for each respondent, of which an example is shown in Table 5.

The similarities matrix for each group of respondents in turn was next subjected to INDSCAL analysis. For each group, the analysis recovered the scales comprising the group evaluation space, the position of transportation alternatives in the space, the weights of each scale for each respondent, and the environmental utilities for each transportation alternative for each respondent.

For each of the four groups three basic environmental dimensions explained the maximum amount of variance in the input data (Table 6). Accordingly, these three basic factors comprised the most important dimensions on which the groups rated their environment under different transportation systems. Because the positioning of the transportation alternatives on the dimensions is different for each group, it seems clear each group has its own criteria on which it evaluates transportation alternatives. The different positionings of the alternatives with respect to each dimension are shown in Figures 17 through 24.

The average scores for each group of all the systems on each of the original 23 components were used to name the scales (dimensions) (Table 7). For Group 1, environmental Dimension 1 (Figure 17) ranges from a high associated with improved mass transit and freeway services to a low associated with the absence of both, particularly mass transit. This correlates with favorable average scores being given by the group to facilities which promote access to outdoor recreation, to sophisticated amenities, and to people and places which give personal freedom as against small town intimacy (Table 7, Column 1). The accent on bus services on this dimension makes it plausible to assume that it is an access to personal freedom and relaxation dimension. Dimension 2, on the other hand, places negative weights

TABLE 5. SIMILARITIES MATRIX FOR RESPONDENT 1, GROUP 1.

Transportation System	1	2	3	4	5	6
1	.00	.37	.50	.40	.83	.53
2	.37	.00	.13	.03	.47	.17
3	.50	.13	.00	.10	.33	.03
4	.40	.03	.10	.00	.43	.13
5	.83	.47	.33	.43	.00	.30
6	.53	.17	.03	.13	.30	.00

TABLE 6. VARIANCE EXPLAINED BY DIMENSIONS FOR CASE STUDY POPULATION GROUPS.

No. Dimensions	% Variance Explained for Group			
	1	2	3	4
1	45.62	46.75	52.86	55.26
2	69.32	63.32	70.32	73.33
3	78.51	73.92	75.16	78.41
4	68.24	67.56	66.51	62.37

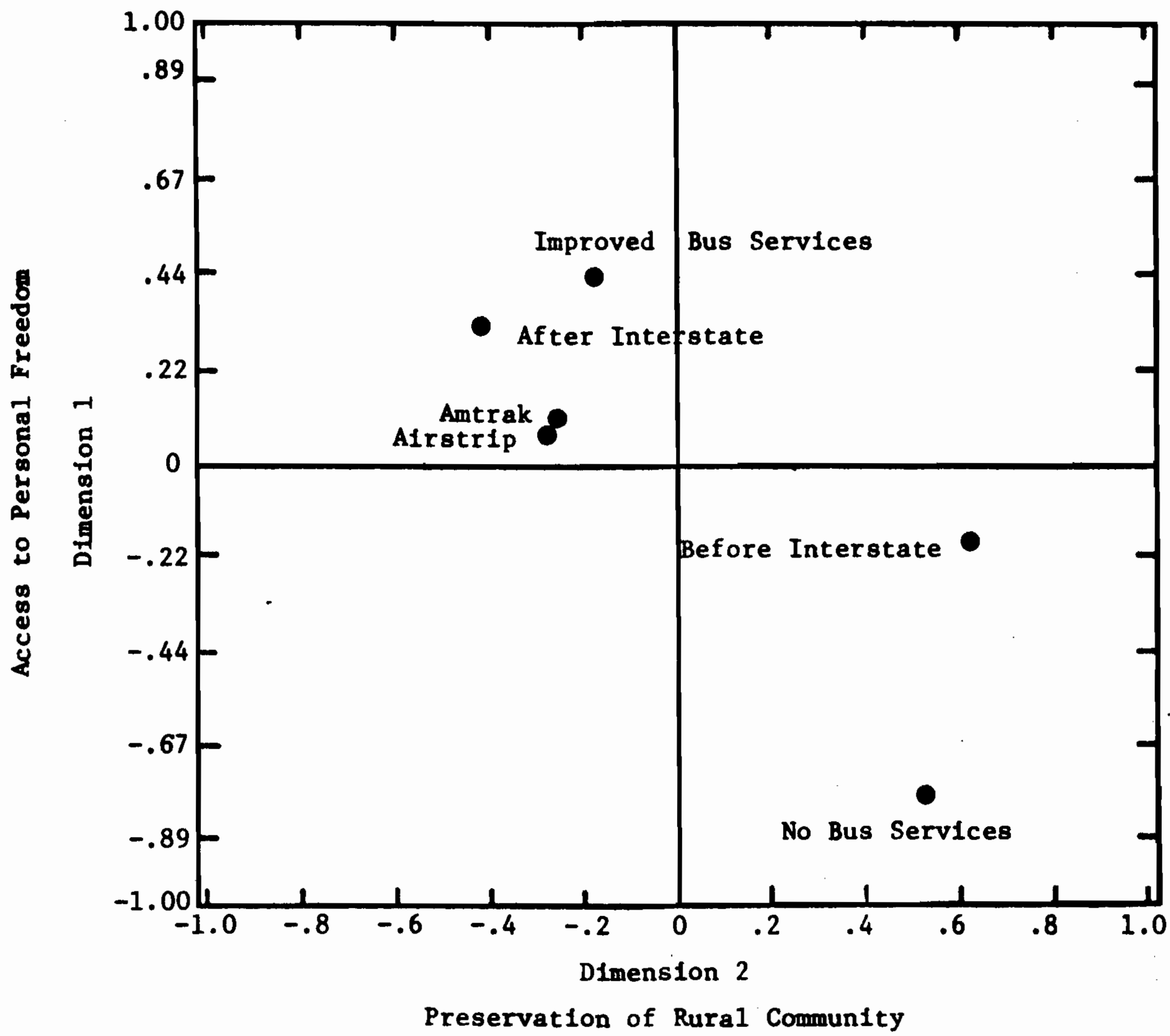

Figure 17. INDSCAL plot of transportation alternatives-Group 1, Dimensions 1 and 2.

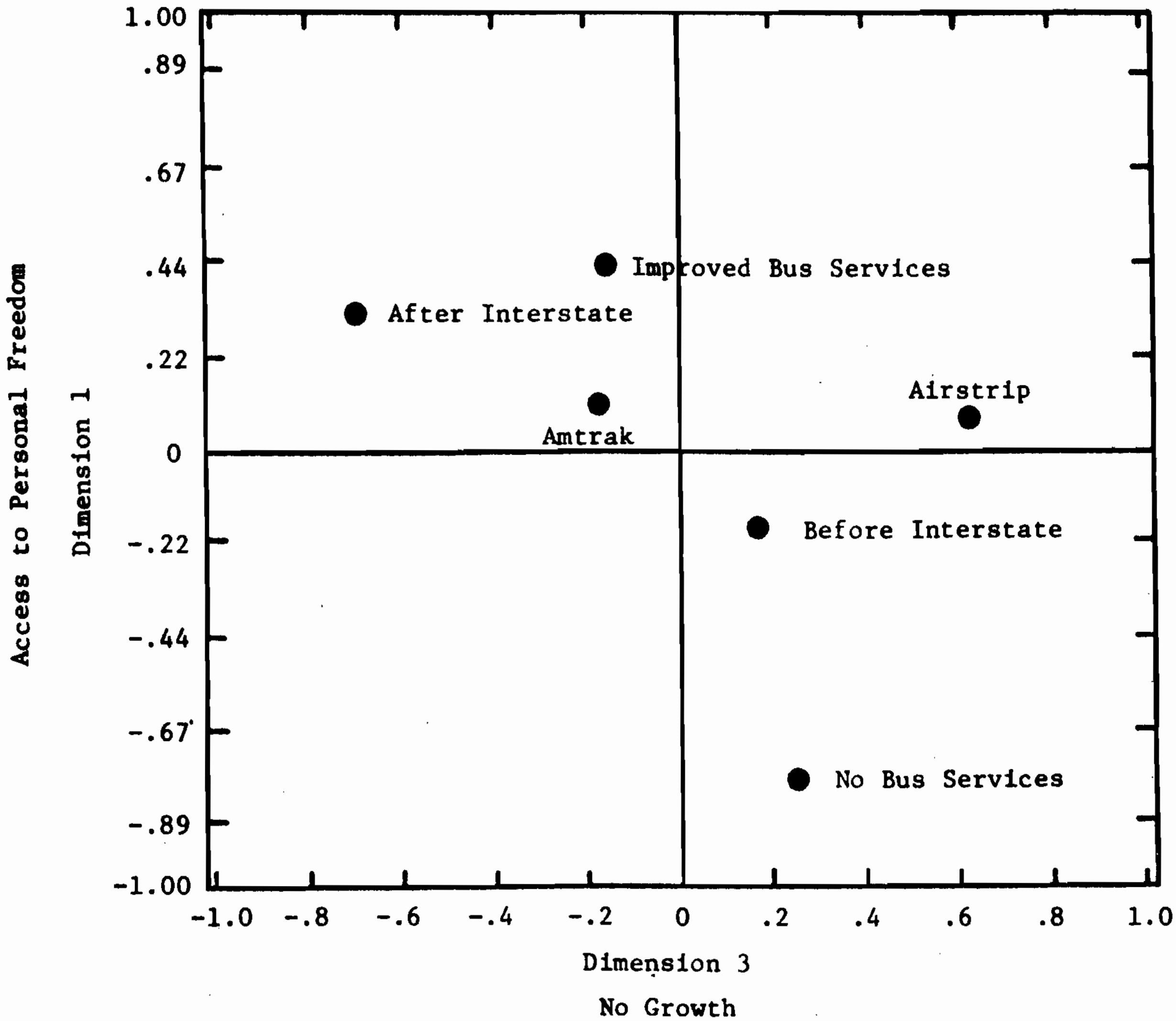

Figure 18. INDSCAL plot of transportation alternatives-Group 1, Dimensions 1 and 3.

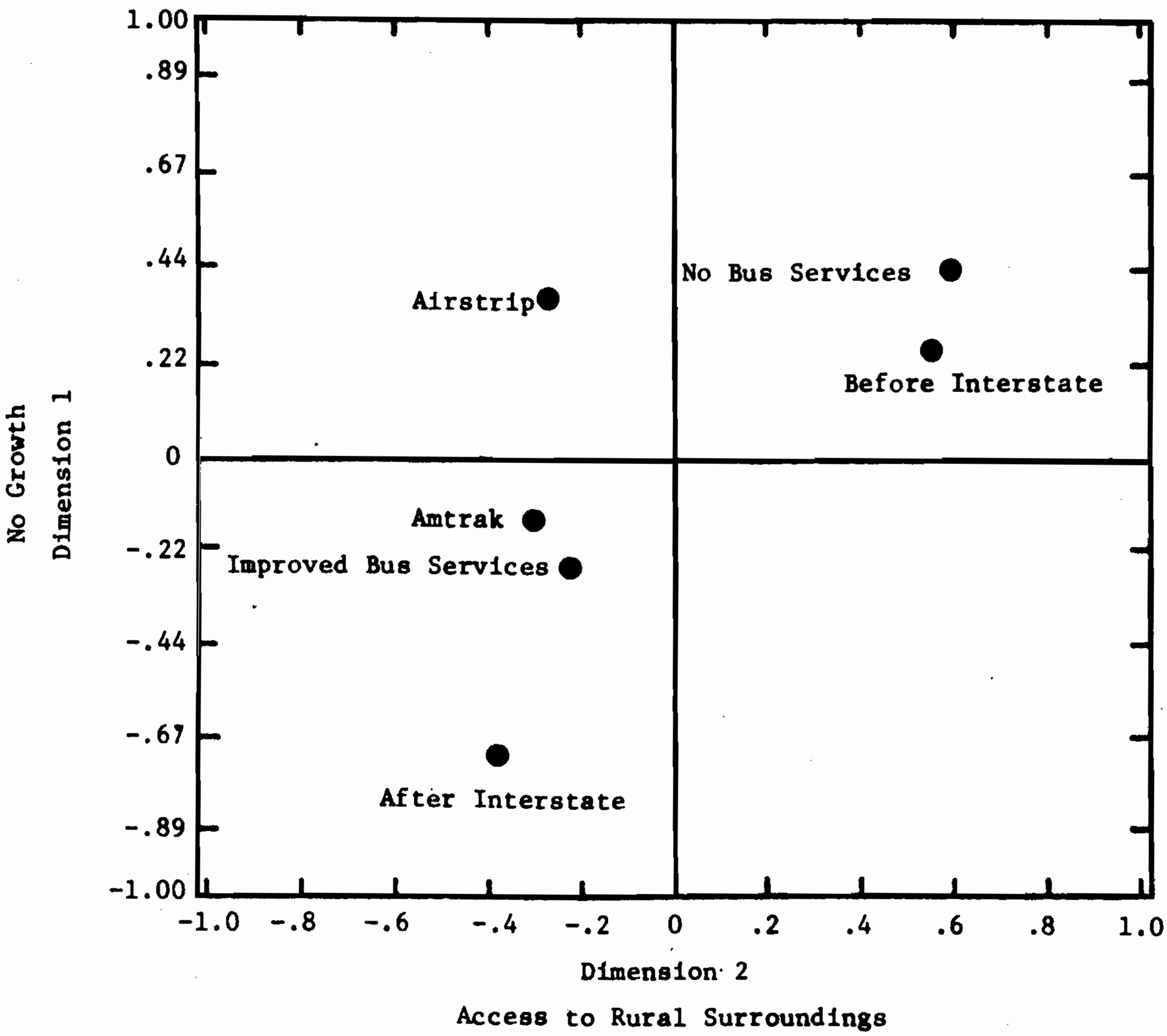

Figure 19. INDSCAL plot of transportation alternatives-Group 2, Dimensions 1 and 2.

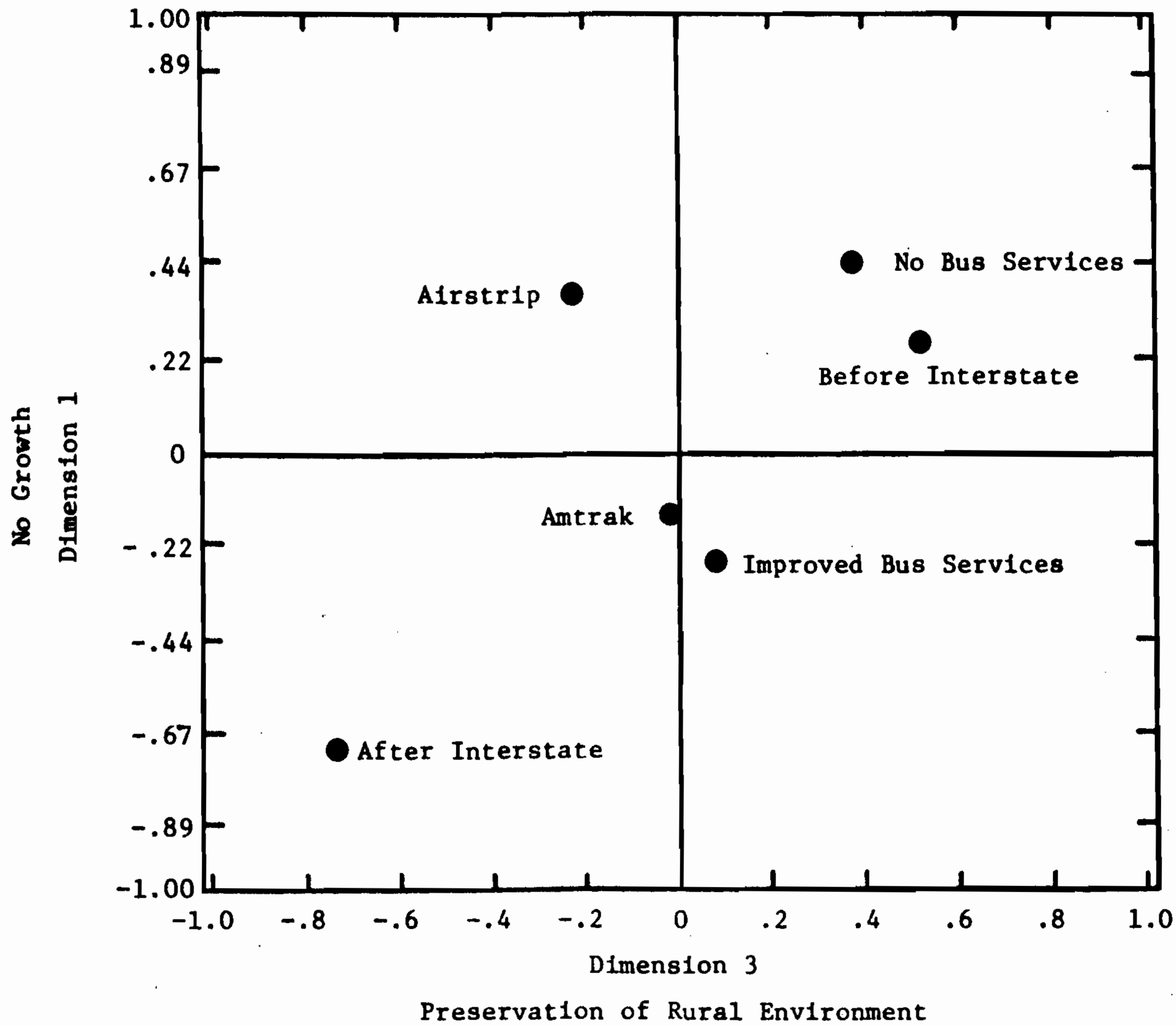

Figure 20. INDSCAL plot of transportation alternatives—Group 2, Dimensions 1 and 3.

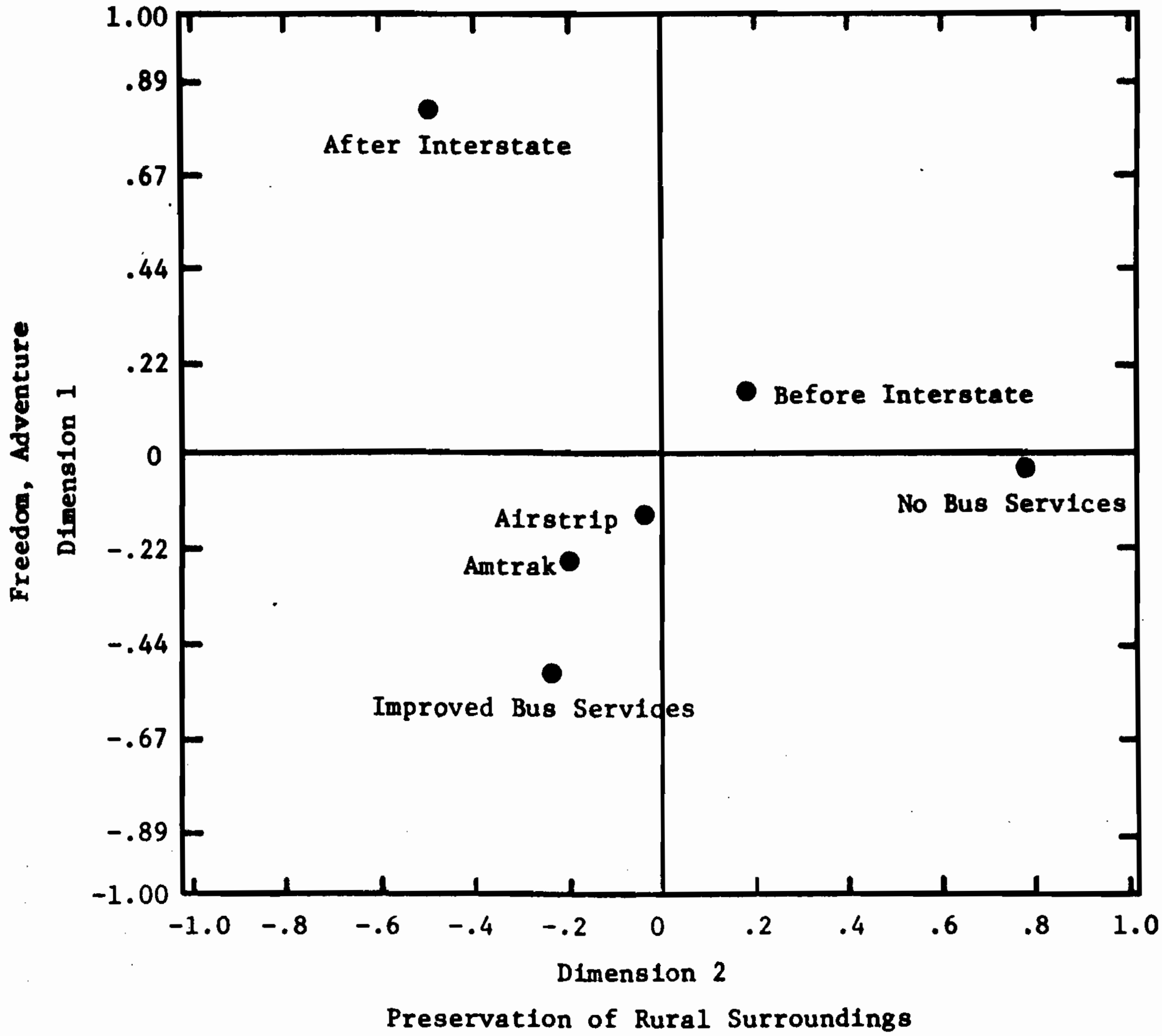

Figure 21. INDSCAL plot of transportation alternatives-Group 3, Dimensions 1 and 2.

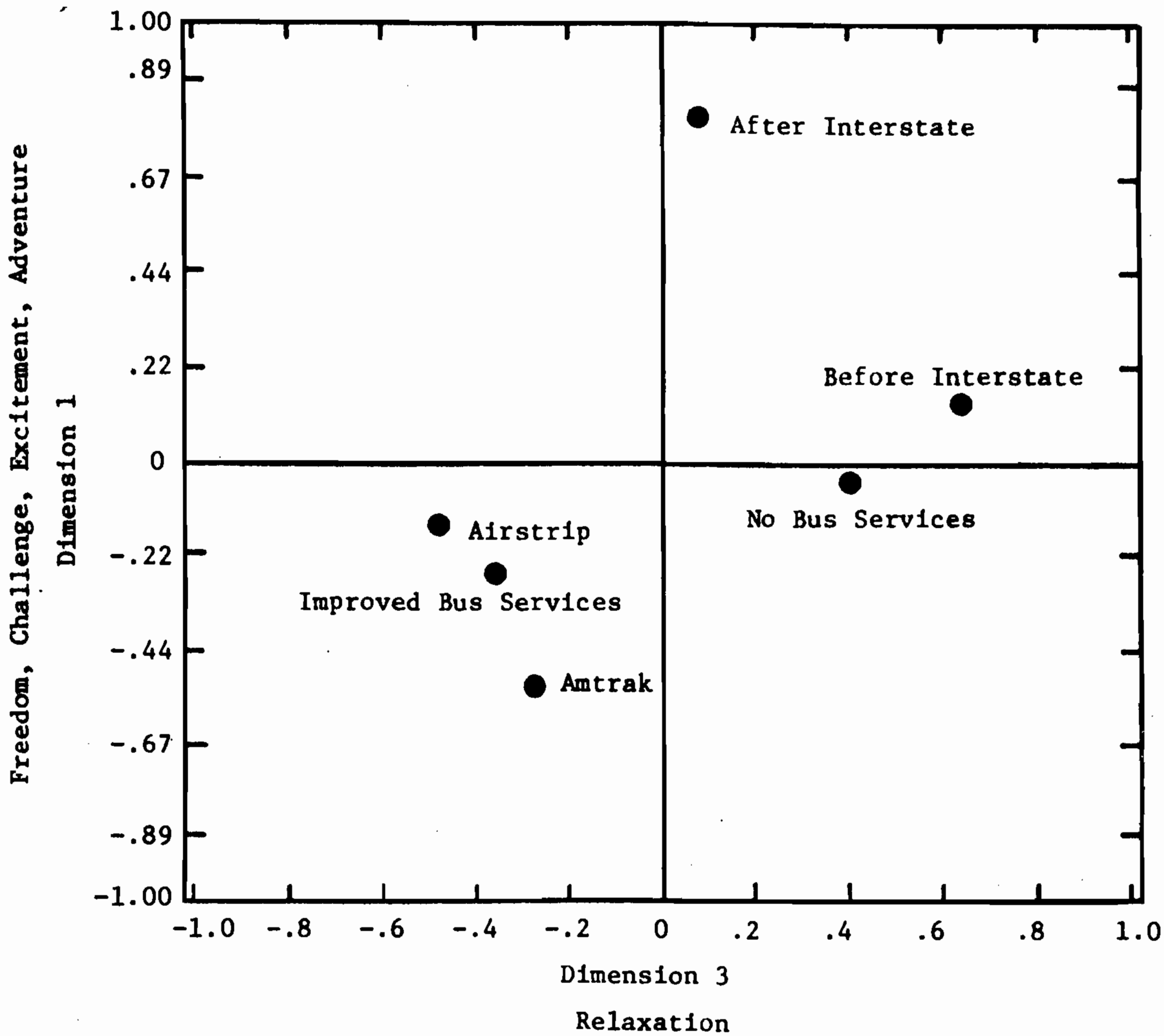

Figure 22. INDSCAL plot of transportation alternatives-Group 3, Dimensions 1 and 3.

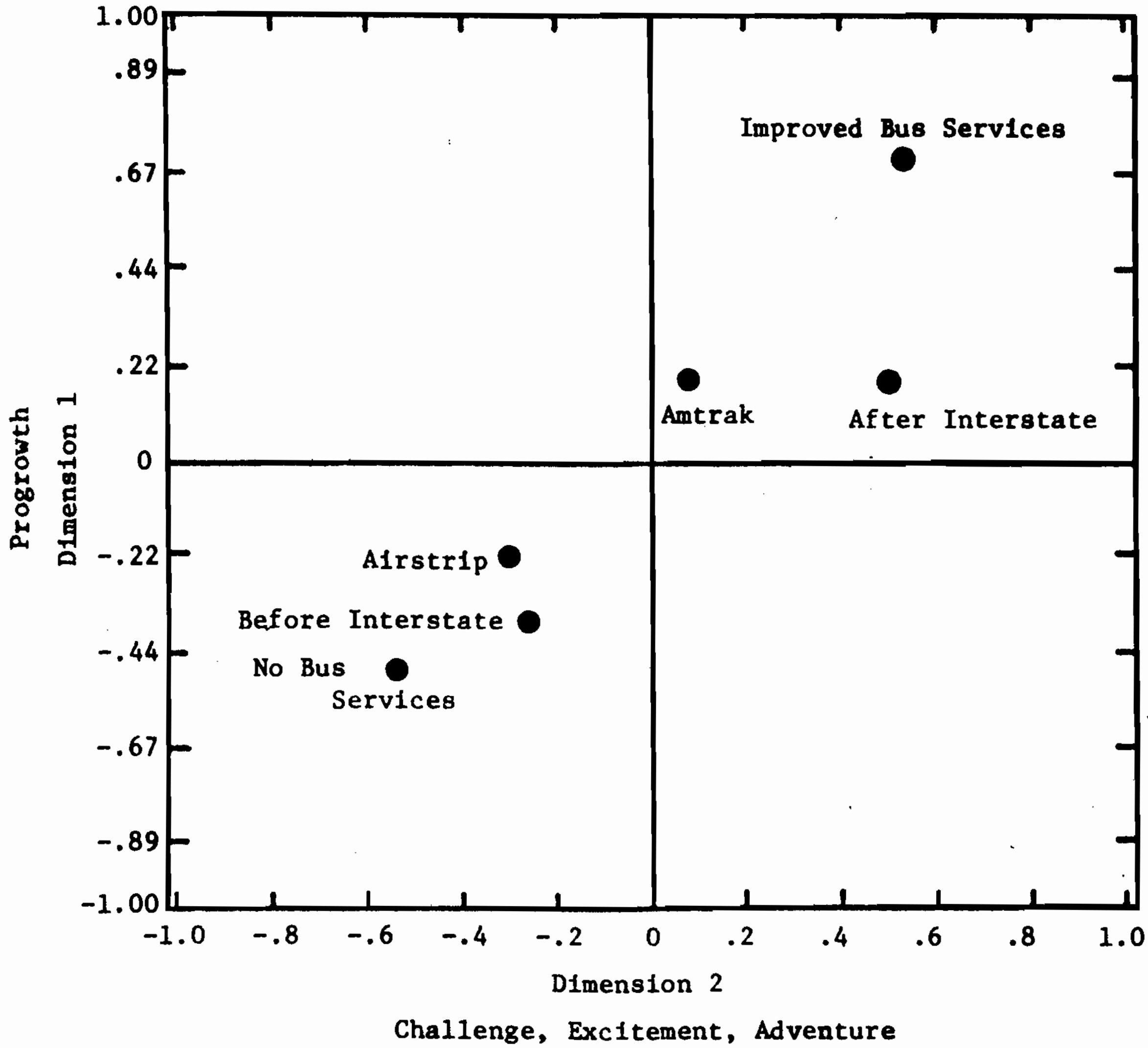

Figure 23. INDSCAL plot of transportation alternatives-Group 4, Dimensions 1 and 2.

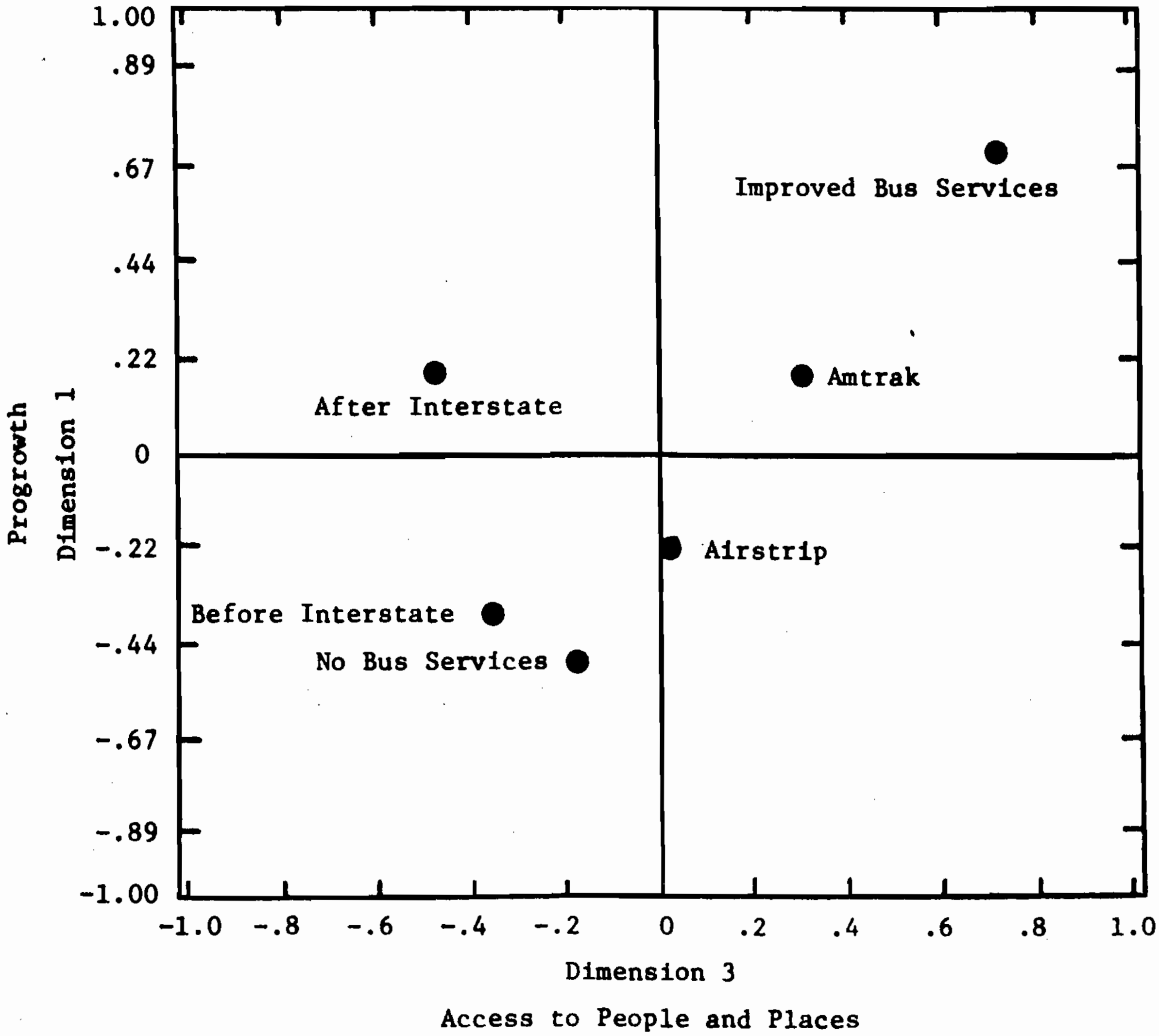

Figure 24. INDSCAL plot of transportation alternatives-Group 4, Dimensions 1 and 3.

TABLE 7. AVERAGE SCORES FOR ALL TRANSPORTATION SYSTEMS ON ENVIRONMENTAL COMPONENTS (1.000 = HIGHEST; 7.000 = LOWEST)

	Component	Group 1	Group 2	Group 3	Group 4
1.	Attractiveness to industry	3.8	3.9	3.8	4.0
2.	Attractiveness to retailing and office	3.6	3.2	3.4	4.0
3.	Respondent's household income	3.4	3.1	3.5	2.2
4.	Community income	3.7	3.9	3.8	4.0
5.	Neighbourhood land values	3.6	3.7	4.0	3.9
6.	Population growth	3.4	3.2	3.0	2.6
7.	Preservation of family ties and friendships	3.4	3.3	3.7	3.2
8.	Enjoyable outdoor recreation with others	3.5	3.4	3.4	3.6
9.	Personal freedom	3.4	3.4	3.3	3.3
10.	Country-western activities	3.9	3.9	4.0	4.0
11.	Access to sophisticated entertainment	3.6	3.6	4.6	3.5
12.	Restraints on behaviour	3.7	3.8	3.7	4.0
13.	Challenge, excitement, adventure	3.3	3.5	3.3	3.7
14.	Informal relationships	3.6	3.5	3.7	4.0
15.	Access to luxuries of life	3.4	3.3	3.6	3.3
16.	Pressure to achieve	3.7	3.8	3.7	4.0

(Cont.)

TABLE 7. AVERAGE SCORES FOR ALL TRANSPORTATION SYSTEMS ON ENVIRONMENTAL COMPONENTS (1.000 = HIGHEST; 7.000 = LOWEST) (Cont.)

Component	Group 1	Group 2	Group 3	Group 4
17. Peace, tranquility	3.7	4.0	4.7	2.7
18. Relaxation	3.9	4.0	3.8	3.1
19. Routine activities	3.7	3.5	3.9	3.1
20. Attractive rural surroundings	3.7	3.4	3.9	3.5
21. Intellectual stimulation	3.7	3.5	4.5	3.0
22. Accessibility to people and places	3.7	3.4	4.3	4.4
23. Personal privacy	3.8	3.8	4.8	4.0

in high access systems (bus, freeway, Amtrak, airstrip) and positive ones on an environment with little or no mass or freeway transportation. This is labeled as a rural community dimension; systems scored favorably on average where they preserved family ties while maintaining population growth (Table 7, Column 1). The third dimension appears to be an anti-economic growth dimension; the three transportation systems promoting growth score low, while the three which do not or are dubious (the airstrip) score high. There is evidence of mixed feelings in the town towards systems promoting growth. Although many persons scored them unfavorably, many also scored them favorably, so that overall the antigrowth dimension appears (Table 7, Column 1).

Group 2 is not too dissimilar from Group 1 in that it scores very high for systems which generate low economic growth and is slightly more concerned about the effects of growth on the environment (Table 7, Column 2). Thus, for this group too, Dimension 1 seems a no-growth dimension, with facilities leading to growth given an unfavorable score and those not doing so being given a favorable score (Figure 19). Dimension 2 seems a dimension associated with access to places for informal but stimulating relationships: facilities providing close countryside access score favorably while those providing access to distant, more sophisticated places score unfavorably (Table 7, Column 2). Dimension 3 seems associated with the stability of the rural community before modern transportation systems were suggested: the presence of the freeway scores negatively and is polarized against its absence (Figure 20). This group scored favorably systems giving routine activities and the preservation of family ties and friendships. Consequently, this dimension is named preservation of rural environment.

The dimensions for the other groups were named in a similar fashion and are as follows: (a) Group 3: access to personal freedom; preservation of rural surroundings; relaxation; (b) Group 4: growth rather than antigrowth; challenge, excitement, and adventure; access to people and places.

The fact that the four groups showed some communality in their dimensions suggests that the town is unified rather than divided about the advantages and disadvantages of alternative transportation systems. This is not the case, however; the INDSCAL diagrams present only composite or group viewpoints. Figure 25 shows how much individuals within a group can vary in the importance which they attach to the different dimensions. The dispersion of weights shown for Group 1 is typical.[26] It is therefore of interest whether these groups, which are homogeneous socioeconomically and in terms of activity patterns, do represent, as previously believed, homogeneous interest groups in terms of the transport systems, particularly with respect to whether their different members will oppose or defend such systems. The analyses of the utilities which INDSCAL supplied for each respondent help answer this question.

Table 8 has been drawn up to show how different members within a group may derive their maximum environmental utilities under different transportation systems. For example, in Group 1, 17/43 people (39.5%) saw their maximum utility coming under the status quo, after the introduction of the interstate highway. However, 26 (60.4%) wanted alterations in the transportation systems to make the environment more desirable: 9 (20.9%) perceived greater benefit with improved bus services, 8 (18.6%) wanted mass transit facilities deleted altogether, and 9 (20.9%) saw their maximum benefit with the addition of an airstrip.

Thus, despite the one central hypothesis in this paper that different homogeneous socioeconomic groups would be supportive of one favorite alternative, the INDSCAL analysis reveals this is not the case. The differential cognitions and evaluations of group members lead to interest groups with supporters drawn from different socioeconomic strata. For example, Column 2 of Table 8 shows that

26. Some of the weights in the space are negative. A personal communication from Prof. R. G. Golledge, Ohio State University, July 16, 1975, indicated that this is not too uncommon a result. In a case like the present one, some subjects could plausibly be negatively weighting some of the dimensions, for example, the dimension concerning economic growth. Considerable controversy over the importance of the dimensions is to be expected in a small town.

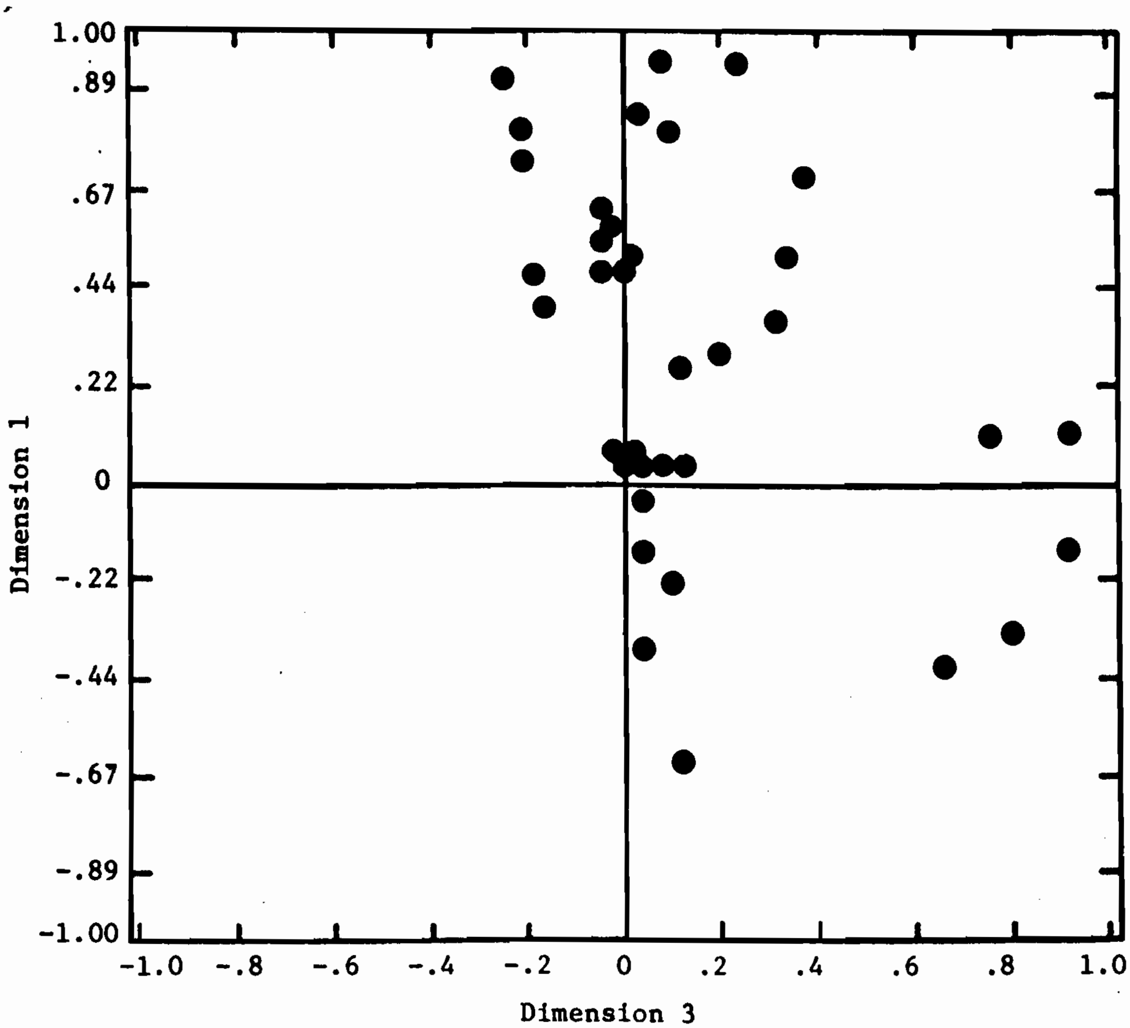

Figure 25. Subject weights for Group 1 on Dimensions 1 and 3.

TABLE 8. NUMBER AND PERCENTAGE OF RESPONDENTS WITH MAXIMUM UTILITIES FOR TRANSPORTATION ALTERNATIVES

	Before Highway	After Highway	Add Train Stop	Improve Bus Services	Delete Bus Services	Add Air Strip	Totals
Group 1		17(39.5)		9(20.9)	8(18.6)	9(20.9)	43(100.0)
Group 2		14(48.3)			13(44.8)	2(6.9)	29(100.00)
Group 3	1(25.0)	2(50.0)			1(25.0)		4(100.0)
Group 4				2(100.0)			2(100.0)
Total	1(1.2)	33(42.3)		11(14.1)	22(28.2)	11(14.1)	78(100.0)

Percentages in parentheses

the post-highway status quo is supported by 17 (39.5%) members of homogeneous Group 1, 14 (48.3%) of Group 2, and 2 (50.0%) of Group 3 in the case study community. This result is interesting in itself. However, its main value is to demonstrate how the INDSCAL framework can be applied to predict ultimately political responses to transportation alternatives in an urban area.

CONCLUSION

This report has presented a framework for analyzing how residents of urban environments themselves perceive and evaluate transportation alternatives. A two phase design was described. In the first phase, a procedure was developed for eliciting the components which residents conceive as comprising their environment under a transportation system. For this, Kelly's Personal Construct Theory and Repertory Grid procedures were used. An example was given of the elicitation of the components which describe the environments of small town residents.

The second phase was more complex. It was hypothesized that, in a sample population, there might be groups who would
(a) be homogeneous according to a very wide range of non-traditional socioeconomic and activity variables and (b) evaluate the components of their kind of environment in the same way under alternative transportation systems. Accordingly, the conceptual framework was extended to define statistically homogeneous groups, using income, occupation, age, and many different kinds of travel behaviors.
This framework was successfully tested with the definition of four homogeneous groups in a case study small town. Finally, the INDSCAL model was employed to determine whether each homogeneous group does evaluate the components of their kind of environment under alternative transportation systems in a distinctive way. For the kinds of homogeneous groups in the case study town it was found that they do not. Each group evaluates transportation systems along similar dimensions, but individual differences within groups are so great that

some members derive maximum utility from one alternative and some from another. Thus, other kinds of interest groups which support or oppose transportation innovations are drawn from different socio-economic and activity groupings. The conceptual framework of this paper demonstrates how such interest groups are derived.

CHAPTER IV. CITIZEN PARTICIPATION

IV. CITIZEN PARTICIPATION

Citizen participation is based on certain ideals that have deep historical roots. The implementation of these ideals is not without problems and challenges. The concepts of representation, organizing for action, conflict, and power have taken on added meanings and call for rational reform. Legislative processes in organizational structures have been challenged, as are some of the traditional ways of solving societal problems. The challenge is to be innovative in the democratic and planning process, so that desirable social change may be accomplished and the spirit of community participation strengthened.

The purpose of this chapter is to consider these various aspects of citizen participation. Since the subject is wide ranging and lengthy, having a substantial literature extant, this chapter must necessarily be of an overview and illustrative type. The intent is to provide the reader with a sufficient feeling and background for the issues of citizen participation and some of the methods or procedures which may be adopted to assist in this process. The references cited throughout the chapter are illustrative of the literature available and are recommended for those readers who wish to pursue the topic further.

HISTORICAL BACKGROUND[1]

There are many differing views on the nature of citizen participation or involvement in the North American scene (Canada and the United States). The concept of citizens' participation is a very important part of the liberal-democratic theory of politics. It is thoroughly imbued in the North American scene. In fact, the term "citizens' participation and involvement" seems almost superfluous in a democratic society. It may certainly be argued that democracy is by nature "participatory" and that the citizen is the source of all political power. However, political theorists have long recognized the

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[1]The basic theme of this section is derived from W. A. Head, "The Ideology and Practice of Citizen Participation," in J. A. Draper (Ed.) Citizen Participation in Canada. Toronto: New Press, 1971, pp. 14-18.

fact that society is composed of a multiplicity of different interest groups. In fact, a potential danger is that powerful interest groups will develop and tend to dominate governmental institutions unless held in check. Therefore, modern citizens' participation and involvement may be viewed as a form of a countervailing power, possessing, at least to some extent, the possibility of checking the influence of other powerful groups exerting pressure upon government on behalf of their interests.

This process is not new in North America. Over a century ago de Tocqueville observed that Canada and the United States are nations of "joiners." North American is characterized by innumerable citizens joining themselves together as interest groups for the purpose of achieving common objectives. In one short study, a total of 215 low-income groups were identified in Canada, most of which had been organized in a two-year period of time.

The most widespread aspect of citizens' participation historically has been the use of the ballot box. In principle, the citizen participates in a democratic government through the exercise of the franchise, and governments get their authority from "the consent of the governed." In practice, some groups make far more use of the ballot box than other groups. There are many reasons for this, but perhaps among the more important is the fact that many groups have a tradition and practice of constant participation in meetings and other group activities. There is ample evidence that members of the middle classes are more prone to organize to protect their interests than lower socio-economic groups.

Much of what has been called "citizens' participation" in the past has been a phenomenon of these middle-class groups. Organizations such as the Rotarian, Kiwanians, other service clubs, Chambers of Commerce, women's organizations, Boy Scouts, professional associations, and so on have been the mainstay of this form of citizens' participation. Undoubtedly, these and other middle-class bodies have contributed a great deal to the social, economic, and cultural objectives of North American society. Furthermore, many interest groups have frequently played an overtly political role in the community. They have succeeded, on occasion, in influencing the acts of governments at the local, state (provincial), and federal levels. Generally, this activity by volunteer groups has been considered a valuable development of North American society as a whole.

However, there has been a qualitative and quantitative change in the nature and extent of citizens' participation and involvement in neighborhood and community affairs in recent years. This development has been rapid and dramatic. Citizens groups represent, in part, an aspect of a world-wide movement by the poor and other disadvantaged people to take action to change their immediate situation. The movement is closely related to the U. S. civil rights movement, the worldwide revolt by increasing numbers of youth, the drive by women to achieve full equality, the efforts of the American Indians to secure rights guaranteed by treaties over the past 200 years, and other similar movements. The new citizens' participation movement includes the activities of tenants demanding decent homes for their families and children at reasonable rates, and of welfare recipients who are organizing against welfare bureaucracies, which have often been oppressive in their treatment of welfare recipients.

But perhaps the largest activating element in the increasing scope of citizen participation has come in the form of concern and response to urban renewal and transportation activities in the larger cities of North America. These activities have often been at the expense of poor people who live in neighborhoods slated for redevelopment or providing relatively low-cost land for transportation corridors. In the case of urban renewal, this type of activity has often meant the displacement of the poor or minority groups. Their neighborhoods and homes have been destroyed to build new high-rise developments for the benefit of the middle-class who can afford to pay the increased rent. In the case of transportation corridors, the neighborhoods and homes of the poor and minority groups have been destroyed to provide transportation systems to bring the middle class into the center of the cities in comfort and convenience -- all too often in the single-passenger-occupied automobile.

The continuing incidence of degrading poverty in the midst of a generally affluent society, the depersonalizing effects of rapid urbanization and technological change and other massive social and economic problems have led to a pervading sense of powerlessness and despair, particularly, but not exclusively, among the low-income people. There is evidence of considerable alienation even among many youths from the more affluent sectors of the North American society as reflected in the "hippie" and drop-out generation. Different groups experience economic, psychological and social deprivation in different ways. However, there is evidence which suggests that the poor suffer the results of alienation much more acutely than other sectors of the population. It is within this context that citizens' participation has become a virtual necessity. It is no longer a question of whether or not participation is a good thing: this is now accepted. For example, citizen participation is mandated by congressional stipulation for many of the federally sponsored and supported programs such as urban and transportation planning.

However, while these sentiments have been expressed by high governmental officials, a considerable body of evidence suggests that much of the public, and particularly the poor, have little faith in participation in the formal democratic structure. At the electoral level, the evidence indicates that citizens from low-income areas participate to a lesser extent in elections than do those from more affluent areas. With the exception of participation in labor unions, few low-income respondents indicate more than minimal participation in various groups and organizations which exist in their neighborhoods. These findings suggest that direct participation of the individual citizen in the process of government and public affairs has long ceased to exist in any meaningful way. The current movement toward increasing citizen participation appears to revive once more, in varying degrees, the involvement of citizens in the governmental process. As such, this process must be recognized as a political activity.

THE RATIONALE OF CITIZEN PARTICIPATION[2]

The ideology of participation appears to be focused upon the following assumption: that the ordinary citizen possesses the right to participate in the decisions which affect her/his life. This concept was given modern expression in the Port Huron Statement, which is a statement expressing the objectives of the Students for A Democratic Society in the United States in 1964. Similar such declarations have become a part of the ideological basis

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[2] Ibid., pp. 18-22.

of much of the new, low-income citizens'-participation activity in North America. This ideology is supported by much of the democratic and liberal ethos of Western societies: an ethos based largely upon faith in participatory democracy as an ideological assumption of great importance. Participatory democracy has been considered to be a reflection of the responsibility of the individual for her/his economic and political station in life. This is a dominate value in Western societies, as reflected in the emphasis upon hard work, freedom of enterprise, thrift, and prudence.

A second assumption underlying the ideology of participation relates to the often expressed attitude of some leaders of disadvantaged groups that the poor have "had enough" and are ready for revolt against the "system" if their demands are not met. In this instance, confrontation tactics are seen as the only way in which disadvantaged groups can demand their share of the fruits of an affluent society. Some groups have used confrontation with considerable effectiveness, particularly in certain situations in which this tactic is appropriate for the achievement for short-term goals. However, there is some evidence that even in many low-income communities in which citizens' groups operate, the majority of citizens do not support militant action for achieving objectives.

A third assumption commonly expressed by leaders of citizens' participation groups, whether in middle-or low-income areas, is that they "represent" the citizens of the area. Clearly, such groups represent the interests of some of the residents of the area. What is unclear is to what degree they represent the interests of the total area. This is, of course, a rhetorical point in that it is almost impossible for any one group to represent the diverse interests of all residents of any area. Membership figures and levels of participation in groups indicate that no more than token interest in the majority of residents exists in most groups. This is not to suggest that a small membership necessarily reflects insignificance and lack of influence. Many well-led groups with few supporters have accomplished impressive results, particularly in terms of their ability to "veto" action which they disapprove.

This form of representation, however, raises a number of basic questions relating to the nature of democratic government. Some of the questions are: (1) Can elected government officials delegate decision-making (political) power to voluntary groups? (2) How does this delegation relate to their official duty to represent their constituents, since by law the elected officials are duly elected decision-makers in a democratic society? (3) Can a neighborhood expect that a self-selected, voluntary-interest type group will actually represent the entire neighborhood rather than merely the interest of its members?

These questions point out the extreme complexity of defining the "public interest" to the satisfaction of all groups in a given community. Furthermore, most neighborhoods are composed of a number of interest groups, each competing with others to influence public opinion and to reach goals important to themselves. An additional problem is the achievement of goals important to one group that may be perceived as detremental to the interests of other groups.

A fourth assumption made by many low-income citizen participation groups is that their activities are "non-political" and above the negotiations and compromises of partisan politics. This belief ignores the central fact of community life. That is, any attempt to alter the economic, social, or political structure of society is, in its broad sense, inherently political. There is little doubt that citizen participation has begun to change the entire concept of the political process in our urban areas. This is not to suggest that politicians welcome the development of citizens groups. In fact, the evidence would indicate that many politicians would prefer the old concept of the citizen restricting her/himself to merely voting in periodic elections. But some politicians are beginning to perceive that citizens groups can be a source of strength and are actively consulting and listening to local groups interested in community improvement and change.

The final implicit, and perhaps insidious assumption about citizen participation relates to the fact that many of the programs that are designed to help the poor involve, at least to some extent, the concept that the poor are responsivle for their own poverty. In this case, the problems of poverty, slums, etc., are defined in terms of having the poor learn "responsible behavior," a type of behavior patterned after middle-class standards and values. The frequent result has been the establishment of retraining programs designed to equip the poor for low-level jobs, "head-start" programs designed to deal with the handicaps of the "culturally deprived" children of poverty areas, or programs designed to teach parents middle-class child-care methods.

Seldom is the question raised whether the programs based on these values are appropriate in terms of helping poor people escape from poverty. There is very little evidence that these programs actually help the poor escape from poverty, although a few of the most capable and socially poor do manage to escape their plight.

Another stance adopted by many community-action programs has a beginning assumption that the problems of poverty are basically problems of social and economic inequalities and that a massive redistribution of power is a necessary goal. Clearly, this stance raises a number of basic questions. One of the central questions involving the issue of citizen participation is whether it is possible for a local citizens' group to achieve change in the status of its members through an attack upon the social, economic, and political structures of the contemporary society. In short, how can the local citizens' group be expected to achieve meaningful structural change when the massive problems of modern industrial society persist in spite of increasing affluence, rising levels of education, better health care, and other effects of modern technology and knowledge?

Little evidence exists, either in the United States or Canada, that the poor alone can plan, operationalize, and conduct major programs directed at major structural change in modern societies. Indeed, given that no other group has been able to handle the task, it is difficult to understand why anyone could have expected that the poor could accomplish such an undertaking. Although there are no answers to these questions at the moment, the emergence of citizen's participation groups is based upon the assumption that citizen's groups, with a low or middle income, can through organized action release major sources of energy and ability which have been largely untapped in the past. While there is no evidence that they have been able to affect major structural changes in society, the activities of most low income groups are beginning to result in some significant changes and improvement in the services available to the poor. In fact, the concerns of citizen's participation groups represent and reflect that, to a significant extent, community agencies and organizations, presumably organized for the purpose of meeting the needs of local citizens, have largely failed in achieving that goal.

Political Decision-Making: Issues of Substance and Process[3]

The litany of our societal ills is by now all to familiar. The size and pervasiveness of all forms of organization and bureaucracy, of the pace of change, and the complexity of the issues are overloading our capacity to understand and our procedures for sound decision-making. There is a simple question, at the gut level, of the sheer stamina required to sustain the working-through of decision-making procedures that produce results that are democratic and technically competent.

All classes in society are increasingly faced with the dilema of participation, though it is the poor who experience most forcefully the inadequacies of current participatory means in seeking redress of inequities in our social structures and in our distribution of resources. Verba[4] suggests that there are four causes contributing to this situation:

1. The economy is expanding and changing rapidly in ways that benefit some and not others.
2. There are great mobility opportunities for some in the social structure.
3. There are emerging values which reject traditional means of social control.
4. The expansion of government intervention in the economic and social life of the nation increases the stakes of participation.

The substantive magnitude of contemporary issues clearly reveals that the stakes are high. Matters of pollution, of resource scarcity, and technological response allow for only slim margins of error, if any at all. There is a sense of finality about the decisions before us, which, once taken, seem irrevocable. The character of a city can be sealed through the development of a freeway network; the fate of a river system can be determined by hydroelectric dams. There is an obvious, almost desperate, need for uncomplicated information and a means to predict with some accuracy the consequences of

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[3]This material is essentially drawn from M. Clague, "Citizen Participation in the Legislative Process," in J. A. Draper, op. cit., pp. 31-34.

[4]Verba, S., "Democratic Participation," The Annals of the American Academy of Political and Social Science, 16 (1967), pp. 53-78.

any given course of action. As Bauer[5] indicates: "In the conduct of human affairs, our actions inevitably have second-ordered consequences. These consequences are, in many instances, more important then our original action."

It is inevitable, given this climate of complication, that there are pressures for technologically correct substantive decisions at the expense of democratic processes. However, it is not simply an issue of "the people versus technology." A case in point is pollution. The tone of the debate sometimes suggests legislation by fiat against further technological defacing of the environment without sufficient concern for the welfare of those affected by such action. Inevitably, those whose livelihood is affected are in opposition to the environmentalist. Somehow technology needs to be re-routed in the manner that ensures basic securities as well as protection of the environment. It is only through democratic means that it is possible to maintain a sensitivity as to what constitutes basic securities.

It is significant that there is a growing concern today for the processes of decision-making. In fact, for some individuals, the values and norms expressed in how a decision is arrived at are more important than the decision itself. For these individuals, there is the implicit assumption that if people are effectively involved, then the decision will be correct. This existential mood is particularly prevalent among many of the young and counter-culture groups and within the human-potential movement. Although it is a frequently isolationest and over-simplified notion, it is a philosophical stance badly needed in a technocratic age. There will undoubtedly be growing pressures for a benevolent, totalitarian decision-making. These pressures will be nourished through our frustrations of trying to manage the technological life confronting us.

The dual concern for both confidence and technological management in a democratic process of decision-making has an inherent strength in that we are forced to ferret out and develop new options that are hopefully more harmonious in solution to both people and the environment. This increases the options available for creative compromise. For example, in a freeway debate

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[5]Bauer, R. (ed.) Social Indicators, Cambridge, Massachusetts: M.I.T. Press, 1966.

the options cannot simply be the number of expressway-route alternatives. The options must include non-freeway proposals which deal with the effective movement of people, goods, and services. This then allows questions to be asked that would include consideration of factors least disruptive to community life and indeed those options that can enhance it for the foreseeable future.

The issue of concern here is that decisions are opposed and made up on a grand scale affecting whole communities and whole societies, yet the individual human scale needs somehow to be protected and enhanced. In short, there is the greater good and there is the particular good. It is easy for a compromise to be too narrowly defined and rationalized through the "creative good of all the people" argument. Guisinger[6] suggests that the goals of large-scale, micro-economic planning and those of community and social development are not fully compatible, and conflict between the two emphases can be expected. People in target areas for economic development frequently prefer planning and resources that strengthen their existing life-style rather than changing employment and residence to suit the requirement of the new industries.

It often seems that there is an implicit assumption that the larger public purposes which foster an area-development plan are in fact accurate reflections of the public good. But, as McCrorie states " . . . if the larger society itself is not questioned then planning is incomplete and a key factor in involvement ignored."[7] It is possible that the values local residents stubbornly protect are worth nourishing for the greater good too. We must assume that effective compromise in planning produces an economy more resilient and ensures maintenance of the best in local values in participation. The problem is that citizen involvement is limited in the spectacular economics of large-scale development while the potential for vast, bureaucratic decision-making is unlimited.

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[6] Guisinger, S., Local Participation, Cambridge, Massachusetts, ABT Associates, Inc., 1969.

[7] McCrorie, J. M., ARDA: An Experiment in Development Planning, Report of the Canadian Council on Rural Development. Ottawa: Queen's Printer, 1969.

Thus, we are confronted with some of the dilemmas of citizen participation. Part of the difficulty stems from society's idealized value premise concerning citizen participation, coupled with an inability to make it work in policy-making. As part of our democratic heritage, citizen participation is often proclaimed as a means to the perfect democratic process. In its simplest form, the viewpoint is that the citizen is the ultimate voice in community decision-making. Citizens should share in decisions affecting their destinies. Anything less is considered to be a betrayal of our democratic tradition.

However, even the most ardent supporters of citizen participation admit that citizens cannot participate in all decision-making functions. The most extreme example revolves around questions of national security. Another area alluded to previously is concerned with decisions requiring technical competency. On what basis, though, are decisions defined as being technically outside the view of the citizen?

There is no easy answer. Indeed, there may not be one. This of course, is the basis of the dilemma--the demand for both participatory democracy and expertise in decision-making. It is clearly not possible to maximize both value preferences. Some accommodations have to be made. Generally, value conflicts--the conflict between freedom and control is one example--tend to be resolved pragmatically. Mechanisms are developed to minimize differences. Existing conditions are used as criteria for determining when and how to maximize one value over another.

Burke suggests that the most difficult area of all is the choice of <u>strategy</u> objectives for citizen participation.[8] Citizen participation is commonly advocated as serving fairly specific objectives, often predicated less upon value premises than upon practical considerations. In fact, this is what makes it acceptable in many cases. According to some, citizen participation can rebuild deteriorating neighborhoods, devise realistic and better plans, pave the way for the initiation of the poor and the powerless into the main stream of American life, achieve support and sanction for an organization's objectives, end drifts toward alienation in cities, hault the rise

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[8] Burke, E. M., "Citizen Participation Strategies," <u>Journal of the American Institute of Planners</u>, 34 (1968), pp. 287-294.

in juvenile delinquency, and recreate small town democracy in a complex urban society.

Implied in all of this is the suggestion that citizens can be used as instruments for the obtaining of specific ends. In short, citizen participation is a strategy. Unfortunately, the ends are sometimes conflicting. In one case, citizen participation is advocated as an administrative technique to protect the stability or even the existence of an organization; in another instance, it is viewed as an educational or therapeutic tool for changing attitudes; In still another case, it is proposed as a means for assisting an organization to define it's goals and objectives.

Obviously, to imply that citizen participation as a single, undifferentiated and overriding strategy is misleading. It is clearly more accurate to speak of several strategies of citizen participation, defined in terms of given objectives. Limits on these objectives may well be determined by the available resources, as well as the organizational character of community activities, particularly community planning. Since formal organizations are responsible for planning, any strategy will be influenced by organizational demands. In summary, the irrelevancy of a strategy depends both upon an organization's abilities to fulfill the requirements necessary for the strategy's effectiveness and upon the adaptability of the strategy to an organizational environment.

Types of Participation and Non-Participation

A variety of typologies of the uses of citizen participation may be developed. For example, Burke identifies five strategies commonly used in citizen participation.[9] Arnstein identifies eight levels of participation.[10] Regardless of which typology is adopted, it is important to realize that these categories are not mutually exclusive, nor necessarily exhaustive. In this chapter we adopt Arnstein's typology and briefly summarize its main points.

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[9] Ibid.

[10] Arnstein, S. R., "A Ladder of Citizen Participation," Journal of the American Institute of Planners, 35 (1969), pp. 216-224.

Figure 26 illustrates the eight types of participation. They are arranged in a ladder pattern with each rung corresponding to the extent of citizen's power of determining the end product. The bottom rungs of the ladder are: (1) Manipulation and (2) Therapy. These are essentially "non-participation" levels of citizen's participation that have been contrived by some individuals and organizations to substitute for genuine participation. Their real objective is not to enable people to participate in planning and conducting programs, but to enable powerholders to "educate" or "cure" the participants. Levels of "tokenism" are illustrated by rungs 3 and 4. That is, the citizenry is allowed to hear and to have a voice: (3) Informing and (4) Consultation. When the powerholders offer this form of participation, citizens may indeed hear and be heard. But under these conditions they lack the power to assure that their views will be heeded by the powerful. When participation is restricted to these levels, there is no follow through, hence no assurance of changing the status quo. Placation, rung 5 is simply tokenism on a higher level. This is because the ground rules provide for citizenry advice, but the right to decide remains with the powerholders.

Higher up the ladder are levels of citizen power with increasing degrees of decision-making power. At level 6 citizens can enter into a partnership that enables them to negotiate and engage in trade-offs with the traditional powerholders. (7) Delegated power and (8) citizen control, the top most rungs, provide citizens with the majority of decision-making seats, for full managerial power.

Obviously the eight-rung ladder is a simplification. However, it does help to point out that there are significant gradations of citizen participation. Knowing these gradations makes it possible to more adequately evaluate the level of citizens participation as well as understand the various types of interactions that occur between citizenry and the powerholders.

To briefly consider the eight levels of participation and non-participation, we start with the bottom rung, namely manipulation. In this case, in the name of citizen participation, people are placed on rubber stamp advisory committees or advisory boards for the express purpose of "educating" them or engineering their support. The bottom rung of the ladder signifies a distortion of participation into a public relations vehicle by the powerholders. The second rung, therapy, perhaps should be the bottom

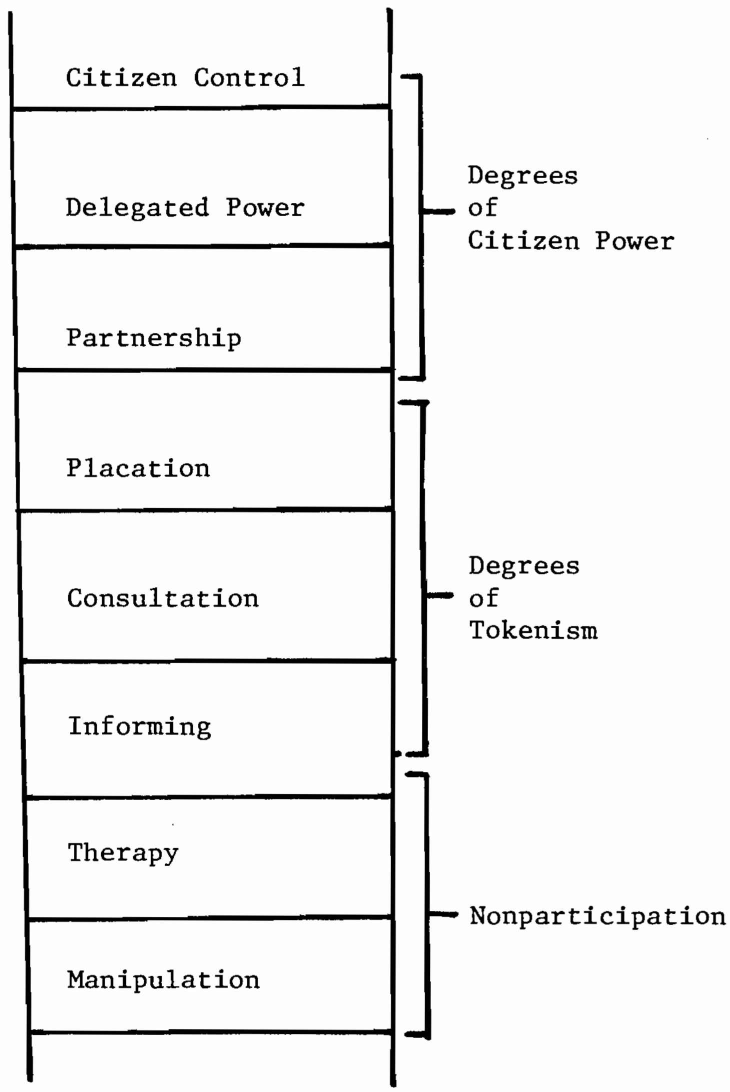

Figure 26: Eight rungs on a ladder of citizen participation (after Arnstein, p. 217).

rung. This is because group therapy, marked as citizen participation, is both dishonest and arrogant. What makes this form of "participation" so invidious is that citizens are engaged in extensive activity, but the focus of it is on curing them of their "pathology" rather than changing the racism and victimization that create their "pathologies".

The third level, informing citizens of their rights, responsibilities, and options can be the most important first stem toward legitimate citizen participation. Unfortunately, the emphasis is often placed on a one-way flow of information--from officials to citizens-- with no channel provided for feedback and no power for negotiation. This is particularly true when information is provided at a late stage in the planning. In these circumstances people have little opportunity to influence the program designed "for their benefit". The most frequent tools used for such one-way communication are the news media, pamphlets, posters, and responses to inquiries. Meetings can also be turned into vehicles for one-way communication by the simple device of providing superficial information, discouraging questions, or giving irrelevant answers. Consultation, step 4, which involves inviting citizens' opinions, can be a legitimate step toward their full participation. But if consulting them is not combined with other motives of participation, this rung of the ladder is still a sham since it offers no assurance that citizens' concerns and ideas will be taken into account. Attitude surveys, neighborhood meetings and public hearings are the most frequent methods used for consulting people. Where consultation is not combined with other means of participation, the citizens are primarily perceived as statistical abstractions, and participation is measured by how many come to meetings, take brochures home, or answer a questionnaire. The value to the powerholders is that they have obtained evidence of having gone through the required motions of involving "those people".

The fifth level, placation, is a point in which the citizens begin to have some degree of influence, although tokenism is still apparent. An example of a placation strategy is to place a few hand-picked "worthy" poor on boards of Community Action Agencies, and on public bodies like the Board of Education, Police Commission, or Housing Authority. These people can be outvoted easily and outmaneuvered if they are not accountable to a constituency in a community and if the traditional power elite holds the majority of seats.

Partnership, rung six, is where power is redistributed through negotiations between citizens and powerholders. Planning and decision-making become shared responsibilities through structures such as joint policy boards, planning committees, and other mechanisms for resolving impasses. Once the ground rules have been established through some form of give-and-take, they are not subject to unilateral change. This level of citizen involvement can work most effectively when there is an organized power-base in the community to which the citizen leaders are accountable; and when the citizens' group has financial resources to pay its leaders reasonable honoraria for their time-consuming efforts; and the group has the resources to hire and fire its own technicians, lawyers, and community organizers. Citizens have some genuine bargaining influence over the outcome of the plan with these ingredients.

Negotiation between citizens and public officials can result in citizens' achieving dominant decision-making authority over a particular plan or program. This is the delegation of power to the citizens. At this level, the ladder has been scaled to the point where citizens hold a significant edge to assure accountability of the program to them. In this situation, powerholders need to start the bargaining process to resolve differences rather than respond to pressure from the other end.

The highest level of citizen participation is in citizen control. Although no one in the nation has absolute control, it is very important that the rhetoric not be confused with intent. Citizens are simply demanding that degree of power (or control) which guarantees that the participants or residents can govern a program or an institution, be in full charge of policy and managerial aspects, and be able to negotiate the conditions under which "outsiders" may change them. The most frequently advocated model is a neighborhood corporation with no intermediaries between it and the source of funds.

Again, it should be reiterated, that the eight separate rungs on the ladder are a simplification. In the real world of people and programs, there might be one hundred and fifty rungs with less sharp and "pure" distinctions among them. In addition, some of the characteristics used to illustrate each of the eight types might be applicable to other rungs. For example, employment of citizens in a program or on a planning staff could occur at any of the eight rungs and could represent either a legitimate or illegitimate characteristic of citizen participation. Depending on their motive, powerholders can hire citizens to co-opt them, to placate them, or to utilize their special skills and insights.[11] These points should be kept in mind when evaluating eigher the procedures in a given context or the involvement of citizens in a given situation.

Review of Available Procedures

Before proceeding with a review of procedures for assisting in the citizen participation process, it is important to point out that the extant literature is primarily urban in thrust. That is, most of the research and reporting on citizen participation has dealt with large city groups and problems.[12]

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[11] See Burke, op. cit., for discussion of various employment strategies.

[12] Illustrative of some of the literature on citizen participation which is concerned primarily with urban or large city situations are: "S. R. Arnstein, op. cit.; L. Axworthy, "Winnipeg: An Experiment in Innovation," In L. Axworthy and J. M. Gillies (Eds.) The City: Canada's Prospects Canada's Problems. Toronto: Butterworth and Co., Lto., 1973, pp. 276-283; Bellush and M. Hausknecht (Eds.) Urban Renewal: People, Politics and Planning. Garden City, New York: Anchor Books, 1967, pp. 278-286, Bureau of Municipal Research "Neighborhood Participants in Local Government," in Axworthy and Gillies, op. cit.; R. Dahl Who Governs, New Haven: Yale University Press, 1961; A. Etzioni, The Active Society: A Theory of Societal and Political Processes. New York: The Free Press, 1968; J. Friedmann, "The Public Interest and Community Participation: Towards A Reconstruction of Public Philosophy", Journal of the American Institute of Planners, 39 (1973), p. 2, pp. 4-7; H. J. Gans, "Commentary", Journal of the American Institute of Planners, 33 (1973) p. 3, pp. 10-12, H. Hyman, "Planning with Citizens: Two Styles", Journal of the American Institute of Planners, 35 (1969), pp. 105-112; M. Kaplan, "Advocacy and the Urban Poor", Journal of the American Institute of Planners, 35 (1969), pp. 96-101; M. Mogulof, "Coalition to Adversary: Citizen Participation in Three Federal Programs, Journal of the American Institute of Planners, 35 (1969), pp. 225-232, D. P. Moynihan, Maximum Feasible Misunderstandings: Community Actions in the War on Poverty. New York: The Free Press, 1969; R. Nisbet, "Commentary," Journal of the American Institute of Planners, 39 (1973), p. 3, pp. 8-9; L. Peattie, "Drama and Advocacy Planning", Journal of the American Institute of Planners, 36 (1970), pp. 405-410; M. Rein, "Social Planning: The Search For Legitimacy", Journal of the American Institute of Planners, 35 (1969), pp. 233-244; T. D. Sherrard and R. C. Murry, "The Church and Neighborhood Community Organization", Social Work, 10 (1965), pp. 3-14; C. E. Silbernam, Commentary, 37 (1969), pp. 51-58; H. B. C. Spiegel (Ed.) Citizen Participation in Urban Development: Volume 1, Concepts and Issues. Washington, D. C.: Center for Community Affairs, NTL Institute For Applied Behavioral Science, 1968; R. L. Warren, "Model Cities First Round: Politics, Planning, and Participation," Journal of the American Institute of Planners, 35 (1969) pp. 245-252; J. Q. Wilson, "Planning and Politics: Citizen Participation in Urban Renewal", Journal of the American Institute of Planners, 29 (1963) 242-249; J. Zimmerman, "Community Building in Large Cities", in Axworthy and Gillies, op. cit. pp. 267-275.

The literature on citizen participation in small towns is virtually non-existent.[13] Thus, it may be necessary to modify or simplify the procedures described here for use in smaller towns or rural communities. To the extent that this can be ascertained *a priori*, suggestions for such modifications are made in the following discussion.

The Public Hearing

The most wide-spread form of citizen participation is still the public hearing, which is mandated by the requirements of federal funding and has been adopted by most states for many projects not receiving federal aid. In the case of highways, for example, at least one public hearing is required prior to the final approval of the location and/or design of a new facility or an improvement where the project would require the taking of additional right-of-way, have a significant impact on abutting property, or change the layout or function of existing streets or roads.

The conduct of most public hearings is relatively formal, consisting of presentations by agency officials, whose role is to describe the proposed plan or project, explain its consequences, and attempt to answer questions from the public. Transcripts of the hearing are required by law.

As noted earlier, the public hearing would not rank high in the hierarchy of strategies (level 4, consultation). The public hearing has often been criticized on the grounds that it is not actually a form of consultation since there is usually considerable momentum behind a plan or a project by the time the hearing is conducted. In practice, the public hearing is often a forum for special interest groups, or it consists of one-way communication between the agency and the public. In such cases, the real intent of the hearing is to manipulate opinion or to meet the formal requirements of the law rather than to solicit advice.

A recent study of actual practices in conducting hearings notes that there is a wide variation among the states in their approaches to public

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[13] See, for example, A. J. Vidich and J. Bensman, *Small Town in Mass Society*, Princeton: Princeton University Press, 1958.

hearings.[14] The effectiveness of the public hearing depends upon a variety of factors relating to administrative procedures, the effort expended prior to the hearing, and the actual conduct of the hearing. Some of the more important factors and their variations are noted in Table 9.

The report's conclusions concerning the effectiveness of the various practices may be summarized as follows.[15]

1. The decentralized administration is preferred because of the greater accessibility of the regional or district office and because, ideally, such an office would be more familiar with the local population and with the area's transportation problems and projects. A full-time public liaison officer should be employed in each region or district

2. The tendency to increase the amount of pre-hearing citizen involvement can lead to greater agency credibility. Further, the use of informal public meetings as stepping stones to the public hearing is likely to reduce controversy by "ironing out" problems beforehand. The hearing thus becomes primarily a ratification of previous decisions and "a formal milestone--signalling to public and private participants that a decision is about to be made."[16]

3. The moderator at the public hearing should be a non-agency person in order to eliminate bias. He should be a professional with expertise that might be relevant to his role as moderator. Lawyers, for example, have served effectively as moderators.

4. The type of communications prior to and after the hearing should be as thorough as possible, emphasizing ease of communication. News releases, advertisements (as opposed to legal notices), billboards, and personal contact with those most likely to be affected by the project are some of the techniques which should be employed prior to the hearing. Return forms, toll-free numbers, and other provisions for citizen-initiated response should be used to encourage citizen input.

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[14] Michael A. Perfater, "Citizen Participation and the Role of the Public hearing," Virginia Highway and Research Council, February, 1975 (VHRTC 75-R36).

[15] For a complete list of the report's recommendations, see _ibid_., p pp. xiii-xiv.

[16] _Ibid_., p. 15.

Table 9:

Factors Which Determine the Effectiveness of Public Hearings

I. Type of Administration of Agency
   a) Centralized
   b) Decentralized

II. Type of Pre-Hearing Public Involvement
   (One or a combination of the following:)
   a) Public Meetings
   b) Citizen Advisory Groups
   c) Opinion solicitation procedures

III. Type of Communication Prior to Hearing
   (One or a combination of the following:)
   a) News media announcements
   b) Mail-outs
   c) Direct personal contact with interested parties

IV. Type of Moderator at Hearing
   a) Public Affairs Officer or Specialist
   b) District Engineer
   c) Non-agency public speaker

V. Location and Time of Hearings

VI. Post-Hearing Procedures
   a) Publication of transcript and/or
   b) Response to unanswered questions through personal contact or mail

5. The location and time of the hearings should be convenient for the citizens most likely to have an interest in the project. Though variations in appropriate locations and time may occur depending on the project, the best location is as near the project site as is feasible, and the best times are, for obvious reasons, in the evening or on weekends.

Perhaps the most important conclusion of the Virginia report, one generally borne out by the opinions of transportation agency officials, is that the public hearing is no longer regarded as the most important form of citizen participation, even if it is still the most widely used. The public hearing is now being superceded by other less formal but more extensive forms of consultation or by strategies that delegate more decision-making power to citizens or their representatives. In fact, as noted by Graven, if citizen participation implies involvement in the processes of planning and decision making, then the public hearing, which occurs after policy and planning decisions are already well advanced, cannot be considered a participation at all.[17]

The Public Meeting

As opposed to the formal public hearing, informal public meetings may take a wide variety of formats and may be used to elicit citizen "input" and participation at every stage of the planning process. Public meetings may provide meaningful forms of consultation and, depending on the techniques used, may establish significant degrees of partnership between citizens and planners. The public meeting may be employed in the following ways:

1. As preparation for required project public hearings;
2. As sources for developing goals and objectives; and
3. As planning sessions where both technicians and the public make decisions on projects.

As noted in the last section, the public meeting is used extensively in the pre-hearing phase of project planning, though not to the same degree in each state.

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[17] David Graven, "Citizen Participation in Regional Planning," Special Report 142, Highway Research Board, Washington, D. C., 1973, p. 55.

> Twenty of the agency representatives interviewed reported that their agencies utilize a very extensive pre-public hearing meeting program. Eight of the agencies reported that pre-hearing meetings are optional or are held only if requested or if a specific problem arises which warrants a special (sic) called meeting. In the remaining 22 state agencies there is at least one pre-public hearing meeting held on most significant projects.[18]

Pre-hearing public meetings may be subject to the same criticism leveled at the formal public hearing when they are used only to provide information to the public or to serve merely as "therapy" sessions. On the other hand, in cases where there are frequent public meetings held over a relatively long period of time prior to the public hearing and where agency representatives are responsive to the suggestions of the participants from one meeting to the next, the result can be, at the least, a means of obtaining consensus and at the best a partnership approach to project planning.

The Problem of Citizen Participation in Small Communities

It might be assumed that small communities would represent the ideal case for full citizen participation. In communities under 10,000, especially, an individual who has lived in town for any length of time is likely to know or have at least a "passing acquaintance" with a great percentage of the other residents. The tradition of the town-meeting in some regions and the variety of voluntary associations usually present in small towns accustom the resident to participation in some form of the decision-making process--setting goals, debating alternatives, and implementing solutions to local problems. Given the opportunities for contact between residents and for most citizens to become involved in an immediate way with the decision-making process, one might expect that it would be relatively easy to get "meaningful input" from a broad spectrum of the community on a particular issue and that the mechanisms for developing community consensus would already be "built in".

There are, however, social characteristics of small towns in general which may often work as inhibitors of genuine citizen participation.

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[18] Prefator, op. cit., p. 9.

The "I have to live here" syndrome. The smallness of a community creates the necessity as well as the opportunity for mutual contact among citizens. That necessity often creates a reticence to publicly express opinions and reveal attitudes that would create controversy or simply expose an individual to the disapproval of his fellow citizens. The desire not to antagonize others too often creates an apparent consensus when none in fact exists.

The distrust of the political process. In many small towns, there is an ingrained distrust of both external authority and the local leadership. An attitude of helplessness, and hence of cynicism, in regard to extra-local authority is wide-spread in small communities. The small town resident feels himself remote from the decision-makers whose actions affect his life. He often feels incapable of understanding the rationale behind a great many policies and decisions, and he does not see any meaningful way that he can contribute to a process apparently designed not to accomodate him.

His view of the local political leadership is often equally distrustful. He alludes to the existence of a ruling elite (the "boys downtown," "the folks at city hall"), and he assumes that its members will act only in their own interest. It might be suggested here that "ruling elites" often exist (or are thought to exist) because of the typical political process in many small communities. The desire to minimize conflict results in the minimization of issues on the local level, which in turn diminishes the political activity and participation in the electoral process.

These two social features will often be encountered in small communities, posing a dilemma for the planner who is genuinely interested in promoting citizen participation. If he chooses traditional tools for obtaining citizen participation (i.e., public meetings, citizen committees, etc.), he is less likely to elicit a set of responses indicative of the full spectrum of citizen attitudes than to discover an apparent but often specious consensus. On the other hand, if he uses means more apt to identify genuine attitudes, his information may well be useless as a measure of what can be expected in terms of actual community reaction.

CHAPTER V. RURAL COMMUNITY INVOLVEMENT IN TRANSPORTATION

V. RURAL COMMUNITY INVOLVEMENT IN TRANSPORTATION

INTRODUCTION

The history of research related to transportation planning in this country has been primarily concerned with the movement of goods and services between metropolitan centers, within metropolitan centers, and from rural areas to metropolitan centers. The problems of our metropolitan areas are continually compounded by people moving from rural areas to metropolitan areas. New legislative programs at the federal, state, and local levels are being designed to check this flow of people and to make the rural community a viable context within which people can live their lives. Regional transport planning can contribute to enhancing the quality of life in rural communities, thereby making it possible for people to consider remaining in their communities and for those presently living in urban areas to consider living and working in rural communities. In order to provide a viable rural community not only must a sound economic base be provided but also a procedure or process by which these people can have a hand in shaping the destiny of their community. Providing a viable "planning process" requires that all persons affected by a proposed course of action be included in its formulation and that these persons be equipped with the appropriate skills and/or knowledge to make a significant input into the decision-making process. A main conclusion of the research described in the preceeding chapter was the need for providing and transmitting skills and knowledge concerning growth and development in rural communities as affected by interurban transportation systems.

Stimulating growth and development in rural communities can assist in relieving the pressure on metropolitan areas, to assist in planning for an uncertain future. The motor vehicle in some form is the primary means for transporting goods, services and people in rural areas and between metropolitan centers. To what extent the motor vehicle will continue to be an economically viable means of primary transportation is problematical. The influence that alternative modes of transportation will have on rural communities is not understood in a clear enough way to seriously evaluate alternative transportation plans as they would promote or retard the growth and development of rural communities. An involvement process at the rural community level must be capable of providing a form to assess the effects of alternative modes of transportation as yet not present in the rural environment.

A community's potential for growth and development is not exclusively generated by transportation systems. For a community to further influence its potential it must also consider education, health care, recreation, police and fire protection, water quality, waste disposal capacity, visual quality, etc.

The region of the United States represented by the Eastern half of Texas was selected as an ideal area within which to develop an understanding of how interurban transportation systems affect the growth and development of rural communities. Within this region there are a few metropolitan centers: Dallas/Ft. Worth, Houston, Galveston, San Antonio, Laredo, Corpus Christi, Waco, and Austin. Scattered between these urban centers are numerous rural communities. These rural communities have been influenced in their growth and development by the transportation systems connecting these metropolitan centers. This region provides an ideal source of information for the development of the predictive model. The interurban transportation systems in this region include the interstate highway system in operation, under construction, and proposed. It includes the railroads for the movement of goods and people. The AMTRAK route from Chicago to Mexico will pass through this area. A network of product pipelines also exists in the region.

The study focused on communities of a population less than 25,000. Communities of this size are not classified as SMSA and are not required to have a planning process to guide growth and development. Assuming that federal, regional, state, and local programs designed to promote growth and development in rural communities are successful, it is desirable to develop techniques of directing change rather than waiting for problems to surface.

Interactions and Perceptions of Rural Communities

From the research described above a problem exists to make the relationship between the community and external agencies more effective. The resentments of many small community residents toward the external agencies need to be overcome.

Based on our own experience in rural communities, there are three general steps which can be taken by transportation agencies to reduce the major sources of resentment:

1. Expand the concept of direct responsibility to permit compensation for a wider spectrum of damages.
2. Extend direct technical planning assistance to rural communities, beginning early in the project phase of facility improvement and continuing into the period when the operational characteristics are established.
3. Increase the levels of assistance and cooperation through the creation of a comprehensive planning group composed of citizens and representatives of planning and advisory agencies to monitor changes and develop strategies for community-wide development.

The rationale for each of these steps and their application to reducing resentments in rural communities may be illustrated through reference to the specific problems encountered in the study community.

Expanding the Notion of Direct Responsibility

In most states, direct responsibility has been assumed only for damages which occur incident to the taking of the right-of-way. Recent policy proposals have tended to recommend expanding the concept of responsibility to include affected areas outside the right-of-way. One such proposal suggests that the current state of the art of impact measurement would allow for the delineation of a "transportation impact zone" and that compensation for losses within that zone could be computed as a part of project costs.[1] The conception of an impact zone seems to be an essential and logical extension of the current legislative requirements that consideration be given to economic, social and environmental impacts. However, under the strict environmental loss criteria employed by the authors of this proposal, the people most likely to be affected in small communities would be excluded.

> . . . Generally, the overall impact of new transportation facility development on commercial values is significantly positive. In those instances where individual businesses are hurt, the evidence suggests that this is the result of changed traffic patterns and not of reduced environmental quality. It is not clear that public

[1] Blackburn, Anthony J., and Sharon M. Oster, "Transportation Impact Zone Policy," Research Record 528, Transportation Research Board, August 1974, pp. 25-34.

agencies should be made liable for commercial losses resulting from the improvement of transportation facilities when they have no current means of appropriating the benefits. Furthermore, in most cases where losses exist, they are incurred not close to the new facility but at a distance and in an area in which traffic flows have been reduced.

> It can be argued that although locational decisions are critical in the success or failure of single commercial enterprises, the outcome of these decisions is a normal business risk. If this is true, it would also reduce the incentives for making sensible and cautious decisions about future location.[2]

The same authors would compensate owners of residential property for losses incurred by increased noise levels.

The usual practice of by-passing a rural community in highway construction normally eliminates many problems associated with impact on existing residential areas. The most immediately affected group are usually those dependent on previous traffic flows for their businesses. In the particular case of the study community, those who were measurably affected owned traffic-serving businesses scattered along a two mile stretch of the old U. S. highway. In light of the lack of advance knowledge about the upgrading of the route, it can hardly be said that their locational choice was "a normal business risk." (Otherwise, it might be also said that someone who buys a house in a residential area that later becomes devalued by the noise of a new facility deserves no compensation because it is a "normal" risk of <u>his</u> investment.) The construction of the new facility had two effects in addition to an immediate loss of revenue to particular businesses. As a result of the controlled-access facility, the number of optimal sites was reduced, being limited to the quadrants of the one local interchange. Larger operations became economically feasible, since fewer operations would be serving an increased traffic flow. Prices rose as outside investors became interested in the new sites, effectively pricing those who wished to re-locate out of the land market. The latter situation is connected with another source of

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[2] <u>Ibid</u>., p. 33

resentment mentioned earlier - the loss of local benefits to "outsiders." While the investment of outside capital is not in itself negative, and in fact is usually desirable, in most small towns it is negatively perceived when such investment seems to be to the disadvantage of individuals in the community.

Although full compensation may not be justified for temporary losses, since future growth often works to offset initial drops in revenus, for the most severely impacted small businesses assistance payments could be made to cover a specific period of loss, and loans could be made available for local partnerships who wished to combine previously separate operations, making them competitive with those who have greater resources.

The extension of the notion of direct responsibility has application to other problems in rural communities, especially after a facility becomes operational. In the case of highways, for example, changes in traffic patterns and density may make control measures necessary or desirable, even though the community may not be able to afford the expense of instituting such measures. The establishment of a procedure to measure the need for, and a fund to meet, any "post-project" costs could alleviate problems experienced especially in those rural communities where there is no off-setting benefit. Problems connected with land use which arise either because the community lacks land use regulations in the vicinity of the facility or because the area is outside its jurisdiction might be handled through the kind of "tied-assistance payments" suggested for other purposes by Blackburn and Oster.[3] The application of their "Transportation Impact Zone Policy" to small communities is certainly worth more attention in spite of the criticism above.

The Extension of Direct Technical Planning Assistance

One of the central problems for rural communities is the lack of expertise in transportation planning. While technical assistance programs are available, it would seem desirable to extend assistance in handling local problems which, at least indirectly, may arise from the construction of a new facility. Monitoring of possible local problems by project personnel

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[3] Ibid., pp. 25-34.

would be of great assistance and, hopefully, would not require any large increase in staff or funding.

One example of the kind of problem entailed here may be illustrated from the study community. The growth of new industry was concomitant with the development of the highway facility. It was not until some years after the facility had opened that the community, in the course of developing a comprehensive plan under a federally sponsored grant, became aware of the future traffic problems posed by the location of the new industry. These, and similar problems, might have been anticipated earlier had local assistance been extended as part of the interstate project.

Increasing the Levels of Comprehensive Planning Assistance and Community Cooperation

Extending the notion of responsibility and providing technical assistance on a local level as a part of interurban system development would hopefully reduce local resentments which grow out of problems more or less directly associated with the impacts of new facilities. However, most of the resentments enumerated earlier could be abated only through a more extensive change in the relationship between communities, transportation agencies and other planning and advisory agencies. While it is impossible, for example, to financially compensate businesses suffering losses because of reduced commuter time to other sources of goods and services, it is possible to give advisory aid as part of a combined agency effort to prepare a community for such transitions as are likely in a changed transportation environment. Successful strategies have been developed for dealing with such problems as faced by retail merchants in the study community.[4] The persistence of fears and resentments among those in this and other small towns is an indication that the accumulated knowledge and experience gained by experts in planning has not been passed on.

The major source of interaction between the rural community and the transportation agency in the past has been the public hearing. Given the

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[4]See, for example: Adams, Bert M. "The Small Town Trade Center: Processes and Perceptions of Growth and Decline," The Community, Itasca, Illinois: F. D. Peacock Publishers, Inc., 1969, Robert Mills Franch, Editor.

lack of resources and the traditional political reticence of small towns, the public hearing is too often ceremonial or merely the forum for the most active and vocal segment of the community. Within such a framework, there is little opportunity for the agency to discover the actual community values to which it, theoretically, must be responsive. Although communities may seek aid from planning and advisory agencies, it is rare that the resources and the benefits of a multiple agency planning effort are currently available.

There is, above all, an important goal related to the reduction of resentment in the small community which could be achieved through an increased level of agency and community interaction. As one recent discussion of the enhancement of highway benefits suggests, an essential element in maximizing benefits and assuring their more equitable distribution is to make the community more aware of its own powers and range of options.[5] A coordinated planning effort, aimed at involving small communities in identifying strategies appropriate to their own development, might reduce not only the specific causes of resentment against the paternalism of the external decision-making process.

Planning Manuals

An advisory committee of rural community experts was established to provide guidance to the research staff throughout the project. The members, for the most part, represented state agencies who have major programs and activities in rural communities.

With their assistance and encouragement a series of planning manuals were formulated. The manuals presented in Volume II are entitled "Transportation and Community Development: A Manual for Small Communities" includes an Executive Summary and seven chapters. The manual was designed to provide interested residents of small communities with information about transportation planning and community involvement in the planning process. The goals of the manual are: (1) to promote a more informed participation in the national, state, and regional decision-making process as it relates to transportation,

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[5] Sloan, Allan K., et al., "Enhancing the Public Share of Highway Benefits," Research Record 528, Transportation Research Board, August 1974, pp. 41-48.

and (2) to provide the basis for initiating and continuing comprehensive local planning for small urban places of populations under 25,000.

The manual is written in layperson language and is not intended for the professional planner. A review of the manual may assist those planners most sensitive to planning in small communities. Each chapter of the manual is bound separately and can be used individually or as a package. The components of the manual are:

Executive Summary -	The Planning Process
Chapter I.	The Transportation Planning Process
Chapter II.	Transportation Impact
Chapter III.	Goals and Objectives
Chapter IV	Community Inventory
Chapter V	Development of Alternatives and Preliminary Assessments
Chapter VI	Evaluation Process
Chapter VII	Glossary and Bibliography

After completing the draft of the manuals, internal review, advisory committee and agency review, a review by U. S. DOT, Texas Department of Highways and Public Transportation and this interested organization, it was ready for field testing. In cooperation with members of the advisory committee, a field testing experiment was designed and implemented.

EVALUATION METHODOLOGY

Introduction

Ideally, the manuals would have been evaluated in a reasonably larger sample of representative cities throughout the country. Again, ideally the evaluation would have involved a field test of the manuals through actual inplementation in selected cities over a time period of at least one year.

Since the project lacked both the funds and the time for such an extensive evaluation, it was decided that the manuals would be sent to a selected group of small cities, meeting specified criteria, for review by the personnel who had chief responsibility for the planning activity in each city.

An evaluation instrument, constrained by available resources and proximity was designed which asked the reviewer to rank specific attributes of each chapter as well as the manuals as a whole on a variety of dimensions (See Appendix III, Exhibit 1). Although our sample was small, we felt that the instrument could supply us with guidelines for revision and for modification of the draft documents.

To assist us in the development of selection criteria and in the actual choice of cities, we enlisted the aid of the Community and Rural Services Division of the Texas Department of Community Affairs (TDCA). This state agency has the responsibility of administering HUD "701" funds for smaller communities as well as the task of giving planning assistance to rural areas and non-metropolitan communities. With their assistance, we developed a set of criteria for choosing cities which were representative of different population characteristics, different experiences with transportation changes, and different attitudes toward and different experiences with planning. Also with the assistance of TDCA, we contacted responsible officials in several cities to determine their willingness to participate.

From an initial list of 125 cities provided by TDCA, a set of six cities were chosen which met the evaluation criteria. A set of manuals was sent to an official in each of the selected cities, and one month was allowed for a preliminary review. At the end of that period of time, a member of the research team conducted an on-site visit in each of the cities to answer questions about the manuals, to pick up the evaluation forms, and to discuss problems connected with either transportation or planning which might or might not have been addressed in the manuals.

The remainder of this section discusses the procedure used in selecting the cities for use as review sites, the background of the chosen cities, the results of the evaluation, and, through narrative discussion, an overview of the planning problems of small communities.

Selection Criteria

At the outset, with the aid of the Texas Department of Community Affairs, we established a set of selection criteria for the cities to be chosen for the review. We wished to obtain cities representative of various dimensions which could be used to classify cities below 25,000 population. The selection criteria were formulated within the following categories:

A. Representative of Different Population Ranges

B. Representative of Different Growth Rates

C. Representative of Different Relationships to Transportation Changes

D. Representative of Different Relationships to External Planning Agencies

E. Representative of Different Interests in Planning

F. Representative of Different Areas within the State

G. Willingness to Participate in the Evaluation.

The specific selection criteria within these categories are described below.

Population Ranges. Three population ranges were chosen in consultation with the Texas Department of Community Affairs. These were

1. Below 5,000
2. 5,000 to 15,000
3. 15,000 to 25,000

The rationale for choosing this set of population ranges was suggested by TDCA personnel. In their view, cities below 5,000 were similar in their resource availability, lack of internal transportation problems, and governmental structure. Cities between 5,000 and 15,000 were more likely to have resources which could be devoted to planning, have some experience with internal transportation problems, and possess a larger city staff. Finally, cities in the 15,000 to 25,000 population range were very likely to possess greater resources, to have a wider range of experience with internal transportation problems, and have a more specialized city staff. A recent study by the Texas Municipal League concerning this administrative capability also supports these criteria.

Growth Rates. We wished to include cities with three different patterns of population change. Thus, we wished to include at least one city with a growth rate in excess of the state average; one which was "stable," i.e., at the state growth-rate average or with no change since the 1970 Census, and one city with a declining population.

Transportation Change. Since the manuals were designed primarily for cities facing externally induced changes brought about by changes in the intercity system, we wished to include cities with different experiences with the intercity system. Basically, the three logical categories would be 1) previous experience with a major change in the intercity system; 2) planned major change in the intercity system; and 3) no experience with actual or planned change in the intercity system.

External Planning Agency. Ideally, our sample might have included cities with a wide range of relationships to external planning agencies. The following represents such an ideal break-down of city types.

A. Included within planning activity of an MPO.
(This category would include "fringe" cities of less than 25,000 which are nevertheless within or adjacent to a metropolitan area and hence included in the long-range activity of an officially designated Metropolitan Planning Organization.)

B. Excluded from planning activity of an MPO.
(This category would include most cities below 25,000 and would be sub-divided as follows.)

   a. included within a regional transportation plan

   b. included within a regional comprehensive plan with a specific transportation component

   c. possessing a local transportation plan

   d. possessing a local comprehensive plan with a transportation component

   e. possessing none of the above

Because of financial and monetary constraints, and because of the reluctance of some cities to participate in the review, we were unable to obtain a sample which contained representatives of all six categories listed above. Also, in actuality, the relationships of rural communities to external planning activity from one region to another, the variety of resources available, and the variation in local interest made impossible any simple classification system. None of the cities in our sample are included within the planning activity of an MPO. Although most of our cities have some on-going relationship with an external planning agency, none has a formal arrangement for ongoing transportation planning per se, and none of the cities has an internal transportation planning staff. The variety of relationships to external planning agencies will be discussed later in this section.

Interest in Planning. We wished to include within our sample cities which had exhibited different degrees of interest in the planning process. We assumed that a city's attitude toward planning might affect the reception of the manuals themselves or help determine their utility as an introduction to the planning process. Based on the past record of applying for planning funds and/or assistance, cities were ranked by TDCA as having a "high," "medium," or "low" interest in the planning process. A more detailed differentiation of the selected cities' attitudes was made possible by the on-site interviews with city personnel. These attitudes will be discussed in the narrative section below.

Areas of the State. Texas is a highly diverse state. Although it is an urban state in the sense that the majority of its population now resides in urbanized areas, most of the state's 262,134 square miles are rural. Nearly two-thirds of the places in the state are below 25,000 in population and are outside the boundaries of an SMSA.

There are three general types of rural areas in the state. The first, which is typified by West Texas, much of South Texas, and the Panhandle region, contains widely scattered rural communities and dispersed urbanized areas in the 50-100 thousand population range. The second type is to be found in much of the east and central portions of the state, characterized by a large number of small places, which are relatively close together, and dispersed urbanized areas, most of which do not exceed 100,000 population. Finally, the third type of area is that of the "golden triangle," which has as vertices the three major metropolitan areas of the state--Dallas/Fort Worth; San Antonio; and Houston. This area contains a network of relatively well-connected, relatively close-together small communities with reasonably good access to the large metropolitan centers.

The three types of rural areas within the state led us to three selection criteria for area representativeness. Small communities may be typified as follows.

1. Isolated communities, separated from both other rural communities and from metropolitan areas.
2. Semi-isolated communities, separated from metropolitan centers but part of a network of small communities.
s. SMSA linked communities, accessible to metropolitan areas as well as to other small communities.

Willingness to Participate. The final criterion was the willingness of a community to participate in the review of the rather lengthy set of manuals. This criterion turned out to be a limiting one. Since the staff of most small communities is composed of people who must necessarily wear a large number of hats and have very busy schedules, the task of reviewing the documents was not readily acceptable. Initial contacts with several cities were made by a member of the Community and Rural Services Staff of TDCA who had worked closely with city officials. Out of nearly two dozen inquiries, only six city officials agreed to accept the task of conducting a review within the thirty-day allotted time span.

Participating Cities

Since the time, funding limitations, and the willingness to participate restricted the number of cities actually involved in the review, we could not include a representative of each and every possible combination of our selection criteria. (This, in itself, would have required a review by 1458 communities!) The selection criteria were used as guidelines in our initial choice of cities to contact. Taken as a group, the cities agreeing to participate did satisfy our general selection criteria categories, although each city did "double duty" as far as satisfying a particular criterion was concerned.

The six cities are listed below in alphabetical order. There follows a brief sketch of each city, describing its relationship to our selection criteria.

1. Halletsville
2. Kerrville
3. McKinney
4. Muleshoe
5. New Braunfels
6. Schulenburg

Halletsville. The seat of Lavaca county in South Central Texas, Halletsville is a community of 3,000 inhabitants. It experienced a negative growth rate in the period between 1960 and 1970 and has remained stable in this decade. In absolute terms, between 1960 and 1970 the city's population declined by 3.42%; relative to the state average growth rate, Halletsville declined by 18%. Lavaca county declined by an even greater percentage.

Halletsville is located at the intersection of two U. S. highways: U. S. 77 and U. S. Alt. 90. It is not served by either rail or inter-city bus. It does operate a small public airport four miles outside the city limits.

The town has experienced no major change in the intercity transportation system in recent years and currently contemplates none, although long range plans call for the eventual by-pass of the current intersection of the two highways within the city limits. U. S. 90 A was previously one of the major arteries between Houston and San Antonio. The upgrading of U. S. 90, located 17 miles north of Halletsville, to Interstate Status in the late 1960's has caused a relative reduction in the use of U. S. 90 A. Halletsville has experienced few internal transportation problems. Currently slightly over 50% of its streets are paved, and the intersection of the two highways is considered a danger by local officials. Traffic and circulation problems in the CBD have been addressed without too much success for several years.

The city's relationship to external planning agencies is fairly typical of a town its size. It has, at various times, received assistance from among others the Local Planning Assistance Agency of the Texas Governor's Office, the Texas Aeronautics Commission, the State Department of Highways and Public Transportation, and the regional council of governments. The only formal, long-range planning activity conducted by the city occurred in 1970-71 under a Community Development grant from the U. S. Department of Housing and Urban Development. As of 1976, few of the recommendations had been implemented because of a lack of revenue. A short-range program of capital inprovements has been initiated, financed through general obligation bonds. Assistance has been sought from HUD, the Farmer's Home Administration, and the Bureau of Outdoor Recreation (Department of the Interior). Halletsville is currently an applicant for a "701" grant from HUD to update the 1971 plan.

The city's interest in planning would have to be ranked "low" in comparison with the others in the group of six. The local Planning and Zoning Commission, formed during the development of the comprehensive plan of 1971, has been inactive since that time. The lack of interest in planning, according to local officials, stems from the city's limited resources for implementing the recommendations of a comprehensive plan. Without a continuous funding source for planning, the Planning Commission tends to become inactive, and in the face of few immediate and tangible benefits, the town itself seems to show little interest in a planning program. The City Secretary, who is the town's chief administrative officer, looks at planning with a very practical eye; it is a prerequisite for federal assistance, and thus a practical necessity for a city with a very tenuous economic base and few internal resources. He hopes to use the "701" planning activity as a stimulus to renew interest in Halletsville's economic development.

Halletsville represents the semi-isolated community. The nearest SMSA is Austin, which is slightly less than 100 miles away. Its real economic ties, however, are with the Houston area, 103 miles to the east. Halletsville lies within a network of other small communities of similar size. The distance between these communities varies between 15 and 30 miles. The cooperation between these communities is rather low. Unsuccessful suggestions have been made by state agency planners for consolidation of school districts within the area and for the development of an area-wide hospital district.

The city officials were very willing to participate in the review of the planning documents and gave them a favorable reception. In spite of the fact that we ranked the community interest in planning as "low," the City Secretary, for reasons given above, is very interested in stimulating an interest in planning.

Kerrville. The county seat of Kerr county in South Central Texas, Kerrville is in the highest of the three population groups. Its population in 1970 was 12,672, but current population estimates place it above 17,000. In the previous and the present decade, Kerrville's population growth has been extraordinarily high. Between 1960 and 1970, Kerrville experienced a growth rate of over 42%, which is 27.7% above the state average. The growth rate in this decade has been even higher than that of the previous one. In the past six years, the population of Kerrville has grown by over 5% per year and is currently 34% higher than it was at the 1970 census.

Located within two miles of a recently completed section of Interstate 10, Kerrville is a city which has experienced a major improvement in the intercity transportation system. Recently completed plans for the city by the State Department of Highways and Public Transportation include a loop to accomodate traffic on state highways 16 and 27. Kerrville has no rail connections, but it has excellent intercity bus service and is the headquarters of the Kerrville bus company, a growing intercity carrier.

Internal Transportation problems have included congestion and parking problems in the CBD, part of which will be eliminated, from the city's viewpoint, with the construction of a loop and the consequent reduction in through traffic. Over 80% of Kerrville's streets are paved with concrete or asphalt (a high percentage for a rural community in the area).

The city officials have pursued an active transportation improvement policy in certain areas. At the time of the review, the city was particularly concerned with airport expansion. Kerrville is a retirement and resort community and has a high level of general aviation activity. It is also the site of an aircraft manufacturing plant. City officals are also interested in rural public transportation, although they opted out of a regional 147 program on the grounds that they could not support it beyond the demonstration period. The city, instead, is exploring the possibility of a locally-financed mini-bus service between Kerrville and several smaller communities with the county.

Kerrville officials have pursued planning assistance at a higher than average level, primarily because of city growth. At the time of the review, planning assistance was being received from several state agencies, private consultants, and the regional council of governments. The growth of the city has created the need for long-range sewage and water distribution planning, and the city has successfully pursued funds through the Economic Development Administration, the Texas Aeronautics Commission, and others for local improvements.

Kerrville's interest in planning was rated as "high". It has an active Planning and Zoning Commission, and it has pursued a policy of zoning and building code enforcement. The growth rate of the city is partially responsible for this interest, but equally responsible is the high level of civic interest among the members of the city's large retirement community, many of whom are retired professionals from out-of-state. One active member of the Planning Commission, for example, is the retired city planner for Ontario, California. Kerrville is currently an applicant for a "701" planning grant to update the city's existing master plan.

The city may be classified as an SMSA-linked community because of its physical proximity to San Antonio, located 66 miles to the east on Interstate Highway 10. Kerrville, however, has its own stable economic base, and city officials do not view the upgrading of the highway as having a significant impact on the community, either negatively or positively. (In spite of this perception, tourism, a major local industry, has been steadily increasing; the local Chamber of Commerce estimates that over 1 million tourists visited the Kerrville area in 1975.) Since 95 percent of the town's labor force works within the community, it is clear that Kerrville has in no way become a "bedroom community." Thus, the proximity of San Antonio is largely an advantage from the point of view of the city's tourism industry and as an attraction to the increasing number of retired persons who seek a rural environment coupled with occasional access to a major city. (the percentage of citizens over 65 increased by 71% between 1960 and 1970, and city officials estimate that over 35% of the current population is in that age bracket.)

Kerrville indicated a medium interest in reviewing the manuals. Eventually, the City Manager to whom the manuals were sent initially, turned them over to a member of the Planning Commission for review. His comments are attached, and they indicate a very thorough reading of the manuals.

McKinney. Like Kerrville, McKinney falls into the highest of the three population range categories. The 1970 Census recorded a population of 15,193, and the local Chamber of Commerce estimates the 1976 population at slightly over 17,000. The population growth rate may be regarded as stable. Although there was in increase between 1960 and 1970 of 10.39%, this change is below the state average growth rate of 14.67% The change between 1970 and 1976 is 13.3%, again somewhat below the state average. While the population of McKinney itself has stabilized, the county population has grown rapidly, showing an increase of over 60% between 1960 and 1970. This growth reflects the proximity of Collin county to the Dallas/Fort Worth metroplex rather than the growth of a local economic base. In contrast to the previous two areas, the Collin county area does not have a high percentage of persons over 65 years of age and older, although the city itself has a relatively high number of senior citizens.

McKinney is flanked on the west by U. S. 75, a controlled access highway, on the south and east by state U. S. highway 380. This network of highways essentially constitutes a loop around the city and has encouraged development outside the older, central area of the community. Other than the upgrading of U. S. 75 and the connection between that highway and the city along state highway 121, McKinney has experienced no major transportation change in the last decade. McKinney is served by two railroads and is on a Southern Pacific main line. The city is served by 10 interstate carriers, two intercity bus lines, and two local cab companies.

As with a great many small towns, the internal transportation problems have centered on the lack of paved streets (currently only 56% of its dedicated streets are paved) and by congestion and circulation problems in the CBD. The city paid for a consultant developed local circulation plan and has authorized construction to relieve traffic problems in the CBD. A major project of the city has been the planning of local airport expansion in conjunction with the Texas Aeronautics Commission. Current plans call for the upgrading of the local airstrip to a general purpose airport with expansion capabilities. The city also has plans to enter into contract with the area Community Action Agency to provide free transit service for the elderly and for social service clientele.

The relationship between McKinney and external planning agencies has been fairly extensive. The regional council of governments has a relatively large planning staff and has provided frequent planning assistance. Other agencies include Community and Rural Services, the Texas Aeronautics Commission, and the State Department of Highways and Public Transportation. The major source of outside funding assistance has been the Economic Development Administration.

The city's interest in planning was rated as "medium." Although the city staff (City Manager and Public Works Director) were highly interested in a continuing planning effort, they often met resistance from the City Council, which was reluctant to fund such activities as traffic engineering, and from the City Planning and Zoning Commission, which has been relatively active but has not followed the recommendations of professional planners in its policies. The city completed a "701" comprehensive plan in 1973 which is currently regarded as outdated. The city has no full time planning staff, but does employ a planning intern.

McKinney falls into the SMSA-linked classification. It is within 32 miles of two SMSA's —— Dallas/Fort Worth and Sherman/Dennison. One of the overriding concerns of McKinney has been dictated by its proximity to these two SMSA's. The growth of commuter subdivisions in the southern portion of Collin county gave rise to the fear that McKinney would become a "bedroom community." The result was the creation of a very active industrial foundation; between 1970 and 1975, 23 new industries located in McKinney. The result has been a reasonably sound local economic base, although the industrial foundation has ceased to be as active as formerly.

McKinney's willingness to participate and its reception of the manuals was quite good. The manuals were reviewed by three members of the staff—— the City Manager, the Director of Public Works, and the Planning Intern.

Muleshoe. Located in the Texas Panhandle, Muleshoe is the only community within the middle population range (cities between 5,000 and 15,000). The 1970 population of Muleshoe was 4,525, but current estimates place the population at just above 5,000. The growth of the city between the 1960 and 1970 census years shows an increase from 3,871 to 4,525, or a growth rate of 16.89%, which is 2.22% above the state average. If current population estimates by the city itself are correct, the next census should show an equal or slightly higher rate of increase. The surrounding area, meanwhile, continues to lose population, having decreased between 1960 and 1970 by over 6% and an additional 3% between 1970 and 1976. Most migration to the city has been from the county.

Muleshoe has experienced no major transportation change in the past decade, although there has been a steady upgrading of U. S. 84 on which Muleshoe is loccated. The highway bypasses most other small communities along its route, and long-range plans call for an eventual by-pass of Muleshoe. This is not an immediate possibility, however. The town is located on a main line railroad and has good shipping connections to both east and west. Only one intercity common carrier is licensed to serve Muleshoe, and there is only one bus line. The city owns a small airstrip, which is currently operated under a lease arrangement. The city officials regard the arrangement as unsatisfactory. They are currently seeking aid from the Texas Aeronautics Commission to expand the facility to a Municipal Airport. General aviation is regarded as essential to the city's function as an agricultural service center.

Local transportation problems, as perceived by local officials, are practically non-existent. The major complaint is that no clear authority exist for control and upgrading of railway crossings, the one safety hazard in the city. The city has a strong local policy of paving and maintaining its dedicated streets. Nearly 70% of local streets are paved, a high percentage for a rural community. Revenue sharing funds rather than assessments or bonds have been used to finance street improvements and maintenance.

Muleshoe has received some planning assistance from the Texas Aeronautics Commission, the regional council of governments, the State Department of Highways and Public Transportation, and the Office of Traffic Safety. The last comprehensive plan was performed in 1968 and is now regarded as obsolete by city officials. No transportation planning other than thoroughfare planning by the Highway Department has been conducted in the city prior to 1976. A traffic study funded through the Governor's Office of Traffic Safety is currently underway. For most planning assistance, Muleshoe is dependent on the regional council of governments. As far as the city officials know, however, there is no regional transportation plan and, if one exists, it is not used as a guide by the city.

The community has no zoning ordinance, and the community's planning commission is currently inactive. The city's interest in planning would have to be rated as "medium," even though the city manager is a strong advocate of planning. Since the city has not conducted a comprehensive plan in several years, and since the Capital Improvement Program recommended in that plan has been completed, the city manager has been unable to sustain interest in a continuing program generated at the local level.

Muleshoe was classified as an "isolated" community in spite of its relative proximity (less than 100 miles) to an SMSA. There are few other towns in the area of more than 2,500 population, and these are 40 to 50 miles apart. Muleshoe remains an agricultural service and processing center. Most shipments from the town are bulk products, and the industries it has attracted are largely food processing plants, dependent on local raw materials.

The city manager was an enthusiastic recipient of the manuals and gave them a good oral endorsement. However, in spite of repeated requests, we never did receive a written response to the questionnaire.

New Braunfels. This community is the largest among the participating cities. The 1970 population of 17,859 has purportedly increased to over 20,000 in 1976. Although the growth rate between 1960 and 1970 was 14.25%, or almost equal to that of the state as a whole, the present growth is estimated by local officials to greatly exceed that of the previous decade.

The major transportation change during the past two decades in New Braunfels was the completion of Interstate 35 between Austin and San Antonio. Internal changes have included the development of a loop on the east and north sides of the city as well as a street improvement program, which has resulted in over 96% of the streets being paved. New Braunfels has eight common carriers licensed to serve the city, and it has good bus connections to major metropolitan areas. It is also served by two major rail lines with daily freight service.

A general aviation airport is located within 4 miles of the city. The city's internal transportation problems have included the usual congestion and circulation problems in the CBD. Social service transportation is available, and New Braunfels will participate in a 147 rural public transportation demonstration project to be operated by the regional council of governments.

New Braunfels in the only one among the participating cities to have a full time planning staff. The city has drawn upon local resources as well as state agencies and federal sources of revenue for their planning activities. The degree of interest, as measured by the amount of on-going planning and by the activity of the Planning and Zoning Commission, was rated "high." The city has become less dependent than most on external planning agencies, including the regional council of governments.

New Braunfels is clearly a SMSA linked community. It is only 30 miles from San Antonio and less than 50 miles from Austin. (In 1976, the city was designated part of the San Antonio SMSA.) While New Braunfels has a long-standing manufacturing base in its cotton mills, it has recently become increasingly important as a tourist and retirement community. (The percentage of elderly in Comal county doubled between 1960 and 1970.)

The manuals were reviewed by the city's Director of Planning, who was generally recptive to the manuals.

Schulenburg. The last of the participating cities is a community of less than 2,500 inhabitants. The 1970 census lists the city as having a population of 2,294, which represents an increase over the 1960 population of less than 4% or 10.73% less than the state average. The surrounding area, however, has a larger than usual percentage of rural non-farm inhabitants (20%) indicating that many who live outside the city limits work in the town, a hypothesis borne out by the City Manager.

Schulenburg is located one mile south of the intersection of U. S. 77 and Interstate 10.

The major transportation change affecting Schulenburg was the completion of Interstate 10 in 1972, a change which involved bypassing the community by a distance of one mile. Schulenburg, at one time, enjoyed a fairly active roadside business (it lies roughly equidistant between San Antonio and Houston) which it is still trying to recapture. Recent efforts to attract a major truck-stop in the vicinity of the interstate failed because the access road was inadequate.

Schulenburg is on a mainline of the Southern Pacific and has two inter/intra state carriers with terminals in the town. It also has one bus line serving the community.

Schulenburg city officials and leaders have placed heavy emphasis on the existence of rail and trucking facilities and on the town's location between four major SMSA's in their goals for the community's development. Schulenburg currently serves as a distribution center for two out-of-state manufacturing plants, and it hopes to attract local manufacturing plants based on its transportation potential. In no other city did officials express as strong a belief that the community's development depended upon its position in the intercity transportation network. Local transportation problems were all perceived within the context of regional or intra-state transportation policies.

Schulenburg has received planning assistance from the Governor's Office, the State Department of Highways and Public Transportation, and the Office of Traffic Safety in previous planning efforts. Assistance from the regional council of governments has been minimal. The city conducted a 701 comprehensive plan five years earlier, but it is now regarded as obsolete. The most recent planning assistance came from a project directed by a faculty member of Texas Tech University who "happened to be" interested in Schulenburg.

The city's interest in planning was rated as "low," even though the city manager himself had a strong interest in planning. The community itself and the city officials were not convinced that planning had any practical application to local needs. Nevertheless, the community has applied for a "701" grant to update its comprehensive plan.

Schulenburg may be classified as a "semi-isolated community." The nearest SMSA is Austin, located 76 miles from Schulenburg. (Since highway and rail connections are better between Schulenburg and Houston, than between Schulenburg and Austin, the former SMSA is more closely linked economically to the community). Schulenburg is part of a network of cities in the same size range, most of which are agricultural service and processing centers.

Schulenburg's city manager was highly interested in the manuals since he felt they felt they might be used to stimulate local interest in planning. His major concern was that the community was unaware of its own potential, and hence unlikely to generate internal programs for community development.

EVALUATION PROCEDURE

Initial contacts with potential reviewers were made by the Texas Department of Community Affairs staff. Once we had obtained the agreement of the six cities described above, a set of manuals was sent to the city manager or his equivalent in each community. He was also sent an evaluation form and asked to review the manuals within the next 30 days, if possible.

Subsequently, each official was contacted and an appointment arranged with a member of the research staff, who was to collect the evaluation form and discuss both the manuals and the planning needs of rural communities as perceived by the official.

As it turned out, only one city official (the City Manager of McKinney) had been able to give the manuals a full review and complete the evaluation form by the time of the appointment. Eventually, four of the remaining five did complete the evaluation instrument and returned it to us. The interviews were thus completed before all of the officials had reviewed the manuals in their entirety. As a result, the interviews focused less on the explicit content of the documents than on the planning experiences, the problems, and the needs of small towns as perceived by local administrators. In some cases, a second administrator sat in on the interview at the request of the other. Each interview was conducted as an open-ended discussion of the problems and perceived needs in small communities, although in each case we asked two primary questions.

1). What do you perceive to be the roles of transportation and transportation planning in your community's development?

2). What are the chief planning needs in your community?

Other questions were community specific, allowing us to fill in gaps in our knowledge of each community and to explore the experiences of the local administrators. The title of the officials interviewed in each city is indicated below.

1). Halletsville - City Secretary and the City Police Chief (the latter was involved in local traffic studies)

2). Kerrville - The City Manager and a member of the Planning Commission

3). McKinney - City Manager

4). Muleshoe - City Manager

5). New Braunfels - Director of Planning

6). Schulenburg - City Manager

For the most part, the city administrators were pleased to be able to discuss their experiences and perceptions with an outsider and hence required few questions. Most interviews lasted for at least 90 minutes, and several lasted for an entire morning or afternoon.

Taken together, the comments on the evaluation form and those obtained in the interviews provided us with a perspective both on the usefulness (or lack thereof) of the manuals and on the perceptions of planning in small communities as held by the administrative officers of one, varied group of such communities.

EVALUATION RESULTS

The results of our evaluation fall into two separate categories: 1) comments and suggestions concerning the manuals; and 2) attitudes and recommendations concerning planning in small communities. The latter is not unrelated to the former, as we were able to take many of the general attitudes into account in our revision of the documents and the comments on the manuals provided further clues to the attitudes of perspectives of the reviewers. A surprising unanimity on three issues addressed in the manuals emerged from both the evaluation and the interviews. Since these issues address both the nature of the planning documents and the perceptions of the role and effectiveness of planning in small communities, the discussion in this section will focus on the issues themselves as they emerged during the course of the evaluations. The issues may be expresses as

1). Transportation planning as a separate activity,
2). The practicality of the planning process itself; and
3). The limitations on the small town's ability to develop meaningful plans.

Transportation Planning as a Separate Activity

As we assumed in the manuals, most small communities cannot justify transportation planning as an activity separate from comprehensive planning, at least on the local level. The small town administrator conceives of planning in terms of comprehensive planning. This fact is extremely important in the context of this report. So strong is this attitude that we encountered some negative reaction to the manuals before they were even read. The title of the manual and particularly the word "transportation" were enough to put the reviewer off.

Outside the context of comprehensive planning, transportation planning on the local level was perceived unanimously as a series of separate responses to particular needs or problems which should or could be best handled by individual engineering studies. The fragmentation of responsibility and/or funding sources for transportation generally reinforced this attitude. Traffic engineering funds for small cities come from one source (NHTSA), for airport planning from another, and thoroughfare planning from still another.

From the perspective of small town administrators, most of their transportation problems cannot be addressed through "planning" at all. A town may feel that additional rail sidings would benefit the community and attract industry, but its desires are totally dependent upon the reaction of railroad company officials. Much of the private sector, as well as some of the public sector, would not be involved in the planning at the local level, and yet would be the only source of implementation.

This attitude, which is not at all unrealistic in our opinion, makes the adaptation of an urban planning process to the small community very difficult if not impossible. One suggestion we followed was to remove, as irrelevant, a section on the urban transportation planning process. The attitude (and the reality) also creates resistance to the effort recommended in Cahpter IV (Community Inventory) regarding the maintenance of a local transportation inventory. A major source of irritation among small town administrators is the fact that urban areas are entitled to funding, while small communities are often dependent upon limited discretionary funds. This will be discussed at greater length in relation to the third issue, but it should be noted here that the lack assured funding for planning leads to a furthering of the "piece meal" approach to transportation planning at every stage of the process.

Regional transportation planning is regarded somewhat differently, although it was difficult to convince most of the administrators that, as Chapter I of the manual assumed, the local community could and should have an input into external transportation planning activities.

There are several aspects of the attitude toward regional, or extra-local, transportation planning. There is the belief that no amount of regional planning can work, especially on a long-range basis. As one reviewer put it, summarizing his past experiences, "No group of planners could possibly visualize this growth, [nor] let alone in 1945 plan for the needed transportation facilities of 1965."

There is also the belief that regional policies and procedures are so separate from local policies and procedures that they constitute an irresistable, almost chance-like force. One city manager commented as follows.

> Small cities' planning policy is often one of "keeping up" even though they have a better opportunity than large cities, or so it seems, to keep ahead of the game. But small cities are often at the mercy of regional plans, and unless there is a significant addition to the small city's transportation plans, the small city will continue to keep up at its own pace.

In spite of these attitudes toward extra-local transportation planning, all the administrators are interested in greater participation in such planning. The one aspect of Chapter I which consistently rated a "useful" or "very useful" rating was the planning status evaluation worksheet. This reflects an expressed desire to participate in extra-local planning and, more importantly, the need for practical guidance in <u>how</u> to participate.

Several recommendations were made in relation to the issue of transportation planning as a separate activity. These are included as sample responses to the issue. They are

1). That transportation planning funds, which reach the local community at diverse times through separate sources, be coordinated much as they are in the development of a Unified Work Program for Urbanized areas;

2). That regional transportation plans be developed at a level "closer to home," such as the county, which would be entitled to transportation planning funds; and

3). That a uniform set of elements be adopted for small town transportation planning, as has been done for urbanized areas, but adapted to the special requirements of smaller places.

<u>The Practicality of Planning</u>. As has already been noted, there was strong scepticism about the practicality of planning activity in general. Nevertheless, in each town, planning has been an important and necessary activity. All of the six communities have had "701" grants to develop long-range plans, and each of these has applied for a new grant under the 701 program to revise and update the existing plan.

In some respects the attitude towards planning is mixed, even though all who were interviewed are in favor of community planning in principle. Their enthusiasm, however, is tempered by the fact that a small city administrator's time is largely devoted to "putting out fires," to getting done what must be done to solve immediate problems. Possessed of little or no technical staff, faced with pressure from both citizens and elected officials to "get things done," with insufficient time or resources to gather and interpret the necessary data, and, above all, lacking adequate funds, the small town administrator often finds the planning process to be something of a luxury. As one put it, "It seems that so much time has to be spent on thinking about the future that there's no time left for the present."

Not one of those interviewed failed to mention the fact that planning funds were insufficient for small towns, especially for the purpose of hiring competent staff or of having adequate studies made. The general feeling, and it is a strong one, is that the large cities siphon off money which could benefit the small ones. Each administrator mentioned the intense competition among small towns for what planning and technical assistance money was available.

While the idealistic aims of planning are recognized, the small town administrator also regards the development of a plan with a practical eye. It is a necessity for federal programs, and federal programs are necessary for the survival of most small towns. (The city administrator "knows" this better than the average city council member of other elected official.) The city manager who wishes to see planned development take place often finds himself in an uncomfortable position between the planning agency and the elected officials to whom he is responsible. In one case, the city manager had to first convince the city council to put up a 50/50 match to have a traffic engineering study done. He then had to mollify an irate city council when the consulting firm recommended a $100,000 improvement program for the CBD. In another case, the city manager was accused of fiscal irresponsibility for entering into a traffic safety program which required the city to provide the standards for new street signs and markers, even though they were needed and the signs themselves came at no cost to the city.

The result is that the administrator is often caught in a vice between the "feds," whose regulations and requirements he must meet, and the city official, whose suspicions and fiscal reluctance he must overcome.) Beyond meeting the externally imposed requirements for funding, the small town administrator also sees planning as having another practical advantage, especially where citizen involvement is high. "It's a way for me to sell a bond issue," said one City manager. "Once they have gone through the process of developing a community plan, it's difficult for them to oppose its implementation.

Thus, planning in general is seen as a political tool as much as it is a means for creating orderly development. It is perhaps for this reason that most of the city administrators regarded Chapter III of the manuals with favor. The section of goals and objectives provided on opportunity to involve the local elected officials and other citizens more deeply in the planning process. Thus, a goals and objectives program is both an educational tool and a source of gaining the alliance of the citizenry in community development which the administrator cannot risk proposing on his own.

This need for educating and winning the alliance of the citizenry also explains the stress on comprehensive planning, which guarantees the involvement of otherwise inactive planning commissions and makes easier the educational task of the city administrator in showing the relation of transportation to land use, economic development, etc.

Chapter III was highly rated by all but one reviewer. The response to one question that was asked on the evaluation form helps explain the reason for its acceptance. The question asked the reviewer to indicate which audience would find particular chapters to be of most use. In all cases but one (and here the reviewer did not seem to understand the question), the reviewers indicated either the city council member or the planning commissioner, or both, as distinct from the professional planner or the city manager.

Limits on The Small Town's Capability to Develop Meaningful Plans

The final issue has been implicit in the discussion of the other two issues. However, there are two specific aspects of this issue which emerged separately. First, there is the "Catch 22" problem involving the interlocking requirements of federal and state funding upon which a very many small towns are dependent. Second, there are the limitations on the professional staff of all the small cities we interviewed.

Most of the reviewers found the manuals informative and interesting. However, few felt that they revealed actual practice in planning as much as they did an "ideal" procedure which was difficult to follow in practice. One of the reasons cited for this view was that federal and state planning dollars are often not forthcoming unless previous plans had been developed. As one city manager put it, "if I want a 701 grant, I have to have a housing assistance plan, but without '701' funds, I can't develop a housing assistance plan."

While many communities are undoubtedly in this position because they are unwilling to pursue a policy of self-initiation, others are simply without the resources to take the required initial steps.

The most frequently voiced recommendation for solving this problem is an entitlement program for planning assistance to small communities. Formula allocations of such funds would be acceptable so long as there would be an assured source of funding.

The lack of local expertise is, of course, a widely acknowledged problem. Essentially, it forces small communities, at least in the eyes of their administrators, to pay more for the assistance they do acquire with their limited funds. Even where a planning staff does exist, most are generalists who learn their trade on the job. Few directors of public works are professional engineers, and few city managers are also trained planners. One of the criticisms of the manuals was that the cities lacked the expertise to implement their recommendations. They did not educate sufficiently to allow the generalist to become a specialist, and thus they promised more than they could deliver.

In many respects, this problem "goes with the territory." Small communities will never have the technical resources of larger ones, or, if they did, would their problems warrant full-time specialists. However, one suggestion, which came from two different sources, poses a possible solution to the problem. It was suggested that <u>circuit</u> technical specialists be provided at the regional level, their salaries paid by several communities. Technical assistance could then be granted on a fairly regular basis to communities with the region.

While such suggestions as those above do not solve the problem of the smaller community's lack of resources, they indicate the perceptions of those who are on the "front lines." The research team was often surprised at not only the dedication of local administrators, but also their eagerness to seek solutions in conjunction with rank outsiders. It is clear to us that many of the problems of small communities have been attacked with too little regard for the resources represented by local administrators with their acute awareness of their problems.

Recognizing the Vitality of Rural Communities

The final, revised set of documents included in Volume II represents the culmination of comments, perceptions, and reflections of the status of "planning" capability and needs by most small rural communities.

Recommendations

Given the unique nature of transportation impact on small towns and the concomitant planning needs of such communities, the following recommendations are offered in pursuit of a specific program for future interurban transportation policy.

1. That a basic transportation plan for each small community within a designated interurban corridor be developed concurrently with the transportation corridor system plan. This would formalize the link between the community and the sponsoring agency and provide a mechanism for making both parties aware of mutual problems. It would also provide the community with an introduction to basic planning and implementation techniques.
2. That a formal update of the original plan be conducted on a five-year basis. In addition, a continuing link between the community and the sponsoring transportation agency would allow the community to request assistance in evaluating their transportation plan in light of unanticipated developments.
3. That the sponsoring agency advise a community likely to be impacted by an interurban facility of particular planning services available from other regional and state agencies. This would insure that the community be fully aware of the range of information required to develop an adequate transportation plan. The sponsoring agency could serve initially to coordinate the community's planning activity.
4. That the criteria used to determine compensation for losses as the result of the impact of a change in transportation facilities be reexamined in regard to the problems of small towns. While it is beyond the scope of this paper to discuss assistance programs in detail, it does seem clear from our own research that current assistance policy is a major source of resentment.

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TRANSPORTATION IMPACT STUDIES: A REVIEW WITH EMPHASIS ON RURAL AREAS

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RESEARCH REPORT

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NOTICE

EXECUTIVE SUMMARY

INTRODUCTION

The close connection between the development of interurban transportation and attendant changes in land development, economic activity and community response has been the subject of a great number of impact studies, especially after the initiation of the National System of Interstate and Defense Highways established by The Federal Aid Highway Act of 1956. As part of a research project designed to develop planning tools for use by government and citizen groups in serving the transportation needs of rural areas, this literature review has been conducted in order to evaluate the current state of the art in measuring the impact of changes in transportation, especially in rural areas.

PROBLEM STUDIED

The aim of the literature review was to define and evaluate the various methodologies used to measure transportation-related impact; to summarize the most important findings to date; and to recommend an appropriate direction for future studies. Most of the studies reviewed were conducted in the period between 1960 and 1970 since it was assumed that current methodology reflects experience gained from earlier work. Also, the most important interurban transportation system, the interstate highway, was constructed mainly after 1960.

RESULTS ACHIEVED

The studies reviewed were classified into four categories (these are not mutually exclusive) according to the following criteria:

(1) The nature of the transportation facility (i.e., highway, rail, etc.);

(2) The kind of area examined in the study (e.g., by-pass area, rural area, interchange area);

(3) The type of effect measured (changes in land use, land value, economic activity, etc.);

(4) The methodology employed in the analysis of impact.

Most studies of impact in rural areas concentrate on the effect of highway improvement, particularly the interstate system. Thus limited-access highways have received the most attention, although arterials without access-control and even farm roads have been studied to some degree. A few studies deal with the effect of new airports and with the importance of rail and bus service, but no report reviewed deals with the effect on rural areas of decreased rail service.

Since most impact studies in rural areas are concerned with highway improvement, the main body of the literature focuses on effects at interchange areas, by-pass routes, and along rural highways.

The impact is usually measured in terms of the effect on one or more of the following:

(1) Land use
(2) Land value
(3) Business activity
(4) Industrial and manufacturing growth
(5) Social characteristics of the community affected
(6) General community response (i.e., attitudes, behavior, etc.)

Out of concern for measuring the costs and benefits of highway improvements, the greatest number of studies concentrate on land value, land use, and business activity. While a reasonable amount of the literature deals with manufacturing growth and relocation in rural areas, very little work to date gives any in-depth analysis of the effect of transportation improvement on the social characteristics of rural communities, and still less work has been done in the area of general community response.

In terms of land value, land use, business activity, and manufacturing growth, most studies have concluded that the results of highway improvement are favorable to the rural community. Most by-pass studies, for example, have attempted to show that declines in land value and decreases in business activity are either temporary or are offset by later growth, which is usually attributed to the highway's influence.

However, the data and the conclusions from the highway impact studies reviewed to date do not provide predictive tools for the transportation planner. Conclusions are often confirmations of the obvious (e.g., that traffic-serving businesses are the first to develop at interchange areas), or else they are limited to the specific region studied and thus provide little that may be used to formulate hypotheses about the general nature of highway improvement impact in rural areas or on small communities. No study can rise above the limitations of the methodology upon which it is based, and most highway impact studies have been subjected to severe criticisms on methodological grounds.

The methodology used to evaluate transportation impact usually involves one of, or a combination of the following:

(1) Before-and-after technique
(2) Survey control area technique
(3) Case study technique
(4) Multiple regression analysis
(5) Projected land use/value relationship
(6) Neutral road comparison method

Most studies employ some use of the "before-and-after" technique. In these studies the before period usually is defined as a 2-5 year time span prior to the transportation improvement, and the after period determined as a 2-5 year period after the facility has been completed. The technique measures the value of some of the characteristics (e.g., land value) of an area in the before period and compares this value with that measured in the after period. The difference is said to be the effect of the transportation facility.

There are several theoretical and practical disadvantages to the simple before-and-after method. First, the technique reveals little or nothing about trends prior to the improvement.(In reality the length of the "before" period is undefinable because it is not known when knowledge of a proposed improvement begins to influence the development of an area.) Second, it does not isolate the impact of the change in the transportation system from other sources of influence.

The survey-control area technique attempts to isolate the effect of the transportation facility by comparing the results in the area being studied with those from a similar area (the control area) which has not experienced a change in transportation. The difference between the results is said to be the "impact" of the change.

In theory, the survey area and the control area would have to be exactly alike in all respects just prior to the improvement, and the factors affecting the development of each area would also have to be identical except for the change in the transportation facility.

These conditions are almost impossible to meet. In practice, the control area chosen is usually itself susceptible to some, often negative impact from the facility. Especially in small rural communities, it would be difficult to find a control area not influenced by any major change in the transportation system. In any case, the multitude of transportation and non-transportation related factors which produce the effects to be measured create a more complicated situation than the assumptions of the survey-control area method would account for.

The "projected land use/land value relationship" approach and the "neutral road comparison method" are techniques which attempt to compensate for some of the limitations on the other methods. The first involves comparing a projection of land use/value, assuming that the facility had not been built, with that which actually took place. The second method, primarily used to predict changes in business activity, compares alternative highway locations to a hypothetical, "economically neutral" road. Both methods are limited in scope, and both depend on the accuracy of the forecasting techniques, which are at best difficult to evaluate.

The case study approach deals with a detailed analysis of events which take place following the improvement of a facility. Consequently, although detailed knowledge may be obtained about specific possibilities in one area, the results are not claimed to have general validity.

Multiple regression analysis, a statistical technique which relates changes in one dependent variable to the behavior of a number of independent variables, has in most cases been used where appropriate "control" areas could not be found. This technique requires more information about non-transportation related factors than do other techniques. Consequently, it may be used to analyze the complex cause/effect relationship in a more complete manner than do the other approaches.

In practice, however, it has not been possible to include all relevant factors because of a general lack of knowledge about how to determine relevancy or how to quantify certain qualitative characteristics. However, these limitations do not apply to the methodology as such, but rather to its present state of development.

UTILIZATION

This review should be of interest to local, state, and federal agencies and to research groups planning future impact studies, especially in rural areas. It summarizes some of the more important findings to date and evaluates the current state-of-the-art, and it recommends guidelines for future studies. For the convenience of the reader, an annotated bibliography, containing over seventy references, is included.

CONCLUSIONS

In order to compensate for the limitations discussed above, an ideal study methodology will have to meet the following requirements:

(1) The study period must be long enough to include all the important changes in both the community and the transportation system.

(2) The study should be continuous over time to reveal the general trends in community development both before and after changes in the transportation system.

(3) The geographic limits of the study area must incorporate the entire community, including extraterritorial controls.

(4) The effects on the community examined must include all physical, social and economic factors of importance for characterizing the community and for measuring the community's potential for growth and development.

(5) The study of the transportation system must include all of the modes serving or influencing the community, and the study method must make it possible to determine what characteristics of the transportation system are of the greatest importance for community development.

PREFACE

This is the third in a series of reports describing the activities and findings as a part of the work done under the research project entitled, "Transportation to Fulfill Human Needs in a Rural/Urban Environment." The project is divided into five topics, and this is the first report under the topic "The Influence on the Rural Environment of Interurban Transportation Systems." This report is a review of the findings of previous studies in the field of research on transportation impact in rural areas, an analysis of the methodologies most commonly used, and a proposed methodology suitable to the study of the impact of transportation changes on rural communities. It is intended to provide both a picture of the state-of-the-art and a summary of specific results, especially those which have a direct bearing on the study of interurban transportation in rural environments.

This review has shown the need to re-evaluate the methodology of impact studies in general and to develop from specific case studies a methodology appropriate to transportation systems impact on small communities.

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I. INTRODUCTION

Mobility is and has always been a major characteristic of American society. Land development, economic activity, and social habits have all been dependent upon this feature of American life. The major development of the nation was made possible with the expansion of the railroad system across the continent. Cities with their attendant economic activities grew up at the focal points in the transportation system, those locations where rail lines crossed each other and where the local road systems were connected to the railroads. Later on, when the automobile opened new possibilities for private mobility, the major investment in transportation facilities went for the building of highways, and there followed an increase in economic activity and changes in social habits which were as dramatic as those produced by the development of the railways.

The close connection between highway transportation, land development and economic activity has been subject to a great number of studies which have attempted to relate public investment in highway facilities to social and economic changes in adjacent land and communities. These studies have been of particular concern in the time period after the National System of Interstate and Defense Highways was established by the 1956 Federal Aid Highway Act. These impact studies have become more and more comprehensive and have increasingly provided valuable information about different types of effects caused by transportation improvements in different areas.

PURPOSE AND SCOPE

Background

The purpose of this report is to review both the findings and the methodologies developed for measuring and analyzing the various kinds of impact produced by changes in transportation, especially the improvement in highway facilities. The literature review is an integral part of a research project, "The Influence on the Rural Environment of Inter-Urban Transportation Systems." This research project, sponsored by the U. S. Department of Transportation, the Council for Advanced Transportation Studies, and the University of Texas at Austin, is directed toward developing a methodology capable of ascertaining the nature of a rural community's potential for development as influenced by either existing or planned interurban transportation systems. Such a methodology will be of great value in transportation and land use planning as well as for those living in rural communities to understand the effect that changes in the transportation system might have on their way of life, given the local economic and human resources.

Communities in the eastern area of Texas are considered appropriate for use in developing such a predictive methodology. There is a large number of communities with populations between 1,000 - 50,000, and major changes in the transportation system have occurred in this area during the last two decades. Initially it was felt that a review of existing literature covering transportation systems impact was necessary in order to provide a thorough understanding of the complex cause-effect relationship between physical and operational changes in the transportation system and community development. A definition of the "state-of-the-art" was necessary prior to the development of an overall research methodology and of specific study techniques suited to the different aspects of transportation systems impact. The literature review, together with preliminary studies of local social and economic conditions in the first community to be examined and a survey of information available on transportation systems and community development, has resulted in a more concrete work plan for the first year of the research and a more specific direction for the two following years.

The literature review will continue throughout the entire study period; this report constitutes a summary of the literature examined during the first twelve months of the project. Additional studies will be reviewed as published, and as the research project advances and as the scope of the project is widened to include a greater variety of community impact, appropriate literature will be reviewed.

Literature Sources Studied

The available literature sources include a variety of textbooks, research reports, and articles. The literature studied, or to be studied, may be divided into three broad categories:

(1) General theoretical background;

(2) Previous research reports;

(3) Specific modeling efforts.

The first category, general theoretical background, includes specific subjects in textbooks on transportation planning, land use planning, community planning, sociology, and economics, as well as a variety of papers describing general techniques of research and modeling. Studies in this category are not included in the first report, but will be referred to in the reports dealing with specific areas of transportation systems impact.

The second category, previous research reports, includes impact studies, and thus gives factual information about impact as observed in a great number of research projects. Most of the research has been conducted by universities or by state and federal highway agencies. These studies in most cases prove that changes in transportation systems do have an influence on development and activities in adjacent communities, and they attempt to measure the effect in each case as much as possible. However, because of the variety of individual cases, these studies cannot be used to predict the degree of the impact of proposed changes in a transportation system on communities other than those studied.

The last category, specific modeling efforts, includes the relatively few previous efforts on modeling the impact of highways on specific adjacent areas. Because of the amount of literature dealing with some aspect of transportation impact, the literature reviewed has been selected so as to include what would be of importance for the research project to date. So far, therefore, most of the literature reviewed deals with transportation systems impact on land use, land values, business activities, and general community economics.

The major purpose has been to locate and trace all previous studies which may be of sufficient importance to warrant further examination. It is believed that the results will yield not only a comprehensive summary of previous findings, but also important information about the different methodologies that have been used. This should both clarify the complexity of the problem and disclose the shortcomings of other research in the field.

Most studies reviewed to date are from the period 1960 - 1970. Studies prior to 1960 are given less emphasis, as it is believed that later research reflects experience gained from earlier methodology. Also, the most important interurban transportation system of today, the interstate system, was to a great extent constructed after 1960.

CHARACTERISTICS OF THE IMPACT STUDIES REVIEWED

So far, practically all of the impact studies deal exclusively with the effect of interurban highways, mainly the interstate system and the effect of circumferential or through routes in urban areas. Thus limited-access highways have received the most attention. However, arterials without access-control and even farm roads have been studied to some degree.

Geographically, there are highway impact studies from every part of the nation. Only in Texas has there been carried out a series of studies, using the same methodology.[1] Of the literature reviewed, these give the most comparable information. Because of the wide variance in study techniques and the dates of different studies, it has not been found appropriate to try to compare studies from different parts of the nation in order to find any specific difference in impact according to geographical location. Although the

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[1] C. V. Wootan and H. G. Meuth, "Economic Impact Study, Temple, Texas," Texas Transportation Institute, Bulletin 14, 1960; J. L. Buffington and H. G. Meuth, "Economic Impact Restudy, Temple, Texas," Texas Transportation Institute, Bulletin 27, 1964; J. L. Buffington, "Economic Impact Study, Rural Area East of Houston, Texas," Texas Transportation Institute, Bulletin 37, 1967; "Economic Impact Study, Chambers County, Texas," Texas Transportation Institute, Bulletin 39, 1967; "Economic Impact Study, Huntsville, Texas," Texas Transportation Institute, Bulletin 38, 1967; "Economic Impact Study, Conroe, Texas," Texas Transportation Institute, Bulletin 40, 1967; "Economic Impact Study, Waxahachie, Texas," Texas Transportation Institute, Bulletin 35, 1966; "Economic Impact Study, Merkel, Texas," Texas Transportation Institute, Bulletin 36, 1966.

areas studied include both urban and rural communities, in this literature review, studies from rural communities have been given the most emphasis.

"Highway improvements" are in most cases defined as the construction of new highways. A new facility may be located relatively close to and serve the same traffic as an old facility, or it may be a new link in the overall road network, thus creating new travel patterns. Most of the previous research has concentrated on new interchange areas or on bypass routes, locations where the most obvious changes take place.

All studies involve definition of the area in which the effect is measured. Different types of areas have different characteristics and may require different study techniques. Consequently, most studies concentrate on one type of area. Study areas may be divided into two major categories, urban and rural. In some cases a third category, "urban fringe," is used. However, it may be difficult to give a unique definition of each area type. Studies of small towns can in most cases be said to be studies of rural areas.

In addition to type of area, the previous studies may be classified according to type of highway improvement which has occurred. It is reasonable to use three categories:

(1) Interchanges,

(2) Bypass routes,

(3) Rural highway routes.

Studies of the two first categories involve both rural and urban study areas.

The basic approach has involved the study of changes in land development and activities in a period before and a period after completion of the new facility. Typically, changes in land use, business activities, etc., are related to the highway improvement. Such variables as distance to nearest city, population density and traffic volumes are also investigated in some studies, as is the effect of proximity to the highway improvement.

METHODOLOGIES USED

The methodology used to evaluate such changes as alterations in land use, land value, economic activity, etc., usually involves one of, or a combination of the following:

(1) Before-and-after study,

(2) Survey-control area study,

(3) Case study,

(4) Multiple regression analysis,

(5) Other study techniques.

The "before-and-after study" method, combined with one of the other methods, is used primarily to determine the effect of road improvement. In these studies, the "before" period includes 2 - 5 years prior to the highway's construction, and the "after" period usually spans 2 - 5 ayears following the completion of the highway. The before-and-after method is most often used to study the effect of a new highway in an area which did not have previous roadway, e.g., an area where a new bypass is built.

The "survey-control area study" method is the most common technique used to isolate the influence of a highway on nearby land, often in combination with the before-and-after study method. The procedure is to measure development both in the study area located adjacent to the facility and in a control area located far enough from the highway to have been unaffected by the facility. The change between the before period and the after period in the control area is compared with the change in the survey area, and the effect of the highway is measured as the difference between the two.

The "case study" approach deals with a rather detailed analysis of events which have taken place nearby a highway facility. Such events may be the construction of new industrial plants or new commercial development. By examining selected cases with emphasis on their relationship to the highway, the case studies may indicate the variety and the extent of significant changes attributable to the highway.

Multiple regression analysis, a statistical technique which relates changes in one dependent variable to the behavior of a number of different independent variables, has been used in cases where appropriate control areas could not be found or to check the results of the survey-control area method. Changes in land development or land value, the dependent variables, are assumed to be the products of many different factors, both highway and non-highway related. The most significant results are achieved by partial correlation, requiring that the different variables be represented quantitatively.

Techniques other than the above mentioned, or variations of them, were also used in the studies reviewed. Among these were the "projected land use/ value relationship approach" and the "neutral road comparison" method.

The first of these two techniques involves comparing the land development which might have occurred had the highway not beeen built with the development which actually took place. The "neutral road comparison" method compares alternative highway locations to a hypothetical, economically neutral road.

All of the techniques reviewed require that highway and non-highway related impact be separated. The non-highway related impact is usually analyzed in terms of such factors as distance to nearest trading center or city, population density, and area-classification (urban, suburban, and rural).

Regardless of the methodology used, most of the studies examine the average effect in the study area. Only a few studies examine the geographical distribution of the effect, usually by classifying areas as within or outside some specified distance from the highway facility. Further comment on the limitations of current methodology is reserved for the last section of this report. It is first necessary to review the particular findings of transportation impact studies, especially those concerned with small town and rural areas.

CHAPTER II. PREVIOUS STUDIES OF THE IMPACT OF TRANSPORTATION IMPROVEMENT IN RURAL AREAS

II. PREVIOUS STUDIES OF THE IMPACT OF TRANSPORTATION IMPROVEMENT IN RURAL AREAS

IMPACT OF HIGHWAY IMPROVEMENT

The impact of highway improvement or location on rural communities is usually measured in terms of the effect on one or more of the following:

(1) Land use

(2) Land value

(3) Business activity

(4) Industrial location and manufacturing growth

(5) Social characteristics

(6) General community response

While this grouping may help to clarify the basic relationship between a change in the transportation system and the types of community characteristics affected, one should have in mind the interaction between the factors, e.g., between land use and land value.

Impact on Land Use

Interchange Areas. Most of the highway impact studies investigate land use adjacent to a highway. Because changes in land use due to a highway facility tend to occur primarily at interchanges, a number of the studies deal only with interchange areas.

It is important to know what development is likely to take place in an interchange area and how this development varies with interchange type, access, and geographical location. A study of 66 interchanges along I-94 in Michigan shows a significant difference in development for different types of interchanges.[2] The findings are summarized in Table 1.

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[2] R. H. Ashley and W. F. Berard, "Interchange Development Along 180 Miles of I-94," Highway Research Record No. 96, Highway Research Board, 1965, pp. 46-58.

TABLE 1. PERCENT OF LAND DEVELOPMENT ADJACENT TO HIGHWAY INTERCHANGES

Type of Development	Interchange Type		
	Closed	Partial	Full
Commercial	-	7.1%	40.6%
Industrial	-	-	5.2
Residential	14.8%	7.1	14.1
Governmental	-	21.5	6.6
Vacant	85.2	6.6	33.5
	100.0%	100.0%	100.0%

This table suggests that different land uses depend upon the kind of access available. "Closed" interchanges are intersections of two limited-access highways. Thus, adjoining land is accessible only by indirect routes. "Partial" interchanges serve on-and-off traffic in only one direction. "Full" interchanges allow the motorist to leave the freeway in either direction. Residential development does not seem to require accessibility at the interchange whereas industrial, governmental and particularly commercial, seem to require immediate access.

The same study also examines full interchanges in order to show the relation between development and geographical location. The interchange locations were classified as:

(1) Major city routes: Major routes, population $>$ 10,000

(2) Secondary city routes: Secondary routes, population $>$ 10,000

(3) Small town: Main intersection, population $<$ 10,000

(4) Rural: All interchanges not associated with a city or a town.

Table 2 shows the result from this aspect of the study. The study ranks land-use as follows: commercial, industrial, residential, and vacant. It should be noted that the table shows only the highest ranked land use in each quadrant in the interchanges. Consequently, the exact nature of land development in each quadrant is not truly represented. The governmental classification is used for land owned by governmental agencies and in this study is not considered available for development.

TABLE 2. QUADRANT DEVELOPMENT AROUND FULL INTERCHANGES

Type of Development	Interchange Location			
	Major City Route	Secondary City Route	Small Town	Rural
Commercial	78.1%	40.1%	44.2%	22.4%
Industrial	-	15.4	1.9	2.6
Residential	9.4	11.5	15.4	17.1
Governmental	-	9.6	3.9	9.2
% of Total Developed	87.5%	76.9%	65.4%	51.3%
% of Total Vacant	12.5%	23.1%	34.6%	48.7%
Total	100.0%	100.0%	100.0%	100.0%

Since this review is most concerned with transportation impact in rural areas and small towns, the results for these two locations are of most interest.

Twice as many quadrants have commercial land use in small towns as in rural areas. Also significant is the relative lack of industrial development near interchanges in small town and rural areas when compared with secondary city routes.

To give an idea of the magnitude of development, as well as the relative kind of land use, Table 3 shows the average number of commercial activities by type. In this table is also included the average number of activities from a study of interchanges in Pennsylvania.[3]

TABLE 3. NUMBER OF DEVELOPMENTS (WITHIN 1000 FT.) PER FULL INTERCHANGE

Interchange Location	Service Stations	Restaurants	Motels	Shopping Centers	Other Sales Uncommitted (a)
Major City Route	3.38	2.38	1.25	0.38	0.38
Secondary C. Route	1.38	0.46	0.15	0.08	0.54
Small Town	1.23	0.54	0	0	0.62
Rural	0.44	0.28	0	0	0.50
Average, Michigan	1.33	0.71	0.31	0.08	0.52
Average, Pennsylvania[b]	0.6	0.3	0.3	0	0.6

[a] Known sales where no construction has started.

[b] Figures from 36 non-urban interchanges.

[3] O. H. Sauerlender, R. B. Donaldson, and R. D. Twark, "Factors That Influence Economic Development at Non-urban Interchange Locations ", Pennsylvania State University, 1967.

According to the Michigan study, service stations and restaurants represent the only kind of interchange development in small towns and rural areas. A rather high number of uncommitted sales indicates that about one property per two interchanges is held for future use. The Pennsylvania study, however, shows a relatively high number of non-highway oriented businesses, although even here service stations, restaurants and motels account for most of the development.

Two recent studies, from interstates in North Carolina and Indiana,[4] also show the percentage of developed land in interchange areas. Tables 4 and 5 give a comparison between the findings from the two studies.

TABLE 4. PERCENTAGE DEVELOPED QUADRANTS, AND AVERAGE NUMBER OF DEVELOPMENTS PER INTERCHANGE

Interchange Location	NORTH CAROLINA		INDIANA	
	Developed Quadrants	Developments per Interchange	Developed Quadrants	Developments per Interchange
Urban	79%	6.5	NA	18.3
Suburban	70%	5.5	NA	6.3
Rural	35%	1.5	NA	2.4

[4] Lawrence P. Fabbroni, "Land Use Development at Interstate Interchanges in Indiana," Joint Highway Research Project, Purdue University, Project C-36-70D, May 1973, pp. 1-85 and Appendix; W. F. Babcock and S. Khasnabis, "Land Use Changes and Traffic Generation on Controlled Access Highways in North Carolina," North Carolina State University at Raleigh, 1971, pp. 1-20.

TABLE 5. INTERSTATE INTERCHANGE DEVELOPMENT (PERCENTAGE) BY LOCATION OF INTERCHANGE

Development	NORTH CAROLINA (a)			INDIANA (b)		
	Urban	Suburban	Rural	Urban	Suburban	Rural
Gas, service stations	27	41	70	28.4	44.7	58.2
Truck stops	5	4	5	1.6	2.4	5.7
Restaurants	1	5	5	10.2	6.1	4.5
Motels	8	12	5	6.3	5.5	8.5
Shopping Centers	3	4	-	-	-	-
Office & Institutions	11	4	2	-	-	-
Retail & misc. sales	21	11	6	-	-	-
Public facilities	-	-	-	3.1	4.2	9.1
Residential	-	-	-	14.5	11.6	8.0
Trailer parks	-	-	-	3.1	3.0	3.4
Educational	-	-	-	-	0.6	0.5
Commercial	-	-	-	19.2	10.3	1.7
Industrial	24	19	7	12.6	12.2	5.7

[a] Approximate percentages.

[b] Actual figures from the report. For some unexplained reason, the figures do not total 100.0% in each category.

These two studies show that service stations are the dominating source of land use near interchanges in rural areas. Also indicated is that industrial and commercial use is much more likely in urban or suburban areas. With regard to motels and restaurants, however, these two studies from North

Carolina and Indiana seem to indicate no significant difference for interchange location.

Despite many similarities in land development at different interchange locations, too little is known about the underlying factors to be able to predict future land use at a specific interchange. One major factor, time, is barely considered in the studies reviewed. This does not, however, mean that time is without interest when short or long term impact on a community is to be determined.

The interchange studies in general seem to indicate:

(1) Highway-oriented services catering to the highway traffic are the first to develop and are the major sources of land use at interchange areas.

(2) The second most important land-use category to develop at interchanges is that of commercial activities which need to be easily accessible from highways. Such activities are shopping centers, some industry, and outdoor theaters.

(3) The third group of land-use categories to develop at interchanges may include non-highway oriented activities (e.g., individual stores) and individual residences. This group has no especially high need for direct access.

Analysis of Interchange Development. In the Pennsylvania study[6] the following variables were included in the analysis of each interchange area in addition to the number and kind of developments: type of interchange, average daily traffic volumes on the interstate and the crossroute, distance to the nearest urban area, age of interchange, topography within the interchange community, population characteristics, and market value characteristics. No complete regression analysis was made, but simple correlation analysis shows that the most important variable is traffic volume expressed in terms of Average Daily Traffic-count (ADT) on the cross-route. Other important factors are topography, distance from nearest urban area, and population change. Table 6, page 16, shows the result from this study.

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[5] Sauerlender, et al., "Factors That Influence Economic Development at Non-urban Interchange Locations."

TABLE 6. CORRELATIONS OF VARIABLES WITH TOTAL HIGHWAY-ORIENTED DEVELOPMENT

(a)

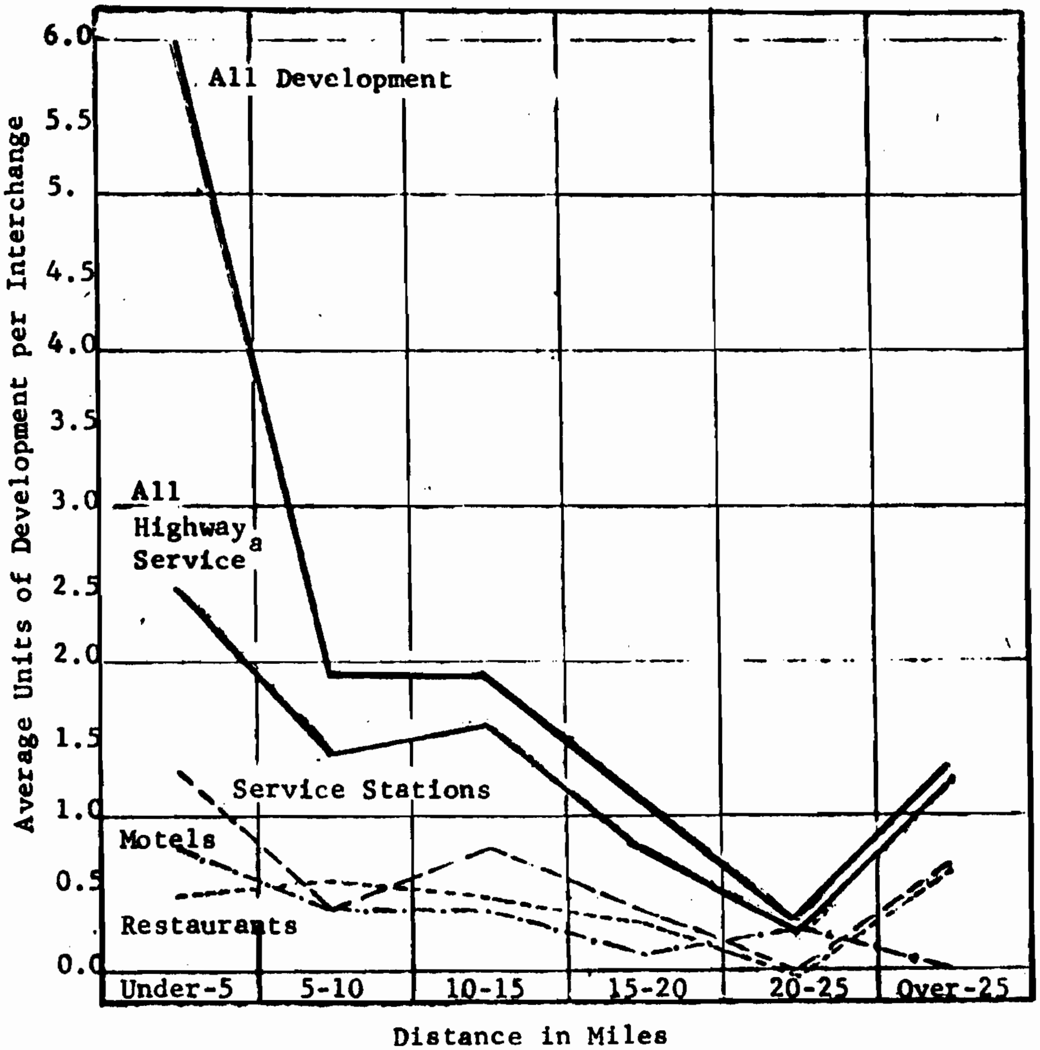
Variable	Correlation Coefficient	Proportion of Variation Explained (percent)
Cross-Route Average Daily Traffic (ADT)	0.514[b]	26.4
Topography (Average Slope)	-0.388[c]	15.1
Distance from Nearest Urban Area	-0.360[c]	13.0
County Population Change	0.333[c]	11.0
Local Municipal Market Value Change	0.320	10.2
Local Municipal Population Change	0.305	9.3
Nearest Urban Area Population Change	0.289	8.4
Nearest Urban Area Population Change	0.235	5.5
Age of Interchange	-0.195	3.8
County Population	0.188	3.5
Interstate Average Daily Traffic (ADT)	0.174	3.0
Local Municipal Market Value	0.135	1.8
Local Municipal Population	0.099	1.0

[a]Total Units include only service stations, restaurants, and motels. Only complete interchanges were considered.

[b]The correlation coefficient is significant at the 1 percent level.

[c]The correlation coefficient is significant at the 5 percent level.

The same report also describes the effect of an increasing distance to the nearest urban area. There seems generally to be a drastic reduction in the number of developments where the distance is more than 5-10 miles. The results are shown in Figure 1, p. 17.



[a]Highway Service, Service Stations, Motels, Restaurants.

Source: Figure from Sauerlender, et al., "Factors that Influence Economic Development at Non-urban Interchange Locations," Pennsylvania State University, 1967.

Figure 1

DEGREE OF DEVELOPMENT AND DISTANCE FROM NEAREST URBAN AREA

The amount of development in an interchange area will depend upon interchange type, characterized by design type and access control. The Pennsylvania study indicates that of all design types, full diamond and full and partial cloverleaf attract more interchange development than other types.[6] (All "full" interchanges provide access to each interchange quadrant from both directions on the main route.) However, other studies have indicated that the most desirable location for highway-oriented development is the quadrant with a direct exit ramp from the main highway. In the case of diamond and cloverleaf design types, these quadrants are often referred to as "right hand quadrants."[7]

Table 7 shows clearly how different types of activities tend to locate according to their dependence upon access from the main highway.

TABLE 7. DISTRIBUTION OF LAND DEVELOPMENT, IN PERCENT, BY HIGHWAY INTERCHANGE QUADRANTS

Land Use	Quadrants	
	Right Hand	Other
Highway related	59%	41%
Commercial	51	49
Residential	50	50
Agricultural	49	51
Vacant	48	52
Institutional	43	57
Industrial	43	57

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[6] Sauerlender, et al., "Factors That Influence Economic Development at Non-urban Interchange Locations."

[7] Floyd I. Thiel, "Highway Interchange Area Development," Public Roads, Vol. 33, No. 8, June, 1965; Martin M. Skin, "Highway Interchange Development: Some Recent Findings," Public Roads, Vol. 35, No. 11, December, 1969.

As expected, highway related activities tend to concentrate near the off-ramps, while industrial activities are more frequently located in other quadrants. The rather equal percentage of vacant land in both right-hand and other quadrants may indicate that most of the interchange areas were not fully developed and that the distribution of land uses consequently was not influenced by scarcity of land.

Bypass Routes. A number of impact studies from Texas,[8] have examined what changes are likely to take place in the area along a new bypass route. The before-and-after study method is the technique used in these studies to obtain information about the impact of the bypass route on adjacent land.

As the summary from four of these findings shows in Table 8, there is an obvious trend in the land use pattern, even though the area characteristics vary. The data from the period before construction of the highway facility shows that most of the land was held for agricultural use. For some areas, a significant part is classified as "held for future use." To what degree this is caused by the highway planning and purchase of right of way for the facility was not investigated in the study.

The most significant change in land use between the before and after periods is the decrease in agricultural land use and the increase in land held for future use. Real estate records showed that many of the properties shifted owners before they shifted land use. This indicates speculation in land caused by the construction of the bypass route. Therefore, the changes in land use which have taken place indicate more about anticipated future exploitation than about real changes in land use.

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[8] C. V. Wootan and H. G. Meuth, "Economic Impact Study, Temple, Texas," Texas Transportation Institute, Bulletin 14, 1960; J. L. Buffington and H. G. Meuth, "Economic Impact Restudy, Temple, Texas," Texas Transportation Institute, Bulletin 27, 1964; J. L. Buffington, "Economic Impact Study, Rural Area East of Houston, Texas," Texas Transportation Institute, Bulletin 37, 1967; "Economic Impact Study, Chambers County, Texas," Texas Transportation Institute, Bulletin 39, 1967; "Economic Impact Study, Huntsville, Texas," Texas Transportation Institute, Bulletin 38, 1967; "Economic Impact Study, Conroe, Texas," Texas Transportation Institute, Bulletin 40, 1967; "Economic Impact Study, Waxahachie, Texas," Texas Transportation Institute, Bulletin 35, 1966; "Economic Impact Study, Merkel, Texas," Texas Transportation Institute, Bulletin 36, 1966.

TABLE 8. CHANGES IN LAND USE FOR SOME AREAS ADJACENT TO NEW BYPASS ROUTES

AREA	Year	Agricultural	Timberland	Held for Future Use	Rural Residential	Urban Residential	Commercial, Traffic-serving	Commercial, Non-traffic-serving	Industrial	Institutional Municipal	Other
Rural area E. Houston	1954	6000	-	5500	500	500	10	10	50	5	625
	1962	3371	-	7600	657	517	11	15	360	17	652
	Change	-2629	-	2100	157	17	1	5	310	12	27
Chambers County	1955	22620	1320	535	130	-	0	2	55	2	1136
	1965	22513	1208	544	216	-	8	43	55	55	1158
	Change	-107	-112	9	86	-	8	41	0	53	22
Conroe	1958	9678	4672	3087	424	570	62	7	57	1743	0
	1965	6025	2904	7356	582	928	69	115	73	1921	327
	Change	-3653	-1768	4269	158	358	7	108	16	178	327
Huntsville	1954	4000	1600	1416	231	289	16	13	1	1007	227
	1964	3607	1374	1460	343	486	31	25	1	905	568
	Change	-393	-226	44	112	197	15	12	0	-102	341

Source: Buffington, "Economic Impact Study, Rural Area East of Houston, Texas;" "Economic Impact Study, Chambers County, Texas;" "Economic Impact Study, Huntsville, Texas;" "Economic Impact Study, Conroe, Texas."

The after-period in these studies varies from 2 - 5 years beyond the time when the bypass section was opened to traffic. Thus it may be said that the studies show only a short term effect on land use. As the area classified "held for future use" constitutes up to 70% of the study areas, the long term effect may be different from the short term effect.

It is often the case that change in land use depends largely upon distance to the highway facility. These studies from Texas show that the change is most likely to take place in the abutting tracts. The highway impact on land use studied in these cases is therefore limited to a very narrow strip along the facility. The number of abutting tracts according to land use is shown in Table 9, p. 22.

Rural Highway Routes. The highway effect upon agricultural land use found in the bypass-studies discussed above is not representative of the over-all effect of the interstate system in rural areas. In the bypass-studies most of the tracts were located just outside of towns ranging from 8,000 to 25,000 in population, and the resulting effect is caused by the combined effect of highway and nearness to a city.

Of the studies reviewed, only three from Texas[9] deal with the effect of construction of a new highway facility through a rural area. These studies cover a period beginning one year before construction and ending one year after the highway section was opened to traffic. In order to account for any external or general influences not attributable to the highway during the period, data were also collected from a control area that was similar to the study area in the before period.

These studies seem to indicate that there is no evidence of major change in land use as a result of the highway construction, except for the fact that parts of tracts of land are acquired for the highway right of way.

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[9] H. G. Meuth, "Right of Way Effects of Controlled Access Type Highways on a Ranching Area in Madison County, Texas," Texas Transportation Institute, Research Report 58-4, 1968; H. G. Meuth and J. L. Buffington, "Right of Way Effects on Controlled Access Type Highway on a Farming Area in Ellis County, Texas," Texas Transportation Institute, Research Report 58-5, 1969; H. G. Meuth, "Right of Way Effects of Controlled Access Type Highway on a Farming Area in Colorado and Fayette Counties, Texas," Texas Transportation Institute, Research Report 58-6, 1970.

TABLE 9. VARIATION IN NUMBER OF ABUTTING TRACTS ACCORDING TO LAND USE ALONG BY-PASS ROUTE

STUDY AREA	Periods Before And After	Agricultural	Timberland	Held for Future Use	Rural Residential	Urban Residential	Commercial, Traffic serving	Commercial, Non Traffic serving	Industrial	Institutional Municipal
Waxahachie	(a)			28	5	8	1	1	1	1
Chambers County	1947-55	43	5	21	0	0	0	0	0	1
	1960-65	43	4	22	4	0	5	1	0	2
Conroe	1952-58	15	25	43	5	6	0[b]		0	6
	1963-65	7	3	58	6	6	5		0	8
Huntsville	1950-54	14	16	1	2	0	0	0	0	6
	1960-69	3	9	24	8	4	7	2	0	6

[a] Difference between after period (1969-62) and before period (1951-55).

[b] No distinction made between the two types of commercial development.

Source: Buffington, "Economic Impact Study, Merkel, Texas;" Ashley, "Interchange Development Along 180 Miles of I-94;" Fabbroni, "Land Use Development at Interstate Interchanges in Indiana;" Babcock, "Land Use Changes and Traffic Generation on Controlled Access Highways in North Carolina."

Further findings state that the loss of land for right of way seems not to have any noticeable effect on the average net-cash operating-income of properties in the study area.

In most cases the new highway improved the farmers' access to the nearest trading center. The ones who continued to use their regular routes to town reported less traffic and congestion on those routes after construction of the new highway.

Most of the farmers whose lands were affected by the highway experienced an increase in travel distance necessary to operate the remainder of their tracts adjacent to the highway. The additional distance to reach these tracts varied from about .1 to 4 miles. In the three studies, the average of additional miles per farmer per year varied from 120 to 390 miles.

Impact on Land Values

The studies reviewed to date tend to verify that accessibility is a key catalyst for changes in land value. Since land value is a function of the possibility of economic activity, and since this possibility changes with ease of access, it is obvious that the value of land may vary with its connection to a transportation system.

Thus, land value may reflect the economic impact of the highway facility; in this way, land value might be considered an important indicator of both real and anticipated effects of the transportation system.

However, accessibility is only one factor and should not be regarded as isolated from traveller characteristics or land use characteristics. Different kinds of economic activities depend upon different groups of travellers (e.g., local traffic or through traffic); therefore, access has to be related to land use and, in some degree, to other general characteristics of the location of the study area.

Interchange Areas. The study of interchanges along I-94 in Michigan clearly shows that study area location and land use must be taken into consideration when land value is analyzed.[10] This study investigates land values for different land uses in full interchanges. Table 10, p. 24, gives a summary of the findings.

Table 10 shows that investors in service stations were willing to pay far more per acre than other investors. The difference is especially high at interchanges in rural areas. The main reason for this is probably the difference

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[10] Ashley, "Interchange Development Along 180 Miles of I-94."

in net annual return for other activities, which, unlike service stations, are more dependent on the general population density in the area. Service stations on the other hand serve the traffic, and it may be expected that traffic volumes are more important than the nature of the area in which the interchange is located. As service stations depend more upon direct access from the highway than other activities (see Table 7), it may be expected that land values vary considerably in the different quadrants according to the interchange design.

TABLE 10. CHANGES IN LAND VALUES BY LAND USE TYPE IN FULL INTERCHANGES

Interchange Location	Average Land Values ($ per acre) 1960 - 1964		Percent Change (a)	
	Service Stations	Other	Service Stations	Other
Major City Routes	54 653	8 600	441	227
Sec. City Routes	18 650	1 830	388	215
Small Town	11 100	995	641	205
Rural	26 470	512	627	161

[a] Period 1958 - 1959 compared with period 1960 - 1964.

Another reason for the difference between the price paid for service stations and that for other land uses may be the fact that the freeway was a relatively new concept in 1960, and thus the investor had little experience in calculating possible future profit. Therefore, these prices may express the investor's anticipations and ability to pay more than real, long-term changes in land value.

Bypass Routes. Four studies from Texas seem to indicate especially high increases in land value along bypass routes.[11] The before-after study method is used; to account for general increases in land value, a control area similar to the study area in the before period is also examined.

Since the construction of the new bypass route is the principal difference between the study and the control area during the after period, the divergence in land values between the two areas is attributed to the highway improvement. Possible factors other than the new highway facility are therefore not considered.

As can be seen from Table 11, p. 26, there is a significantly higher land value in the study areas during construction and the after period than in the control areas. The control areas seem to have a rather stable pattern with regard to land value. The land values in the separate study areas fluctuate to such a degree between one study period and another that it is difficult to see a clear pattern. What can be learned, however, is that there is a significant increase in land values, over and above what might be expected without the highway's influence, between the before and the after periods.

Table 11 gives the average sales prices per acre, regardless of land use. Since land value is highly dependent upon land use, a dominance in sales of land devoted to a given use in a particular period may explain the great variation in sales price between one period and another. However, without detailed information about land use or speculation, no definite conclusions may be drawn about the specific reasons for particular fluctuations in land value.

Increase in land values for improved areas is not shown in Table 11. The Texas studies indicate, however, that this is smaller than the increase for unimproved areas. One reason for this may be that improved lots are fixed in land use, and their prices normally do not respond so readily to changing surroundings as do those for unimproved lots.

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[11] Wootan and Meuth, "Economic Impact Study, Temple, Texas"; Buffington and Meuth, "Economic Impact Restudy, Temple, Texas"; Buffington, "Economic Impact Study, Huntsville, Texas"; "Economic Impact Study, Conroe, Texas," "Economic Impact Study, Waxahachie, Texas."

TABLE 11. CHANGES IN LAND VALUES IN UNIMPROVED AREAS ALONG BYPASS ROUTES

Study Area	Study Period (b)	Average price per acre ($) (a)			Percent Increase		Highway Influence	
		Abutting	Non-Abutting	Control Area	Study Area	Control Area	$/acre	percent
Temple (I)	1941-48	58	58	57				
	1949-54	440	91	112	168	45	733	1227
	1955-57	920	214	108	430	-4		
Temple (II)	1943-48	91	91	98				
	1949-54	921	549	136	531	39	2331	2562
	1958-61	3779	2062	143	2601	0		
Waxahachie	1951-55	172	243	109				
	1956-58	1123	429	142	290	30	590	288
	1958-62	847	833	141	20	-1		
Conroe	1952-58	1231	497	793				
	1959-62	500	436	930	3	17	702	95
	1963-65	1658	684	698	77	-25		
Huntsville	1950-54	1197	891	400				
	1955-59	8127	1460	487	192	22	2376	253
	1960-64	7205	1038	497	26	-2		

[a] All prices adjusted to Labor Statistics Consumer Price Index, 1947-49 - 100.

[b] The first period for each study is the "before" period, the second is the "construction" period, and the third is the "after" period.

In order to determine the effect on land values with proximity to the highway facility, the sales were classified as abutting and non-abutting. As shown in Table 11, the unimproved properties abutting the highway right of way received a much greater highway influence than nonabutting properties. As there were frontage roads along most of the bypass routes, this difference between abutting and nonabutting properties could be caused by the direct access to the frontage road for abutting properties.

Rural Areas. In most cases, studies of highway impact in rural areas tend to support the view that there is an increase in land value due to highway construction or improvement.[12] However, the results are not uniform, and the causes of changes in land value are not readily identifiable.

One study of the influence of highway on rural land values in the United States does tend to show that land value of farms varies with the quality of the road, although distance to nearest trading center appears to be the most significant factor.[13] Farms were classified according to both the surface of the road which served them (hard-surfaced, gravel, and dirt) and the quality of the land. Regardless of land quality the sales price per acre increased with better quality of service road.

Analysis of the effect of interstate routes on land values in rural areas is complicated by accompanying changes in land use. One study in North Carolina found an increase in land value along three different interstate routes ranging from 3.6 to 133 percent.[14] It is clear from the study that land value varies greatly with land use, but the increase in land value for some categories of land use showed an even greater variance than that of all categories combined. Thus, no clear pattern emerges that might explain the increase in land value according to land use alone.

When results from different study areas are compared, no hard and fast inferences about the effect of highways on rural land values may be drawn. For example, the North Carolina study indicated an increase in the price of

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[12] See, for example, P. D. Cribbins, W. T. Hill, and H. O. Seagraves, "Economic Impact of Selected Sections of Interstate Routes on Land Value and Use," Highway Research Record 75, 1967, pp. 1-31; G. E. Bardwell and P. R. Merry, "Measuring the Economic Impact of a Limited Access Highway on Communities, Land Use, and Land Value," Bulletin 268, Highway Research Board, 1960, pp. 37-73; Buffington, "Economic Impact Study, Rural Area East of Houston, Texas," and "Economic Impact Study, Chambers County, Texas."

[13] T. W. Longley and B. T. Goley, "A Statistical Evaluation of the Influence of Highways on Rural Land Values in the United States, Bulletin 327, Highway Research Board, 1962, pp. 21-55.

[14] Cribbins, et al., op. cit., pp. 18-22.

farm land ranging from 21 to 198 percent, while three studies from Texas found no significant increase in farm land value along interstate routes.[15]

Impact on Business Activity

As it has been pointed out, land value varies with land use. Apparently there also is a relationship between the anticipated net return of business activity and what an investor is willing to pay for a special site. Some types of businesses are to a high degree dependent upon good access; thus it is reasonable to think that transportation facilities have a great influence on these business activities.

Interchange Areas. The study of interchanges along I-94 in Michigan analyzes service station gallonage at full interchanges.[16] The gallonage is averaged within each interchange classification (major city, secondary city, small town, and rural area). A statistical analysis was made to test whether there was a significant difference in business success between one interchange classification and the other. The major city interchange stands out from all other classes with a pumpage almost double the average of the others. A significant difference was not found between the other classes, even though the average pumpage for service stations in small towns was a little higher than the average at secondary city and rural interchanges.

To find the influence of proximity to the highway, the difference in pumpage for service stations within or outside a distance of 400 feet from the freeway was tested. The difference was found to be statistically significant and sharply focuses on benefits derived from the freeway.

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[15] Meuth, "Right of Way Effects of Controlled Access Type Highways on a Ranching Area in Madison County, Texas"; Meuth and Buffington, "Right of Way Effects of Controlled Access Type Highway on a Farming Area in Ellis County, Texas"; Meuth, "Right of Way Effects of Controlled Access Type Highway on a Farming Area in Colorado and Fayette Counties, Texas."

[16] Ashley and Berard, "Interchange Development Along 180 Miles of I-94."

Bypass Routes. Several studies from Texas investigate the influence on business activities of new bypass routes.[17] In these studies the average of the gross sales for different business activities is calculated for different time periods. To provide a truer picture of the net effect, some of the studies include information on businesses located along both the new facility and the old route. In other cases, comparison is made between business activity along the bypass route and that of the local area and/or the state. The result is summarized in Table 12, page 30.

Traffic-serving businesses, such as service stations, motels, etc., are separated from non-traffic serving businesses. However, it is difficult to draw any general tendency from the table. As can be seen in the table the variation is less for non-traffic service businesses than for traffic-serving businesses. Also, the non-traffic services in all but a few cases show an increase in annual gross sales, while many traffic-serving activities experienced great decreases. The information in this table indicates that traffic-serving businesses are more affected by the highway facility than are other types of operations, but the reports do not give enough information about the design of the highway facility or about community-related factors to explain why, when both old and new routes are considered, service stations and motels in some areas experienced an increase in gross sales while those in other areas showed a decrease.

Rural Areas. A study of businesses along secondary roads in Kentucky may indicate the effect of highway improvement in rural areas.[18] Two periods, 1938-50 and 1955-60, were studied. The total number of businesses in the area increased, even though there was a decrease in the number of "open-country" stores. Analysis of the data shows that improvement of intercounty routes and of intracounty "collectors" appears to be of primary benefit in effecting market adjustments.

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[17] Buffington and Meuth, "Economic Impact Restudy, Temple, Texas"; Buffington, "Economic Impact Study, Rural Area East of Houston, Texas"; "Economic Impact Study, Huntsville, Texas; "Economic Impact Study, Conroe, Texas"; and "Economic Impact Study, Waxahachie, Texas."

[18] R. H. Stroup and L. A. Vargha, "Economic Impact of Secondary Road Improvements," Highway Research Record No. 16, Highway Research Board, 1963, pp. 1-13.

TABLE 12. PERCENT CHANGE IN ANNUAL GROSS SALES OF BUSINESSES ALONG BYPASS ROUTES

Study Area	Before and After Study Periods (a)	O-Old route B-Both routes	Traffic Serving				Non-Traffic Serving				Total % Change of Gorss Sales For All Businesses
			Service Stations	Food Service	Motels	Total	Grocery	Services	Miscellaneous	Total	
Temple (II)	54,57	O	10.6	-19.1	-54.4	-15.3	5.5	NG	19.2	8.2	4.7
	54,57	B	NG[b]	NG	NG	NG	NG	NG	NG	NG	7.7
Bell County	54,57	-	NG	NG	NG	NG	NG	NG	NG	NG	12.6
State of Texas	54,57	-	NG	NG	NG	NG	NG	NG	NG	NG	19.5
Waxahachie	58,62	B	-18.7	0.8	43.3	-13.5[c]	NG	NG	NG	NG	3.5[d]
	58,62	O	NG	NG	NG	NG	-19.4	33.8	25.0	10.1	NG
Total City W.	58,62	-	NG	NG	NG	NG	NG	NG	NG	NG	13.1
State of Texas	58,62	-	NG	NG	NG	NG	NG	NG	NG	NG	17.8
Rural, East of Houston	58,62	-	NG	NG	NG	6.7	- 7.2	NG	36.7	-1.0	0.5
Conroe	62,65	O[e]	-10.0	-14.0	17.0	- 9.0	6.0	80.0	-3.0	25.0	9.0
	62,65	B	-20.0	-15.0	17.0	-17.0	1.0	63.0	171.0	53.0	NG
Huntsville	58,64	O[e]	25.0	6.4	-23.7	13.4	-21.5	15.3	50.0	20.9	19.1
	58,64	O	- 8.5	23.3	19.3	2.4	NG	NG	NG	NG	NG
	58,64	B	19.1	47.1	48.7	29.0	85.0	97.0	43.0	58.1	NG
Merkel	58,62	B	NG	NG	NG	64.7	NG	NG	NG	24.9	NG
Total City M.	58,62	-	55.1	70.9	-66.6	53.3	7.2	32.7	4.5	13.1	18.9

[a] The study periods are designated by the last year of each period.

[b] This information was not gathered.

[c] Figures from 36 businesses.

[d] Figures from all 73 businesses.

[e] Figures only from firms operating both first and last year in a period.

Impact on Industrial Location and Manufacturing Growth

An objective of two of the studies reviewed was to determine which factors are important to industry in making plant location decisions. One of the studies included interviews of a small number of the owners of industrial firms currently located on free access roads.[19] All of the firms but one were primarily dependent upon trucks to transport their final product, and all of the firms, with one exception, felt that location in close proximity to a major highway was necessary. However, little priority was given to specific types of highway facilities. If the road was paved and in good condition, it was judged adequate. Advertising benefits resulting from location received little consideration by the owners. For most, this factor was viewed as providing a possible extra benefit rather than as being a requirement. However, some concern for the value of the advertising benefits of a location was shown by firms serving consumer as opposed to industrial markets.

Another study analyzes a nationwide questionnaire survey of manufacturing, wholesale and warehousing establishments.[20] Each of the firms had made one or more moves during the period 1955-59.

Survey findings indicated that, of 13 different plant location factors included in the questionnaire, the most frequently mentioned concern was proximity to good highways. On the average the next four most important factors were, in this order, abundant labor supply, availability of suitable land, proximity to markets, and rail service. However, different establishments ranked the rail service differently in importance from first to eleventh place. Industries giving emphasis to both highway proximity and rail service are printing and publishing, wholesale trade, fabricated metal products, furniture and warehousing.

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[19] Donald J. Bowersox, "Influence of Highways on Selection of Six Industrial Locations," Bulletin 268, Highway Research Board, 1960, pp. 13-28.

[20] Edward V. Kiley, "Highways as a Factor in Industrial Location," Highway Research Record No. 75, Highway Research Board, 1965, pp. 48-52.

In two highway impact studies (bypass studies), operators of retail businesses reported advantages and disadvantages of the construction of a new highway facility.[21] The results from both studies are quite similar. There was a general agreement by both traffic-serving businesses and others that the new bypass route relieved traffic problems. As Table 13 shows, non-traffic serving businesses reported more advantages of the new facility than did traffic serving businesses (this is in harmony with reported business activity in Conroe according to Table 12).

TABLE 13. ADVANTAGES AND DISADVANTAGES OF A BYPASS ROUTE AS REPORTED BY OWNERS OF RETAIL BUSINESSES

Item	Number of Businesses	
	Traffic Serving	Nontraffic Serving
Advantages:		
Relieved traffic problem	22	24
Helped personal business	4	10
Helped all except traffic serving	9	3
Helped all businesses	3	4
Other	8	10
Disadvantages:		
Failed to relieve traffic problem	0	1
Hurt personal business	16	3
Hurt only traffic serving	0	8
Hurt all businesses	9	2
Others	3	7

One of the few studies investigating air, rail and water transportation in addition to highways deals with the effect of transportation on urban manufacturing growth.[22] One hundred and six different city pairs (freeway located

[21] Buffington, "Economic Impact Study, Conroe, Texas"; and, "Economic Impact Study, Waxahachie, Texas."

[22] Leonhard F. Wheat, "The Effect of Modern Highways on Urban Manufacturing Growth," Highway Research Record No. 277, Highway Research Board, 1969, pp. 9-24.

cities matched by similar non-freeway located cities) all over the nation are included.

In short, the conclusions and observations developed by this study are:

(1) Modern highways significantly affect manufacturing growth, but not in all situations. Freeway cities grew faster only in regions where traffic flow along regular highways is seriously impeded.

(2) Freeway cities with populations greater than 16,000 grew faster than corresponding non-freeway cities.

(3) Cities with airline connections grew significantly faster, particularly in the South and West, for pairs above 19,000 population. This suggests that industry is attracted especially to freeway cities when there is concomitant air service.

(4) Cities with poor rail service might experience "catch-up growth" with the advent of a freeway, the road becoming a substitute for rail service.

(5) For the five waterway pairs included in the study, both freeway and non-freeway cities showed lower employment rates.

(6) The relationship between growth and distance to the freeway is described by a normal probability curve peaking at 0 miles with a standard deviation of roughly five miles. Benefits of growth do not usually accrue to cities located more than about ten miles from the nearest freeway.

(7) Freeways probably stimulate existing industry as well as attract new plants.

Impact on Social Characteristics

The literature on this subject is rather incomplete. However, there are a few studies concerned with the social impact of interurban transportation links on rural communities.[23] Although detailed information about social impact does exist for urban areas, it is questionable whether such data can

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[23]A. S. Lang and M. Wohl, "Evaluation of Highway Impact," Bulletin 268, Highway Research Board, 1960, pp. 105-119; U. S. Department of Transportation, "Benefits of Interstate Highways," Federal Highway Administration, Department of Transportation, June 1970, pp. 1-32; Floyd I. Thiel, "Social Effects of Modern Highway Transportation," Bulletin 327, Highway Research Board, 1962, pp. 1-20; H. Kirk Dansereau, "Five Years of Highway Research: A Sociological Perspective," Highway Research Record No. 75, Highway Research Board, 1965, p. 76-81.

be of use in the study of rural areas because of the basic differences in the profile and composition of rural and urban communities.[24]

Most studies dealing with social impact have shown positive consequences resulting from highway construction. The Federal Highway Administration reports that the Interstate Highway Program received broad community support because of reduced congestion of local streets, reduced noise and air pollution, better access to recreational facilities, and higher economic levels for the town's businesses. For rural communities, in particular, they have served to upgrade primary and secondary educational facilities, improved vocational training possibilities, and made medical care more accessible.[25] Other advantages reported include increased accessibility to shopping and recreational facilities as well as to church, lodge, and organized farm-related functions.[26]

The best discussion found so far has been presented by Dansereau.[27] In his study of rural/suburban communities he found that when a highway was introduced into an area, certain results occurred. The population increased because of the inward migration of younger and higher-income people, thus, raising the standard of living. This population increase took place more rapidly in communities located on arteries of the highway than in those not located on arteries. In the areas studied, levels of living rose visibly with the introduction of new manufacturing concerns (attracted, in part, by the new highway). It was further found that towns which were located nearer highways were more likely to develop a comprehensive community plan. However, most of the users of the highway were those who were in higher occupational, income, and educational groups, who were active in organizations, and who were newcomers to the area.

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[24] R. J. Bouchard and E. L. Lehr and M. J. Redding and G. R. Thomas, "Techniques for Considering Social, Economic, and Environmental Factors in Planning Transportation Systems," Highway Research Record No. 410, Highway Research Board, 1972, p. 1-7; E. A. Beimborn and B. P. Nedwek and C. R. Ryan, "An Evaluation of the Feasibility of Social Diagnostic Techniques in the Transportation Planning Process," Highway Research Record No. 410, Highway Research Board, 1972, p. 8-23.

[25] U. S. Department of Transportation, "Benefits of Interstate Highways."

[26] Thiel, "Social Effects of Modern Highway Transportation."

[27] Dansereau, "Five Years of Highway Research: A Sociological Perspective."

There is a relation between impact on land use and social impact. In one study, it was found that a highway and its bypass routes have a significant effect on a community's growth pattern.[28] This particular study also points up the difficulty of separating studies of social "impact" from the evaluation process. The article concludes that, in order to allow "orderly" growth, a highway should be located at a considerable distance from the community's "prime growth center."

The general view that interurban highways increase the mobility of the rural population deserves comment here. Modern freeways and the private automobile have shortened travel time drastically. Thus people can commute over longer distances in the same amount of time. This means greater opportunity of employment in metropolitan areas for people in outlying communities, but it also may result in other, less desirable social and economic change in these same communities. Thus there is a need to determine the net change in the socio-economic structure of rural communities affected by alterations in the interurban transportation system.

General Community Response

Little has been done in investigating community response to highway improvement. Even though some of the fundamental effects of highway improvement upon land use, land value, business activities and location of industry are known, the resulting effect upon the development of communities with different potentials for response has not been determined.

This lack of knowledge, to choose one example, led to the effort to reverse economic trends in eastern Connecticut by means of a highway system, the Connecticut Turnpike.[29] This example seems to illustrate that merely providing a highway system does not necessarily mean an economic boom for the adjacent communities. Highways can be a stimulus for change, but the response to this stimulus depends on the capacity for change existing in the areas to

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[28] Louis A. Vargha, "Highway Bypasses, Natural Barriers and Community Growth in Michigan," Bulletin 268, Highway Research Board, 1960, p. 29-36.

[29] W. C. McKain, "Community Response to Highway Improvement," Highway Research Record No. 96, Highway Research Board, 1965, pp. 19-23.

be served. What the change will be depends greatly on both economic and human responses.

Walter C. McKain states:[30]

> Highways can furnish only the external stimulus for change. The response made to this stimulus depends on the capacity for change existing in the areas to be served. The presence of other resources, the availability of community leaders, and a plan for action are needed components for social action. Depending on the availability of these other elements, a new road can be either a minor irritant or a positive force for change. The ingredients for community development go far beyond adequate or even superior transportation.

The effect of the turnpike on the individual communities in eastern Connecticut varied. Retail sales, as measured by tax receipts, increased 54 percent in an eight year period for the entire area served by the Connecticut Turnpike. In four of the towns, the revenue increased by 300 percent or more, in three other towns the increase was less than 35 percent, and in two towns there was actually a decline. Although manufacturing employment increased 42 percent for the entire area, in nine towns the number of jobs declined. Real estate values rose in every town, but not uniformly in the entire area.

One plausible reason for the difference in development may be attributed to differences in the resources of separate communities. The potential for development is a function of the interaction of natural and human resources, and thus a given community will respond to change in accordance with its own potential. For example, a textile mill in one community is said to have created a group of workers who do not readily improve their skills. More generally, some communities tended to resist change and adopted a crisis approach to social action.[31]

EFFECTS OF OTHER TRANSPORTATION MODES

Effect of Airports

Previous studies of the effect of airports on rural communities have shown that air transport can play an important role in promoting community

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[30] W. C. McKain, "Community Response to Highway Improvement," Highway Research Record No. 96, Highway Research Board, 1965, pp. 19-23.

[31] Ibid.

and regional growth.[32] However, no body of literature exists comparable to that of highway impact studies.

A study from Texas Aeronautic Commission gives the results of an attitude survey among towns and communities in Texas.[33] The report states that towns of 2,000 - 5,000 population are most apt to be aware of the importance of the need for an adequate airport to attract new business and to maintain and enhance its position in the struggle for economic growth. Small communities placed considerable emphasis on their proximity to adequate airport facilities in adjacent metropolitan areas. Interest in commercial service began when a city reached a population of 24,000 or more.

A nationwide study of cities located along freeways indicates that for places with a population of more than 19,000, cities with air transportation grew faster than cities without air transportation.[34] This was particularily the case for cities located in the South and West. Possibly industry is especially attracted to cities with air facilities in areas with significant distance between one city and another and no developed public interurban transportation system.

Rail or Bus services.

Wheat points to the fact that the effect of highway improvement to some degree may be influenced by existing rail service.[35] Cities with poor rail service might experience "catch-up-growth" with the advent of being connected to the freeway network, with the freeway becoming a substitute for rail. No report reviewed deals with the effect of decreased rail services, and no

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[32]For a review of studies of the effect of air transport on regional and community development, see the "Joint DOT-NASA Civil Aviation Research and Development Policy Study," Supporting Papers (DOT TST 10-5/NASA SP-266), Department of Transportation and National Aeronautics and Space Administration, Washington, D.C., March, 1971, pp. 7/7 - 7/9.

[33]Texas Aeronautic Commission, "Importance of a Modern Airport," Austin, Texas, 1965.

[34]Stroup and Vargha, "Economic Impact of Secondary Road Improvements."

[35]Ibid.

report has been found which explains the importance of the presence of public interurban bus transportation.

MODELING OF HIGHWAY IMPACT

The data and the conclusions from the highway impact studies reviewed to date do not provide predictive tools for the transportation planner. Conclusions are often confirmations of the obvious (e.g., that traffic-serving businesses are the first to develop at interchange areas), or else they are limited to the specific region studied and thus provide little that may be used to formulate hypotheses about the general nature of highway improvement impact in rural areas or on small communities. No study can rise above the limitations of the methodology upon which it is based, and most highway impact studies have been subjected to severe criticisms on methodological grounds.[36] Before proceeding to a review of methodology, however, we will consider the relatively few efforts to model the impact of highway improvement. The small number of such efforts is probably explained by the complex cause/effect relationship between highway improvement and community characteristics and also by the fact that many important variables are qualitative and not readily quantifiable. As modeling efforts in most cases depend upon obtaining information for previous years from local records, available data may limit the number of different factors included in the analysis.

Different models may be created according to the purpose of particular highway impact studies. So far only models of land development and land value have been reviewed.

Land Development

One important effect on land development in an interchange is increased traffic volumes, possibly producing capacity problems on entrance or exit ramps. The study of interchanges along Interstates in Indiana evaluates the

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[36] See Charles Rivers Associates, Inc., "Measurement of the Effects of Transportation Changes," National Technical Information Service Report PB 213 491 (September, 1972).

[37] Fabbroni, "Land Use Development at Interstate Interchanges in Indiana."

ability of a model to predict magnitude of road user developments at an interchange.

The interchange development is expressed as "weighted development"; different land uses are given different weights, since they have different traffic generation rates. The following weights are used:

Service stations	1
Restaurants	1
Motels (small or large chain)	1/2 - 1 1/2
Truck stops	4
Neighborhood shopping centers	3
Regional shopping centers	6
Service stations combined with short order restaurants	1 1/2

"Total weighted development" is the weighted sum of the establishments at the interchange. The final regression model gives the following expression:

$$\begin{aligned}\text{Weighted development} &= 2.016 \\ &+ 1.18 \times (\text{ramp volume}) \times 10^{-3} \\ &- 0.5897 \times (\text{population within 20 miles}) \times 10^{-4} \\ &- 2.49069 \times (\text{interchange age}) \times 10^{-1} \\ &- 0.84518 \times (\text{economic index}) \times 10^{-3} \\ &-25.18036 \frac{(\text{economic index})}{(\text{population index})}\end{aligned}$$

The population index is an expression of population in the highway corridor divided by distance from the interchange under consideration. The economic index expresses the influence of parallel routes.

Standard error of estimate turned out to be 13.87, and $R^2 = 0.5989$. The above model was found to be the best that could be developed without adding extensive additional data. In addition to the low R^2 achieved, the study may be questioned on the basis of whether "weighted development" is an appropriate measure for interchange development. One may also question the use of the two theoretical variable indices. To refine the model further, more factors describing the transportation and the community probably would have to be considered.

Land Values

Another study from Indiana was undertaken to develop a technique for predicting the impact of highway improvement on the value of adjacent land parcels.[38] Two different sets of data, one from Indiana and another from Florida, were used to run a regression analysis of the change in land value as a function of different variables.

The predictor variables included in this study were:

(1) Parcel size (in acres)

(2) Time elapsed between completion of highway improvement and sale of parcel (in months)

(3) Type of highway improvement (interstate, primary or secondary highway)

(4) Type of land use (residential, commercial, agricultural or vacant)

(5) Type of area (urban, urban fringe or rural)

(6) Type of access control (full, partial or none).

Each type within variables three to six was treated as a dummy variable, which assumed a value of one or zero depending on whether or not it was observed for the parcel in question.

All but four of the 100 parcels in the Florida data included interstate highways with full access control. The regression analysis showed that the variables included in the regression equations gave an R^2 varying from 0.24 to 0.46 depending upon the form of the regression equation. Consequently, at most only 46% of the change in land values could be explained by the above mentioned variables.

The Indiana data (33 parcels) indicated a much stronger relation between change in land values and the independent variables. The regression analysis gave an $R^2 = 0.87$. Some classes of the variables contained only a few observations, and the regression equation is consequently not presented as a reliable predictive model. Figure 2 (page 41) shows the relative importance

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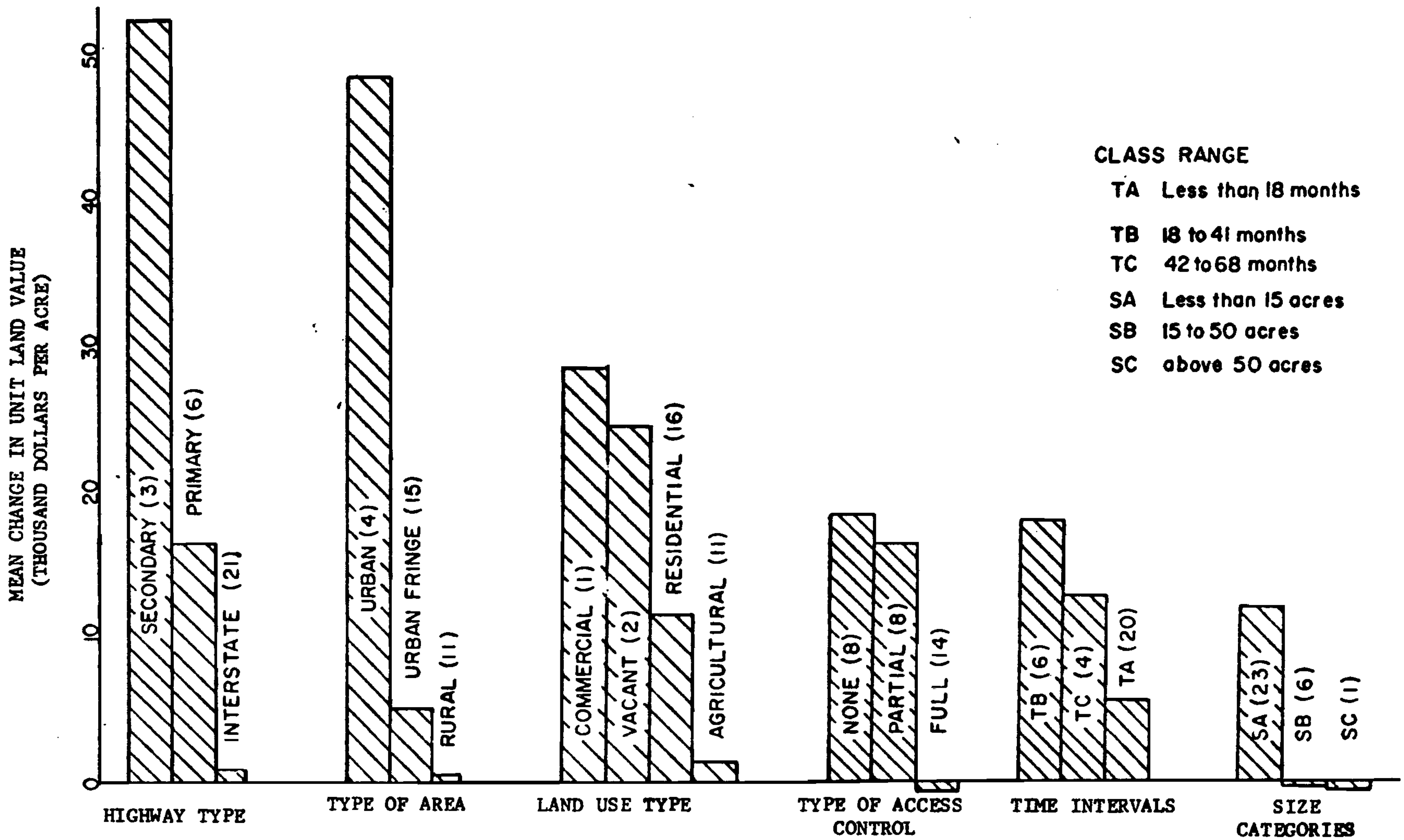
[38] Edward I. Isibor, "Modeling the Impact of Highway Improvements on the Value of Adjacent Land Parcels," Joint Highway Research Project C-36-64G, Purdue University, December, 1969.



MEAN CHANGE IN LAND VALUES FOR
CLASSES WITHIN EACH VARIABLE

Figure 2

VARIATION IN LAND VALUE
BY TYPE OF VARIABLES

of the independent variables used in the regression analysis. According to the analysis, the type of highway improvement is the most important variable, followed by type of area, land use type, type of access control, time elapsed after highway improvement, and size of parcel.

As can also be seen, construction of a secondary or primary road appears to cause greater changes in land values than does construction of an interstate highway. The changes in land value are greatest in urban areas. Without regard to type of area, commercial and vacant land both show a greater increase in land value than that devoted to residential or agricultural uses. Full access control can result in a decrease in land value. Parcels smaller than 15 acres evidently increased more in land value than did large parcels.

One should have in mind that this study was limited to "remainder" parcels which sold some time after the highway improvement. No information is available about which factors influence an owner's decision to sell or not to sell a remainder parcel. The model, consequently, is not of general use for predicting the value of parcels adjacent to or in the proximity of highway improvement.

A more general modeling effort of land values was done in North Carolina.[39] The study included interstate construction in different rural areas. The dependent variable was land value, and the independent variables included size of parcel, year of sale, land use, distance to right-of-way, distance to business district, distance to interstate access, etc. The most important single variable influencing land value was found to be the size of the parcel; the smaller the parcel, the higher the unit price. For specific land uses, certain other variables showed high simple correlation with unit price, but these correlations vanished when multiple regression analysis was used. This indicates a relationship between the independent variables rather than between the dependent and the independent variables. No information about R^2 for this analysis was given, and therefore the degree to which variation in land value was explained by the independent variables is unknown.

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[39] Cribbins, et al., "Economic Impact of Selected Sections of Interstate Routes on Land Value and Use."

Modeling efforts reviewed to date deal primarily with land value as the dependent variable. In this area, the evident need is the development and refinement of indices for the independent variables in order to isolate highway-related from non-highway-related factors influencing land value.

Results from different studies are not always comparable, as might be expected given the different modeling techniques and the different indices developed for the expression of the independent variables.

CHAPTER III. ANALYSIS OF THE PREVIOUS STUDIES

III. ANALYSIS OF THE PREVIOUS STUDIES

Most of the studies reviewed concentrate on impact from highway improvement. Even though the private automobile is the major mode of transportation today, these studies cannot reveal any information about the consequences of changes in air, rail or bus services. The studies show clearly that highway improvement has a significant impact, and usually a positive impact, on the areas along the facility, but not one of the studies reviewed evaluates the consequences of reduction in transportation service, as has been the case in most areas with rail service during the last two decades.

The previous highway impact studies provide a great deal of information, but their limitations should be noted. Many studies are directed more towards describing an impact, and the magnitude of the impact, than toward examining the cause/effect relationship. These studies are of value in showing the benefits of public investment in highway improvement, and they justify the spending of public funds in terms of "non-highway user" cost/benefit. However, they are of less value as a tool for highway or community planners since they cannot be used to predict the future impact of changes in the highway system in a particular community. All of the studies support general observations about the development of adjacent land, the increase in business activity and increasing land values close to the new facility, but few of them are designed to reveal the impact on the community as a whole.

The fact that each community has its own characteristic in terms of economic and human resources, geographical location, etc., makes it difficult to use the highway impact observed in one community to forecast the effect of highway improvement in another community. A forecast would be possible only where general community characteristics are included in the analysis, but unfortunately this is not usually the case.

In addition to these general limitations, previous highway impact studies are subject to criticism on more specific grounds, depending upon the particular methodology used in the research. Consequently, it is important to examine the advantages and limitations inherent in each of the five categories of study methodology before recommending a strategy for future research.

METHODOLOGY

The Before and After Technique

This technique is the most commonly used; it is used either singly or in combination with other techniques in all studies dealing with changes in highway facilities. The main advantages of this approach are, first, that it is simple to apply and, second, that it is easy to understand. The technique measures the value of some of the characteristics of an area before and then after the highway improvement; the difference is said to be the effect of the improvement. Consequently, the only quantity measured is the change in value between one time period and another. The greatest disadvantage is very obvious: this technique cannot relate the measured effect to any specific cause. Since in most cases there will be a span of 3 - 5 years between the before and the after period, many factors other than highway improvement are likely to influence the study area. Thus, this technique cannot determine whether an effect is, or is not, caused by the road improvement. In an attempt to isolate highway effect, the survey- control area technique is often used with the before-after technique. However, as will be shown in the next section, the survey - control area technique is not itself a sufficient way of revealing the scope of the highway impact.

Most studies are conducted in the after period. This may cause difficulties in determining or measuring the nature of the study area in the before period. The only way to avoid this shortcoming is to select an area where the necessary information on the before period is available, thus considerably limiting the number of areas which may be studied. Even assuming that sufficient information from the study area is available, there still remains a major disadvantage to the before and after technique. For each characteristic to be measured, only one value can be assigned for each of the two time periods. The before period, theoretically, has only one defined limit, usually the date on which construction of the improvement was begun; the after period is also defined by narrow limits, usually the period between completion of the highway facility and the date of the study itself. In practice the average length of the before period is approximately only two years; the length of the after period usually varies from two to four years. (In reality, the length of the "before" period is undefinable because it is not known when knowledge of a proposed highway improvement begins to influence the development of an area.)

Figure 3, p. 48, shows the possible pattern of a single response, in this case land value, to changes in the highway system. As can be seen, the before-after technique reveals no information about the trend in the before or the after period. The measured effect of the improvement will be the same regardless of the trend during the time preceeding the change in the highway facility. It is reasonable to say that the effect of the improvement is greater in cases where an existing "downward" trend is reversed than in the cases where the trend is already "upward," even though the measured effect in terms of a value for community response is the same. Consequently, it would be more logical to measure the effect in terms of the difference between the response to actual transportation improvement and a projection of the before-trend (assuming that no improvement had occurred). This situation is represented in Figure 4, p. 49. The total community impact over a time period would be the area between the two curves. Different phases in the improvement planning and implementation process may have different effects on community response (also indicated in Figure 4). What the general shape of such a curve would be, assuming that the effect caused by the highway system development could be isolated for each period, is not known.

It is assumed that general public knowledge of the project, purchase of right of way and so on, will have an influence on the community response, even if not of the same magnitude as the acutal construction of the improvement. Since events other than construction usually fall outside the scope of the before and the after study periods, their effect cannot be determined.

<u>The Survey-Control Area Technique</u>

This is the most common technique used to isolate highway impact. It has been frequently used to study the effect on land values in an area adjacent to a new highway facility (the survey area). To separate the effect of non-highway related factors from those related to the highway, a control area, similar to the survey area, is selected. This control area is ideally chosen far enough from the highway to have been unaffected by the highway facility.

In theory, the survey area and the control area would have to be exactly alike in all respects during the period just prior to the highway improvement. Also, the factors affecting development in the two areas should be the same,

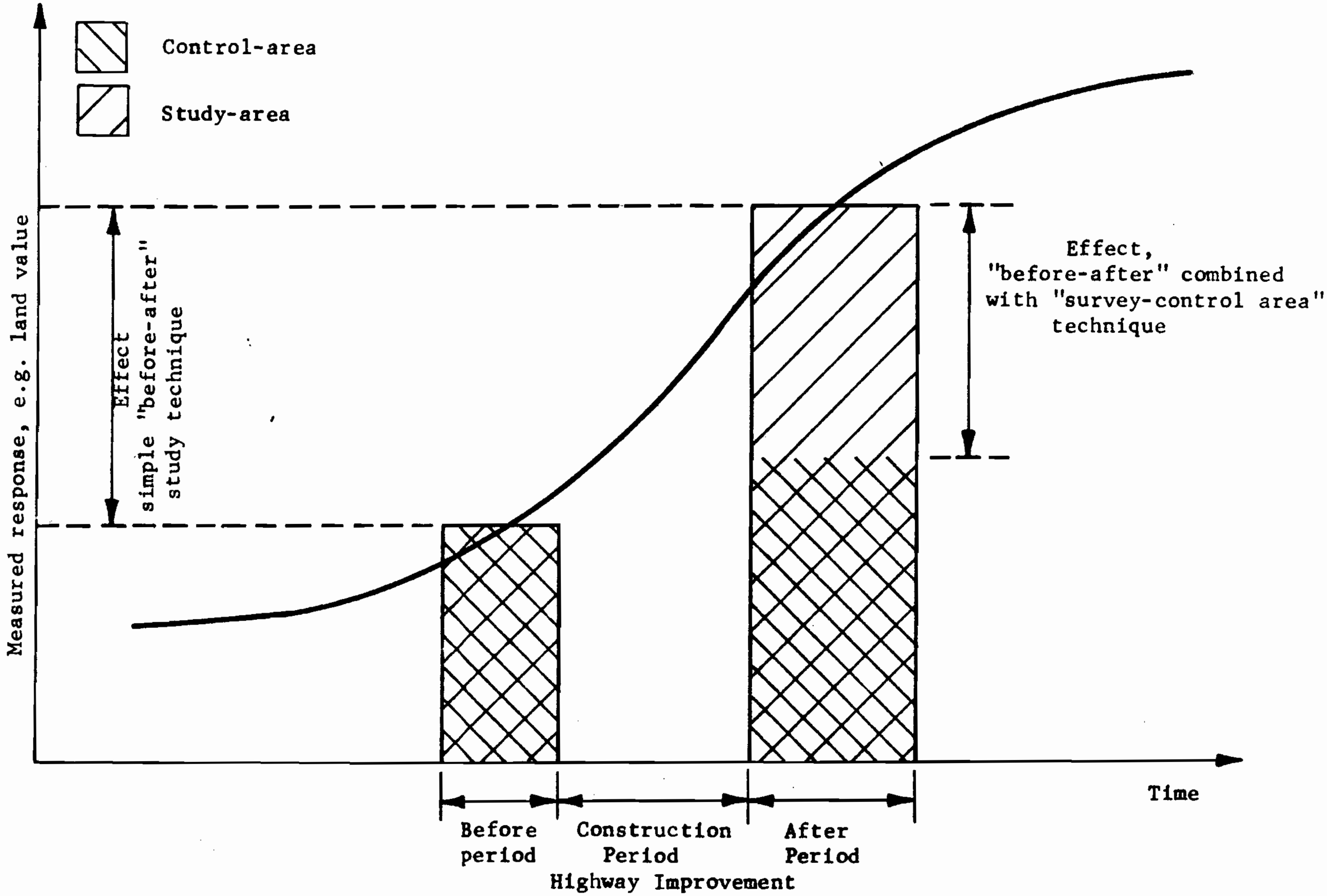


Figure 3

BEFORE-AFTER STUDY TECHNIQUE

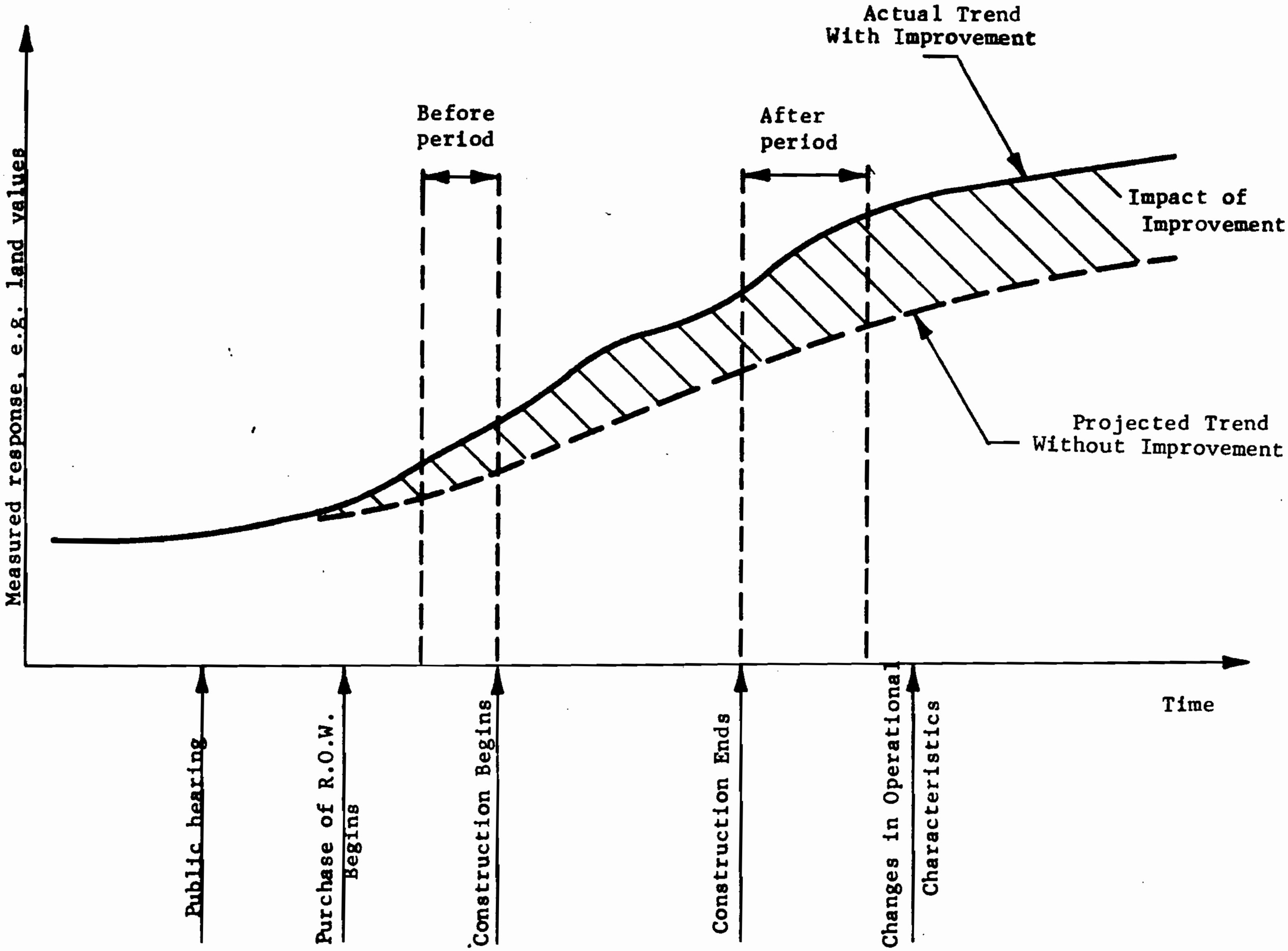


Figure 4

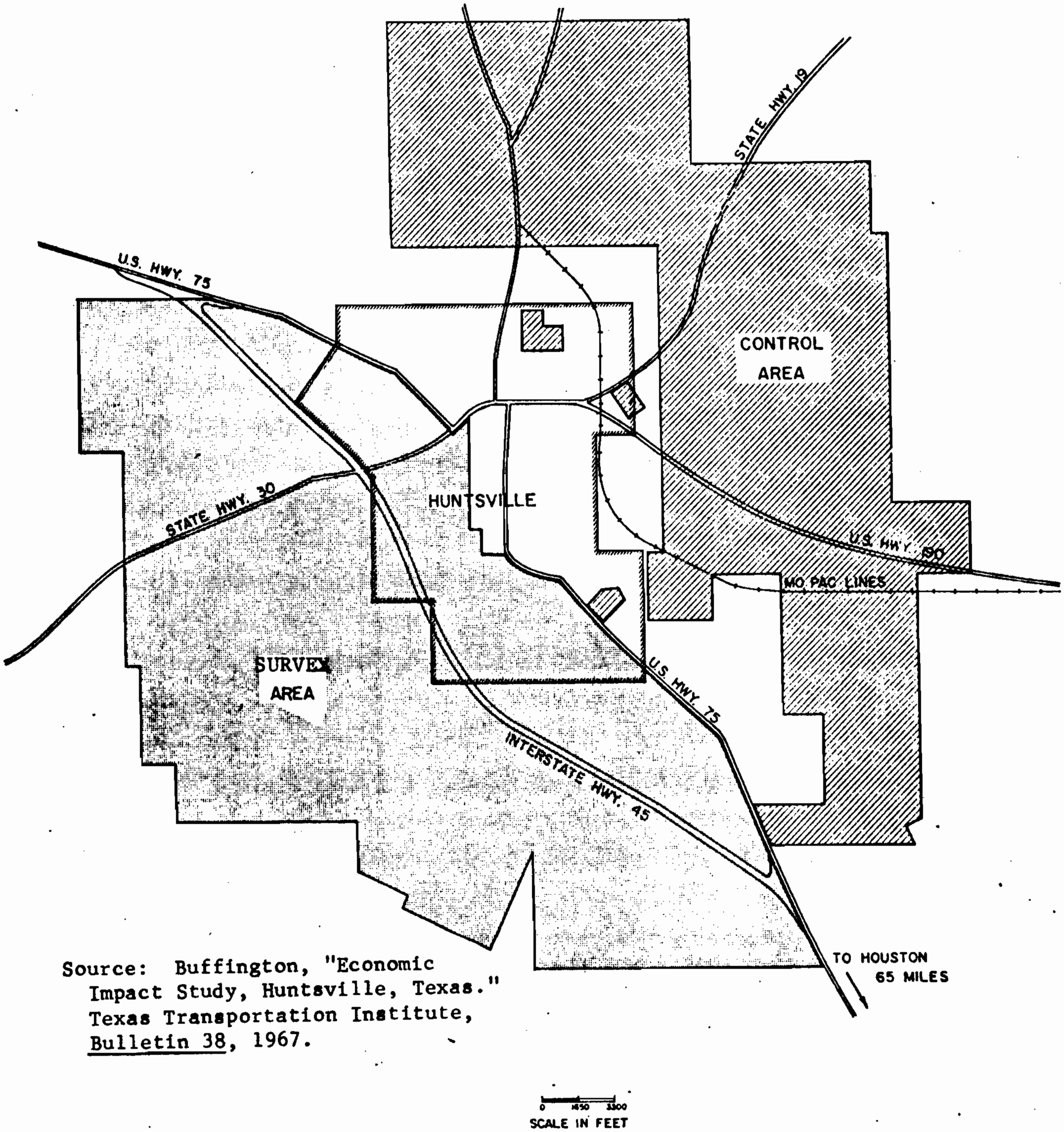
POSSIBLE EFFECT OF DIFFERENT PHASES IN HIGHWAY IMPROVEMENT except for the highway improvement. These requirements are hard to meet, as the spatial limits or distribution of the highway impact are not known in advance, and it is difficult to gather information relating to all non-highway related factors. For example, certain social groups frequently control certain areas of the community, and thus economic activity may be linked to a limited area, and land development may be strongly influenced by the local power-structure. For these and other reasons, it may not be possible to find an ideal control area.

In practice, the survey-control area approach does not give any information about the spatial distribution of the impact unless the survey area is divided into sectors, bands, etc. Usually, this has not been done. Figure 5, p. 51, shows survey and control areas as selected in an actual study. It is obvious that the effect of the different factors will not be evenly distributed over the two areas. When the average value for each area is used, the character of this spatial distribution is lost, and thus the interpretation of any results of the study would be extremely limited.

The same figure also illustrates that these two areas, as chosen, could not be used to describe the effect of changes in the total transportation system if the changes were more extensive than merely the construction of the bypass route. Changes in rail or air service and alterations in local traffic conditions could affect the survey area and the control area differently, making it impossible to measure the total effect of changes in the transportation system.

While the survey-control area approach has offered an apparently scientific way to determine impact in a limited survey area, providing the requirements for the selection of a control area can be met, the method cannot be used to study the effect on the entire community. The community effect will include the effect in both the survey and the control areas; consequently, the "zero" effect in the control area, as well as all degrees of effect up to the maximum in the areas adjacent to the new highway facility, are of interest. This is illustrated in Figure 6, p. 52. The average community effect depends on both magnitude and spatial distribution of the effect on the entire community area.

In a small community it probably would be difficult to find any control area not influenced by major changes in the transportation system. A new



Source: Buffington, "Economic Impact Study, Huntsville, Texas." Texas Transportation Institute, Bulletin 38, 1967.

A map showing the relationship of th3 study and control areas to Huntsville and the transportation facilities in 1964.

Figure 5

EXAMPLE OF SELECTED SURVEY AND CONTROL AREAS

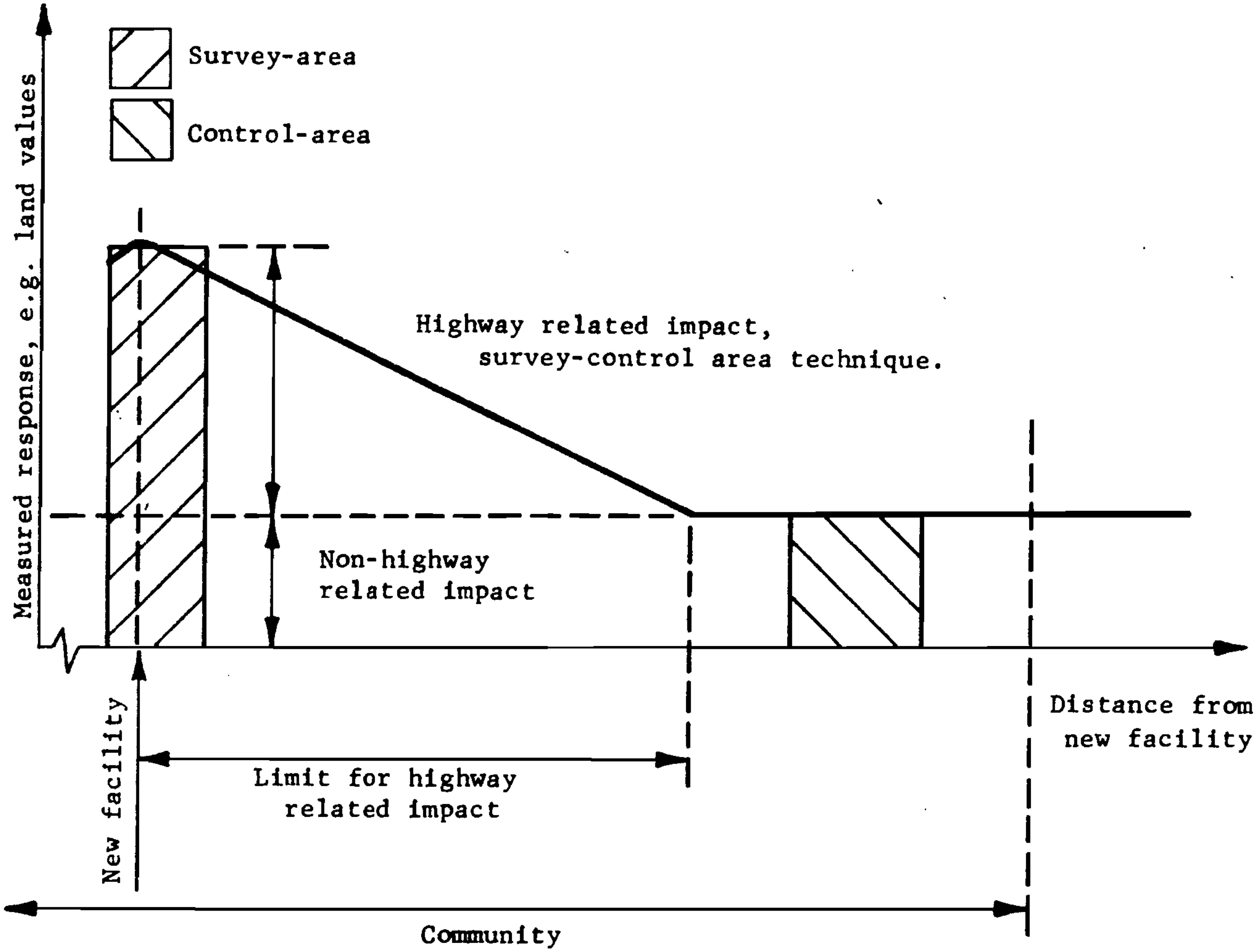


Figure 6

SURVEY-CONTROL AREA STUDY TECHNIQUE

facility will possibly cause new activities to be established, but it might also cause already established activities to move from their old locations to sites closer to the new facility. Thus, because of limited resources and the relatively small number of activities in a community, it is likely that there will be a shift in the spatial distribution of activities affecting the entire area. This is illustrated in Figure 7, p. 54. According to the assumptions of the survey-control area technique, the highway impact is measured as the change in the survey area minus the change in the control area. As a result, any negative effect in the control area will actually contribute to an increase in the total measured highway impact. Such a situation may occur frequently in small communities where major changes in the transportation system will cause businesses to move, resulting in both positive and negative effects in the area as indicated on Figure 7.

Thus, although the survey-control area approach is designed to correct for the limitations of the simple before-and-after study, in practice and in theory it has not been wholly successful. The problems involve finding a suitable control area, identical to the survey area in all respects except for the change in the highway facility, and isolating the impact on the survey area from the impact on the control area. The multitude of highway and non-highway related factors which are involved in the changes to be measured create a more complicated situation than the assumptions of the survey-control area method would account for.

Multiple Regression Analysis

This technique requires more information about the non-highway related factors than the other techniques, and it has in most cases been used when appropriate control areas could not be found. In this method the highway impact is isolated by examining both highway-related and non-highway-related factors. Consequently, the technique is not strictly limited to the analysis of highway impact, and it may also be used to analyze the complex cause/effect relationship in a more complete manner than do the previously described approaches. In practice, however, it has not been possible to include all relevant factors because of the lack of general knowledge about how to determine relevancy or how to quantify qualitative characteristics. At the same

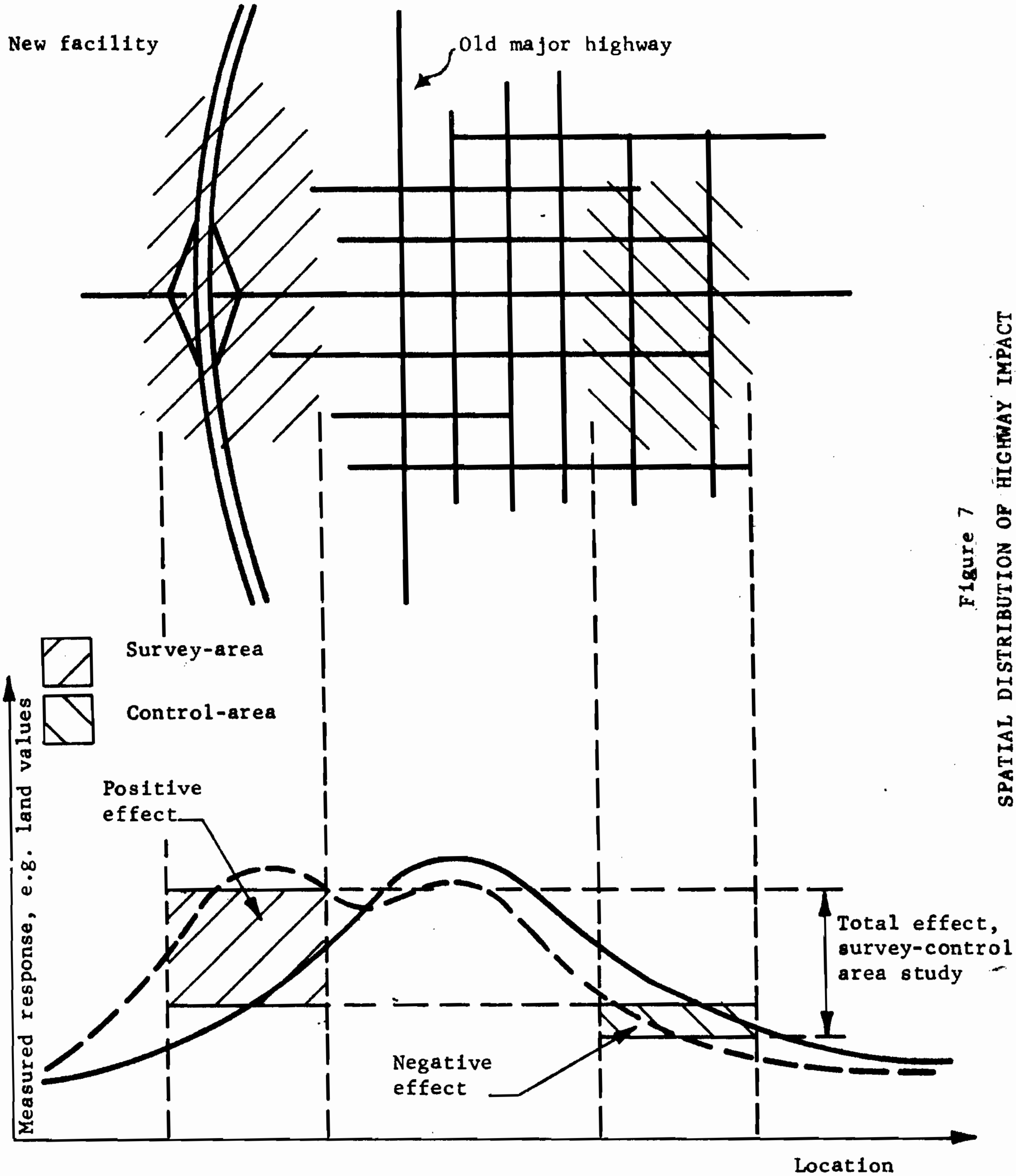


Figure 7
SPATIAL DISTRIBUTION OF HIGHWAY IMPACT

time, it is not always possible to gather sufficient data on those factors whose significance is known. However, these limitations do not apply to the methodology as such but rather to its present state of development.

The dependent variable in the regression equation is the specific area effect to be studied, e.g., land development or land value; the independent variables are all the relevant factors contributing to any part of the effect to be measured. By ordinary regression analysis, the best regression model can be found. The degree to which the included variables can explain the effect and an expression for the model's accuracy can be found.

In order to get a meaningful expression for the effect, all of the factors included in the regression model must be represented quantitatively. This creates great problems because many factors are qualitative, and no technique to give them a meaningful quantitative representation has yet been evaluated. This problem should be overcome, however, as more knowledge about the different factors involved in highway impact is acquired through future research.

Multiple regression analysis may be used together with a refined before and after approach to reveal information about changes in some community characteristic, e.g., land value, due to changes in both the transportation system and other aspects of the community.

It is important to be aware of the limitations connected to a regression model, especially since in most cases the model may seem to be general in character. The "best regression model" is entirely an empirical equation based on a given set of data, and it is not known whether the model can describe the effect when the range of any factor is extended beyond that in the data set previously analyzed. As "time" usually will be one factor in the model, it cannot be used for prediction of future impact unless certain assumptions about the future are made.

Case Studies

The case study approach deals with rather detailed analysis of specific events which have taken place. Such events may be as simple as the decision to construct a new industrial plant in a given location or as complicated as the whole set of events involved in the construction of a new transportation facility. The case study can be an intensive examination of the entire situation in one specific area. Consequently, although detailed knowledge about the cause/effect relationship in the specific case may be obtained, the findings are not claimed to be general.

The value of a case study lies in the possibilities for detailed analysis, and thereby in providing experience on which broader studies of more general character can be based. Since general studies have to cover a wide spectrum of different cases, it is important to identify the most significant factors, to determine what information is available, and to establish the most efficient way of data processing and analysis.

Other Techniques

Techniques other than those discussed above have been used, but to very little extent. The major reason for this lies probably in the degree of complexity of the models and in the subjectivity of their assumptions.

One of these techniques is the "projected land use - value relationship approach." This technique is used for examining changes in land value, and it tries to take account of the close interaction between land use and land value as well as the acceleration or deceleration in land development. Realizing that land use may change in any case, highway improvement or not, the after situation cannot be directly compared to the before situation. To get a correct picture of the impact, the situation after highway improvement will have to be compared with a hypothetical projection of the before situation. Thus the researcher will have to make some general assumptions or do a thorough job of projecting land use development as it might have occurred supposing that no highway improvement took place. Because of the lack of sufficient information about trends in land use development in the before period, the projections often will have to depend on personal judgement and subjective assumptions. Personal judgement will also always be involved in determining land values in connection with the projected land use.

The projected land use - value relationship approach may be valuable in connection with other techniques. The projected land use may serve as a check on the appropriateness of control areas selected, or as a check on the actual highway impact affecting land use in an area close to a new highway facility.

A similar technique for evaluating the differences in impact on business activity in different locations is the "neutral road approach." Since the neutral facility cannot be physically constructed, it is a hypothesized road which can handle future traffic without causing any change in existing trends in land use development or business growth. The basic reason for adopting this approach is the necessity for retaining a perspective on over-all possibilities for area business volume in the future. It is expected that alternative highway locations will result in different predicted business volumes. The measurable effect is not the variation of each alternative from the neutral road, but the differences among the variations, which theoretically should be the result of facility location and design.

MAJOR SHORTCOMINGS OF PREVIOUS STUDIES

This discussion of the most commonly used methodologies in the previous transportation impact studies has revealed several shortcomings which should be observed when planning comprehensive impact studies. The comments should, however, be seen in connection with the actual study planned, and, consequently, simpler methodologies might be used for studies of limited character.

Most of the previous studies are limited in that they concentrate on a narrowly-defined study area. In studies of small towns in rural areas the entire community has to be included in order to provide a true picture of the total effect. In such communities, with limited resources and few existing activities, an increase in the activities in one particular area may have a detrimental effect in other areas of the community.

Today, the private automobile is the most common mode of transportation in the United States. In spite of this, an impact study should include in its analysis any transportation mode available in the community during the time period under consideration. Again, small communities may be very sensitive to, e.g., changes in railway services simply because in many cases they owed their initial development to rail transportation.

Many of the previous studies fail to give a good description of the total transportation system and other important community characteristics both before and after the improvement. For this reason it is difficult to see which factors of the improvement are the most decisive and in what types of communities they will cause the specific effect predicted.

As a last major point, it may be added that the studies reviewed reveal little information about the time when an effect occurred relative to particular human decisions or physical changes. Public hearings, right of way designations, highway construction -- all are particular moments in a process and cannot be detached from the total cause/effect relationship.

REQUIREMENTS FOR FUTURE RESEARCH

In order to compensate for the limitations discussed above, an ideal study methodology will have to meet the following requirements:

(1) The study period must be long enough to include all the important changes in both the community and the transportation system.

(2) The study should be continuous over time to reveal the general trends in community development both before and after changes in the transportation system.

(3) The geographic limits of the study area must incorporate the entire community, including extraterritorial controls.

(4) The effects on the community examined must include all physical, social and economic factors of importance for characterizing the community and for measuring the community's potential for growth and development.

(5) The study of the transportation system must include all of the modes serving or influencing the community, and the study method must make it possible to determine what characteristics of the transportation system are of the greatest importance for community development.

The many weaknesses of the "before-and-after" and the "survey-control area" approaches would be overcome by employing a continuous long term study period. It would be necessary to make the study period continuous over the entire term, before, during, and following major changes in the intercity transportation system. This makes it possible to relate previous community conditions to later responses to change. Figure 8, p. 59, shows briefly the proposed technique.

The major feature of this approach is the ability to relate the indicator (s) under study to previous changes both in the transportation system and in the community itself. As an overall approach, it should be suitable

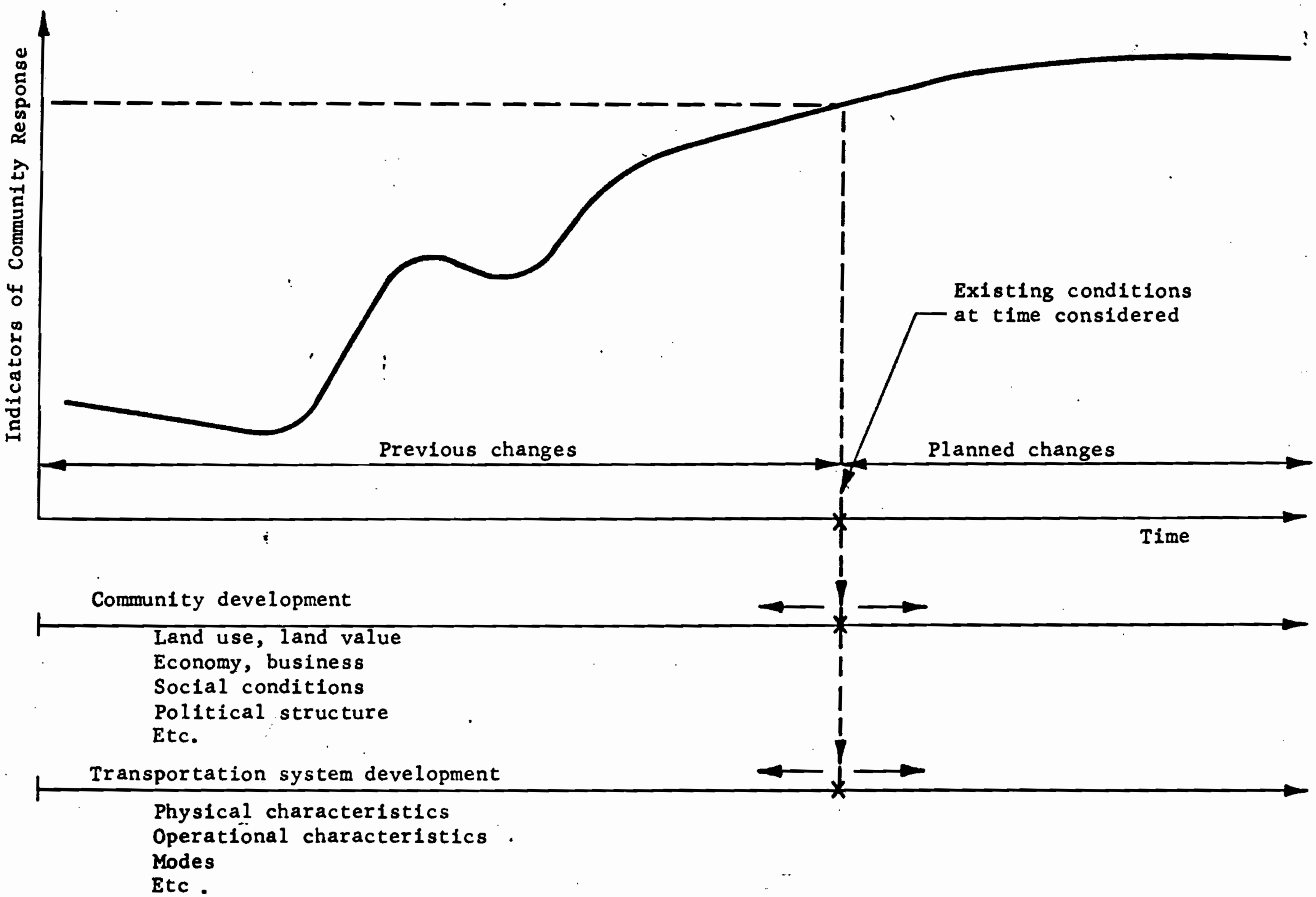


Figure 8
CONTINUOUS STUDY APPROACH

to any indicator capable of study, even though it is perhaps not feasible to use statistical analysis for all indicators. These may vary from directly measurable indicators, e.g., land value, to such less quantifiable indicators as the changes in community political and social structure. This general approach should make it possible to reveal the relationship between the effect in a community and the factors producing the effect. Consequently, for any case, it should be possible not only to describe what happened, but also to explain why it happened. Once the effects of transportation impact are more fully understood, it should be possible to develop more precise modeling techniques for those aspects of community change which can be related directly to changes in the transportation system.

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Pillsbury, Warren A. "Economics of Highway Location: A Critique of Collateral Effect Analysis." Highway Research Record No. 75, Highway Research Board (1965), pp 53-61.

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Study of adjacent properties to 74 interchanges on I-40 between Memphis and Knoxville, with listing of tracts, property sales and land uses. Summary of interchange development in different groups of interchanges.

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Report of a study method used in an examination of the comparative economic impact of three alternative routes for 1-65, Kentucky.
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Texas Transportation Institute. "Economic Effects of Bypasses and Freeways." Bibliography.

Listing and short description of 38 papers and studies about economic effect of highways.

Thiel, Floyd I. "Social Effects of Modern Highway Transportation." Bulletin 327, Highway Research Board (1962), pp 1-20.

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____________. "Seminar on Sociological Effects of Highway Transportation, Introductory Remarks." Highway Research Record No. 75, Highway Research Board (1965), p 75.

Five different articles, dealing with sociological effects and (one article) trip generation.

____________. "Highway Interchange Area Development." Public Roads Vol. 33, No. 8 (June, 1965), pp 153-166.

Discussion of controlling the development in interchange areas. Includes treatment of development problems, available means of controls, application of control, space needs at interchanges, and techniques to implement interchange planning.

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Mainly summary of changes in land values from previous highway impact studies.

U. S. Department of Transportation. "Benefits of Interstate Highways." Federal Highway Administration, U. S. Department of Transportation, June 1970.

Summary of user and non-user benefits from interstate highways. General economic and community benefits: land use and value, industrial and commercial effect, non-work opportunities, opportunities for community change, etc.

U. S. Department of Transportation. "Economic and Social Effect of Highways." Federal Highway Administration, U. S. Department of Transportation, 1972.

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U. S. Department of Transportation. "Guide for Highway Impact Studies." Federal Highway Administration, U. S. Department of Transportation, 1973.

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A review of early impact studies, and bibilography.

Wheat, Leonhard F. "The Effect of Modern Highways on Urban Manufacturing Growth." Highway Research Record No. 277, Highway Research Board (1969), pp 9-24.

Nationwide study of manufacturing growth in 212 cities (population 10,000-50,000), 106 "freeway-cities" ($<$7 miles from freeway) and 106 "non-freeway-cities" ($>$16 miles from freeway). The study findings indicate that modern highways do significantly affect manufacturing growth, but not in all situations. Freeway-cities grew faster only in regions where traffic flow along regular highways is seriously impeeded. The study also considers effect of air service, rail, waterways, and distance to freeway.

Wootan, C. V. and H. G. Meuth. "Economic Impact Study, Temple Texas." Texas Transportation Institute, Bulletin 14 (1960).

Study of the economic impact of the new by-pass route for IH 35, Temple, Texas. The study area is located along a section (3 miles) of the new IH 35. Changes in land values compared to a control area; changes in land use along the new route; and changes in business activity along the new and old route.

Wynn, F. Houston. "Who Makes the Trips? Notes on an Exploratory Investigation of One-Worker Households in Chattonooga." Highway Research Record No. 75, Highway Research Board (1965), pp 84-91.

Studies question: given shorter working days and/or shorter working weeks, how will future urban travel demands be affected?

Zinkefoose, Paul W. "Economic Survey of Raton, New Mexico - 1958-1966." New Mexico State University, Bulletin No. 37 (May, 1968).

The after portion of a highway impact relocation study. Discusses land values, businesses activity, employment, and general economic conditions.

________________. "Economic Survey of Anthony. New Mexico - Texas." New Mexico State University, Bulletin No. 41 (May, 1970).

Study of the impact of highway relocation in a small town having practically no economic data. More or less a general description of the effect without use of any modeling procedures.

A MULTIVARIATE ANALYSIS OF TRANSPORTATION IMPROVEMENTS AND MANUFACTURING GROWTH IN A RURAL REGION

Ronald Linehan
C. Michael Walton
Richard Dodge

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RESEARCH REPORT

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NOTICE

EXECUTIVE SUMMARY

INTRODUCTION

One factor long considered an important influence on regional growth and rural town development has been the nature of the transportation networks which serve the region or rural town. While it is widely agreed that economic growth is a function of a variety of human and natural resources, it is also widely assumed that transportation systems serve to facilitate the use of the resources extant in a given area. As a part of our research into the influence of transportation systems on rural towns, this study undertakes the task of evaluating some of the economic influences of the transportation system on rural towns.

PROBLEM STUDIED

The aim of this study is to evaluate the influence of the transportation system and of alterations in that system on the growth of the economic base of towns in a rural region. The approach employed involves describing and evaluating a manufacturing growth model which incorporates transportation variables derived from the concept of regional infrastructure. The measures of growth are fluctuations in manufacturing employment in towns in a rural region over a 14 year period.

The study concentrates on a region impacted by the construction of Interstate 10, a major interurban link connecting Houston and San Antonio. Manufacturing employment data for forty rural communities in the region were collected for 1960 and 1974 (pre and post I-10) by a survey conducted through the Chambers of Commerce in various towns in the area. A multiple regression program were then used to establish the statistical relationship between the differences in employment with the following independent variables:

(1) distance to the nearest SMSA,
(2) population,
(3) accessibility to I-10,
(4) accessibility to rail,

(5) distance to next larger town, and

(6) accessibility to other major U. S. Highways.

RESULTS ACHIEVED

Data were gathered on the dependent variable (manufacturing employment gains) on forty towns in the region between San Antonio and Houston by a survey of local Chambers of Commerce and from the Texas Directory of Manufacturers when information could not be supplied by a Chamber of Commerce. Accessibility to highways was measured in terms of travel time to a given network, while access to rail was measured in terms of the number of main trunk lines serving a given town.

A multiple regression program, using the stepwise mode, was applied to various combinations of the six independent variables, producing 10 models, the last set of three being selected as the most applicable based on (1) the value of R^2, (2) the computed T-value of the coefficients, and (3) the F-ratio of the equation. While the last set of three equations was chosen as the best set of models for predictive purposes, each of the other models was helpful in (1) developing the final set and (2) shedding light on the influence of each of the variables on manufacturing employment growth.

The first model, for example, which incorporated the complete 40 town data base, illustrated a problem of multicollinearity between the population variable and the distance to the next larger town variable. Thus, in subsequent models the latter variable was dropped to avoid an inaccurate predictor equation.

The final model essentially consists of three equations, each fitting a subset of the 40 town data base representing a determined population range. The equations for each population range are shown below along with a summary table of the significance tests.

FINAL MODELS

Population (50 - 700)

(Change in manufacturing employment) = 19

+ .3290 . (Distance from SMSA)

+ .0327 . (Population 1960)

-1.3622 . (Travel time to next nearest U. S. Highway

-1.3688 . (Travel time to nearest U. S. Highway)

Population (701 - 3,000)

(Change in manufacturing employment) = 33
+ .7658 . (Distance from SMSA)
+31.5542 . (Rail link)
- 5.0899 . (Travel time to nearest U. S. Highway)
- 4.5359 . (Travel time to next nearest U. S. Highway)

Population (3,001 - 10,000)

(Change in manufacturing employment) = 327
-2.8143 . (Distance from SMSA)
+ .0192 . (Population 1960)
-8.2911 . (Travel time to next nearest U. S. Highway)

FINAL MODELS: SIGNIFICANCE TESTS

Population	No. Towns	No. of Variables	R^2	F-test	Standard Error	Mean Dep. Variable	Standard Deviation
50 - 700	15	4	.6760	5%	14	17	20
701 - 3,000	16	4	.8083	1%	33	62	66
3,001 - 10,000	9	3	.7994	5%	75	187	121

From the evolution of the models the following observations were made:

(1) access to transportation facilities is an important influence on the growth of economic base;

(2) in the case of towns with population from 50 - 700 and 701 - 3,000 the single most influential factor in aiding economic base growth was increased accessibility afforded by proximity to more than one major highway link;

(3) proximity to an SMSA encouraged economic base growth in the larger rural towns (pop. 3,001-10,000);

(4) proximity to an SMSA "discouraged" economic base growth in smaller rural towns (pop. 50-700); and

(5) the combined rail and highway influence was most evident in the middle range of towns (pop. 701 - 3,000), suggesting the growth stimulus potential of such a combination at this stage of rural town development.

UTILIZATION

It is hoped that this study will be helpful in providing insight into the growth of manufacturing and the role of transportation in rural areas. The report should be useful

(1) as a transportation-manufacturing growth model for projected regional impact evaluation,

(2) for local transportation need assessment, and

(3) in developing growth probability and constraint factors in larger models.

CONCLUSIONS

This study examines the spatial pattern of growth in manufacturing employment in a rural region and correlates that growth with recent transportation improvements, the existing transportation system, and the hierarchical characteristics of the towns. This study differs from many others in that it is not limited to aggregated data at the county or regional level, but rather attempts to delineate manufacturing growth on a town-by-town basis in a rural area. Although not purporting to prove a cause/effect relationship, the study nevertheless indicates a manufacturing growth pattern corresponding to linear relationships with the variables studied. These results suggest the adaptability of measuring projected shifts in basic economic growth within the context of these variables.

PREFACE

This is one in a series of Research Reports describing the activities and findings of the research project entitled, "Transportation to Fulfill Human Needs in a Rural/Urban Environment"; it is the fourth report issued as part of the work conducted under the topic, "The Influence on the Rural Environment of Interurban Transportation Systems."

This report investigates the correlation between the transportation infrastructure in a rural region and the growth of manufacturing employment in the small communities of that region. The study also capitalizes on the concept of hierarchical relationships among towns in a region.

The resulting models suggest that the factors in the study are adaptable for use in evaluating possible economic impacts of changes in transportation networks in rural areas and for the development of a planning tool to gauge the economic growth potential of small communities.

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I. INTRODUCTION

The goal of this project is to present and test a manufacturing growth model which incorporates transportation variables derived from the concept of regional infrastructure. The measures of growth are fluctuations in manufacturing employment in towns in a rural region. Hopefully, the results may prove valuable in assessing the benefits of proposed transportation links at the level of regional planning.

The study concentrates on a region impacted by the construction of Interstate 10, a major interurban link connecting Houston and San Antonio. Manufacturing employment data for forty rural communities in the region were collected for 1960 and 1974 (pre and post I-10) by a survey conducted through the Chambers of Commerce in various towns in the area. A multiple regression program was then used to establish the statistical relationship between the differences in employment and the following variables:

(1) distance to the nearest SMSA central city,
(2) population,
(3) accessibility to I-10,
(4) accessibility to rail,
(5) distance to next larger town, and
(6) accessibility to other major US Highways.

The role of the rural town in America and its fate in a nation of the megapolis is a serious question in the formulation of national urban growth policy. The 1970 Housing and Urban Development Act commits the U.S. to "the establishment of a national growth policy, to encourage and support the proper growth and development of our states, metropolitan areas, cities, counties and towns . . ."

Legislative wording in recent years has tended to favor the small town as a necessary and viable component of national growth, but there have been questions raised not only as to the most effective method to encourage the economic participation of small towns in the national scheme, but as to the ultimate ability of rural America to compete with large urban centers in a rapidly changing society.[1]

One factor long considered an important influence on regional growth and rural town development has been the impact of improvements in the transportation system. Straszheim suggests, "The instrument which seemingly affords the most potential for pursuing regional objectives is the redirection of investment in transport infrastructure . . ."[2] The reallocation of productive forces by effecting changes in the transportation system was an assumed result in the Appalachian highway program.

The extent to which a given network influences the distribution of basic industry in an area can be an important factor in the long-run development patterns of the towns involved. Locational economic effects may be measured in various ways. Heretofore they have been viewed in terms of increases or decreases in land value or business starts and closings at a very localized level. This has told us little about the larger regional effects of changes in the transportation infrastructure.

Transport itself may not produce economic growth; however, transport networks are recognized as important factors in facilitating the use of the resources which may exist in a region.[3]

The notion of transportation as one of several influences on economic growth as opposed to being a producer of economic growth is essential to understanding the role of the transportation planning process. Economic growth in a given region is a response to a variety of factors such as human resources, natural resources, and regional demand. The availability of and accessibility within the transportation system, however, may have an influence on location decisions and over time be a key to long-term

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[1]For a summation of Congressional attitudes see, for example, Norman Beckman and Susan Harding, "National Urban Growth Policy: 1972 Congressional and Executive Action," American Institute of Planners Journal, Vol. 39, No. 3 (July, 1973), pp. 229-243.

[2]Mahlon Straszheim, "Researching the Role of Transportation in Regional Development," Land Economics, Vol. XLVIII, No. 3 (August, 1972), p. 212.

[3]See, for example, John Friedmann and Barbara Stuckey, "The Territorial Basis of National Transportation Planning," in Perspectives on Regional Transportation Planning by Joseph S. DeSalvo (Ed.), Lexington, Massachusetts: D. C. Heath and Co., 1973, pp. 141-175.

evolution of the rural towns in a region.

In the evolving transportation planning process as applied to interurban areas, there are three essential components built into the evaluation system: the projected environmental impacts, social impacts, and economic impacts. Underlying this study is the concept that economic impacts must be evaluated and understood within the infrastructure extant in a given region. Infrastructure is used here to mean the hierarchy of cities and towns and the transportation system which links that hierarchy.[4]

The second section of this study deals with previous research in the area. The third section describes the basis for including hierarchical components in the study and the importance of manufacturing growth as a key to long term economic development. Section four describes preliminary models, while section five presents the final models in detail. The last section consists of general conclusions and recommendations.

II. PREVIOUS RESEARCH

This section deals with studies which investigate transportation infrastructure and its influence on economic and demographic growth.

Transportation Impacts and Manufacturing

Approaches to evaluating economic impacts of highway improvements may generally concern themselves with one of three areas of impact: (1) selected interchanges, (2) the transportation corridor, or (3) the network and/or system. Economic changes then are changes which occur in a determined spatial structure. At the interchange level, impacts on land values and land use may constitute a new spatial organization, albeit on a very small and perhaps temporary scale. Impacts at this level are well documented and are generally comprised of commerical starts.[5] Furthermore, in a study of rural

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[4]This term is used frequently to denote the systemic relationship between the transportation structure and the "nodes," i.e., cities, located within that structure. See, for example, Straszheim, op. cit.

[5]See, for example, Lidvard Skorpa, et al., Transportation Impact Studies: A Review with Emphasis on Rural Areas, The Council for Advanced Transportation Studies, The University of Texas at Austin, October, 1974.

interchanges along interstate highways in Pennsylvania, Sauerlender noted that almost no industrial development occurred on land contiguous to the interchanges but, rather, occurred in or near towns in the vicinity.[6]

Examination of transportation corridors in their entirety has involved essentially the same variables as interchange analysis but includes a specified area on both sides of the route to be studied. The approach has been utilized in urban or developed areas to predict relocation of residential and commercial land uses.[7]

Approaches to manufacturing location on a regional scale have been, for the most part, based on traditional location theory, although the role of the transportation system has largely remained an unintegrated variable, at least in empirical studies in the U. S.[8] The technique most often applied involves, first, a short term before-and-after documentation of plant starts or relocations on a given transportation route and, second, a survey of locational preferences. This kind of approach has tended to underscore but not quantify the directive force of transportation forms and point to other important variables in location choice within a limited geographic area. In a predominantly urban context, Bone and Wohl studied the relocations of industries in the Boston area subsequent to the completion of a 25-mile segment of Route 128. Although it was perhaps influenced by other factors, there was a significant shift of industries in the Boston area, specifically from the central city to locations on the new highway. Through survey studies they deter-

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[6]Owen H. Sauerlender, Robert B. Donaldson, Jr. and Robert Twardk, Factors That Influence Economic Development at Non-Urban Interchange Locations, Research Publication Number 48, Institute for Research on Land and Water Resources, Pennsylvania State University, 1966.

[7]Skorpa, *et al.*, *op. cit.*

[8]Work has been done for developing countries, although application of findings may be of doubtful use in the U. S. See, for example, B. J. L. Berry, An Inductive Approach to the Regionalization of Economic Development, University of Chicago, Department of Geography, Research Report 62, 1960.

[9]A. J. Bone and Martin Wohl, "Massachusetts Route 128 Impact Study," Bulletin 227, Highway Research Board (1959), pp. 21-49.

mined that the four most important factors considered in relocation were (1) land for expansion, (2) availability of labor, (3) employee accessibility, and (4) commercial accessibility. Voorhees, in his study of the growth of manufacturing in ten large cities in the U. S., also found "available land" as the most important variable.[10] Accessibility was also noted. Breese, however, looked at transportation as one of many factors in a comparative analysis of plant locations of a partly rural county in New Jersey and concluded that the transportation system was the primary influence on industrial plant location and that taxes and utilities were of only marginal importance.[11] This conclusion was based primarily on the coincidence of plants and networks and on the homogeniety of other comparative factors throughout the county.

The coincidence of manufacturing location and transportation change was also noted by Rhodes, who found that of all the manufacturing concerns that located in Indiana between 1957 and 1960, 44 percent located within a distance of 22 miles from the Indiana Turnpike.[12] In Alameda County, California, following the construction of the Eastshore Freeway, 43 percent of the total new industrial development occurred within an area "most subject to highway influence," comprising only 9 percent of the acreage of the county.[13] Industrial expansions along the New York State Thruway have also been noted.[14]

As for predominantly rural areas, Burch noted the overall benefits derived from secondary road improvements in North Carolina and suggested the improved network accounted in part for the fact that, at the time, 25 percent of the new industries locating in North Carolina were choosing

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[10] Alan M. Voorhees, "Urban Growth Characteristics," in A Geography of Urban Places, by Robert Putnam, Frank Taylor and Phillip G. Kettle, (Eds.), London: Methuen Publications, 1970, pp. 81-87.

[11] Gerald Breese, Industrial Site Selection, The Bureau of Urban Research, Princeton University, 1954.

[12] Farwell Rhodes, "Toll Factors for the Indiana Turnpike," Traffic Quarterly, Vol. 14, No. 1, (January, 1960), pp. 26-35.

[13] Highways and Economic and Social Changes, U. S. Department of Commerce, Office of Research and Development, November, 1964, p. 54.

[14] Ibid., p. 54.

rural areas.[15]

Hansen found a significant correspondence between rural counties classified as "consistent fast gainers" in population and proximity to an Interstate Highway or other limited access divided highway, although he emphasizes the concommitant influence of the nearness to a Standard Metropolitan Statistical Area.[16]

In terms of location preferences and the importance of transportation, Kiley did a survey of 4,000 firms in the United States which had changed, expanded or located during 1955-56 to determine the most important factors in the location decision.[17] Thirteen location factors were tested in the survey. Access to good highways was ranked as the first in importance in 11 of 22 manufacturing S. I. C. classifications, and access to rail service was ranked fifth overall.

Greenhut, too, found transportation, in terms of transport type and cost, to be an important factor in the location of several manufacturing concerns in Alabama.[18] There is also evidence that, for some firms, a combination of modes is an important influence. Bowersox interviewed six manufacturing industries in Michigan to determine the importance of accessibility to a major highway in the location decision and found it to be an increasingly important variable since most of the firms were relying more heavily than ever on motor transport.[19] Although only one of the firms set

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[15] James S. Burch, "The Secondary Road Program in North Carolina," Bulletin 147, Highway Research Board (1956), 27 pp.

[16] Niles Hansen, The Future of Nonmetropolitan America, Lexington, Massachusetts: D. C. Heath and Company, 1973, pp. 25-28.

[17] Edward Kiley, "Highways as a Factor in Industrial Location," Highway Research Record Number 75, Highway Research Board, 1964, pp. 48-52.

[18] Melvin Greenhut, Plant Location in Theory and Practice, Chapel Hill: North Carolina University Press, 1956.

[19] Donald S. Bowersox, "The Influence of Highways on Selection of Six Industrial Locations," Bulletin 268, Highway Research Board (1960), pp. 13-28.

specific standards for a highway facility to be considered, none would consider locations which did not offer "adequate" highway facilities.

If transportation serves to organize areas, and attract industry as well, then, conversely, the lack of sufficient transport facilities has been blamed for the lack or loss of manufacturing base. In March of 1965 the Appalachia Redevelopment Act was passed, the major portion of expenditures being earmarked for the construction of a major highway network linking the depressed region internally and with more prosperous areas. The underlying premise for highway funds was that the lack of economic development had been to some extent the result of inadequte accessibility of areas in the intra- and interregional transportation system. It is significant that between 1965 and 1969 46 percent of the 1,149 new industrial plants locating in the Appalachia region located within 10 minutes of an interstate or development highway.[20]

The thrust of these studies has been, at the least, to document location and relocation in light of improvements to a transport network and, at most, to suggest some of the influences on the location decision. Statements on the spatial impacts of this process, however, have been limited. As mentioned, Bone and Wohl noted in passing the outshift of industries from Boston to locations on Route 128. This trend to "decentralize" was also observed by Reinemann in Chicago.[21] He found that between 1946 and 1954, of all the relocations of manufacturing concerns, 16 percent moved out of the metropolitan area altogether to locate in nearby small towns. However, causative factors and transportation linkages have not been analyzed. Decentralizing tendencies have also been noted in a number of studies undertaken for the Department of Commerce, Bureau of Public Roads, but again with no specific inferences to a larger spatial order.[22]

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[20]Carl W. Hale and Joe Walters, "Appalachian Regional Development and the Distribution of Highway Benefits," Growth and Change, Vol. 5, No. 1 (February, 1971), pp. 3-11.

[21]Martin Reinemann, "The Pattern and Distribution of Manufacturing in the Chicago Area," Economic Geography, Vol. 36, No. 2 (April, 1960), pp. 139-144.

[22]Highways and Economic and Social Changes, op. cit., pp. 58-60.

Infrastructure and Growth

Certain studies further suggest the applicability of approaching transportation impacts from a hierarchical perspective. Garrison et al point out that an important result of transportation innovation has been the process of specialization:

> Unifying large territories politically, relieving congestion, opening new economic areas, and other motivating factors in transportation developments were all worth-while because they introduced efficiencies in the form of specialization: armies could specialize, governments specialize, farmers and manufacturers could act as specalized production agents, and routes themselves were specialized as efficient carriers. Individuals and groups of individuals specialized at places to serve larger areas.[23]

This seems to be supported by empirical studies in rural areas. Stroup and Vargha studied the effects of highway improvement in six rural counties in Kentucky and found an increasing tendency for business to consolidate and centralize.[24] Stores once found in the "open country" tended to relocate in towns and at interchanges, and some specialization occurred in the goods offered in each town over a relatively short period of time. C. C. Zimmerman found a similar concentration in his study of rural areas of Canada.[24] Kolb and Polson noted the areal interdependence of growth in their study of rural towns in Wisconsin, with larger centers growing rapidly from having absorbed many of the functions of smaller towns.[26]

A study was undertaken by Hale and Walters to predict economic benefits from an overview of the regional infrastructure of Appalachia.[27] They suggest that the non-Appalachia cities in the "immediate environs" of

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[23] William L. Garrison, et al., Studies of Highway Development and Geographic Change, Seattle: University of Washington Press, 1959, p. 5.

[24] Robert H. Stroup and Louis A. Vargha, "Economic Impact of Secondary Road Improvements," Highway Research Record Number 16, Highway Research Board, 1963, pp. 1-13.

[25] C. C. Zimmerman, The Changing Community, New York: Harper, 1938.

[26] Garrison, et al., op. cit., p. 12.

[27] Hale and Walters, op. cit.

Appalachia have become more economically linked to the extended Appalachia region than the Appalachian cities, and, "since these non-Appalachia cities are already better linked to the rest of the nation than the Appalachian cities, it is likely that a preponderance of the benefits associated with the ARC (Appalachia Redevelopment Commission) highway development program will accrue to the non-Appalachia cities . . ."[28] Their methodology was to develop essentially a growth potential matrix which incorporated (1) an index of accessibility and (2) an index of economic potential (EP). For 35 cities, some of which are contiguous to the Appalachia region, accessibility was determined by travel times between towns and the EP was derived from a gravity model. Increases in accessibility were denoted by reduced travel times between cities (from 1955 to 1972), and the EP was derived on a per capita interaction based on the formula

$$EP_i = (P_i/\frac{1}{n}) + \sum_{j=1}^{n} P_j/d_{ij}$$

where "i" refers to the city being analyzed; there are j=1 . . . n other cities, and "d_{ij}" refers to the economic distance (travel time) between city "i" and each of the other cities. Hale and Walters concluded that the peripheral non-Appalachia cities will benefit more from the highway program. Although empirical data on manufacturing is not presented, short term population data are used to indicate the validity of their hypothesis.

An empirical analysis of manufacturing location also using the gravity concept, although not including transportation as an explicit consideration, is that of Duncan. Duncan gathered data on percent of labor force employed in manufacturing industries for 100 non-metropolitan SEA's in the U.S. for 1950.[29] Locating the nearest metro center, Duncan grouped the population into totals for concentric bands with radii of 150 miles and divided the population total by the distance from the metro center to the midpoint of each successive band

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[28] Ibid., p. 4.

[29] Beverly Duncan, "Population Distribution and Manufacturing Activity: The Non-Metropolitan U.S. in 1950," Papers and Proceedings, Regional Science Association, No. 5, 1959, pp. 95-103.

to arrive at a "population potential" index. Using the population potential and a control variable which represented "degree of urbanization" in a regression analysis, she found that the percentage of total labor force involved in manufacturing employment varied inversely with distance from a metro center and directly with the population potential.

However, using data aggregated to the county level, a Department of Transportation report classified the counties of nine planning regions in Iowa as either "central place" or "hinterland" counties and comparing manufacturing employment growth from 1960 to 1970 found a more rapid relative growth of manufacturing employment in the hinterland counties.[30]

A recent attempt was made to adapt a simulation model for evaluating proposed changes to the transportation network. Putnam describes a model used to predict changes in the spatial distribution of economic and demographic activity in light of transportation alterations in the northeast corridor of the U. S.[31] The model measures economic activity by (1) employment totals (both basic and non-basic) and (2) personal income. The model begins with a large-scale econometric model, which sets "control totals" for a small interregional input-output, which in turn sets control totals for an intersectoral area model. Transportation as a variable is measured in terms of accessibility in a rather different way from gravity models. It is a function of impedance, i.e., (1) the costs involved in obtaining inputs for production and (2) the costs of transport to market. The region involved in this model is extremely large, and the model has been only partially tested. A similar model was developed by Amano and Masahisa, but its major concentration was on traffic generation and land use impacts.[32]

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[30]Engineering Research Institute, Iowa State University, Integrated Analysis of Small Cities Intercity Transportation to Facilitate the Achievement of Regional Urban Goals, prepared for the U. S. Department of Transportation, June, 1974.

[31]S. H. Putman, "Developing and Testing an Interregional Model", Regional Studies, Vol. 4, No. 4 (December, 1970), pp. 473-490.

[32]K. Amano and F. Masahisa, "A Long Run Economic Effect Analysis of Alternative Regional and National Transportation Facility Plans," Journal of Regional Science, Vol. 10, No. 3 (December, 1970), pp. 297-323.

III. DEVELOPMENT OF THE MODEL

This section develops the conceptual framework for the model to be presented and tested in this project. It examines (1) the importance of central place in the dynamic process of the growth of economic base, (2) the independent variables to be tested and their value to the model, and (3) the area to be studied.

The Dependent Variable - Growth in Manufacturing Employment

The notion of viewing cities and towns as a hierarchy of nodes in a transportation system has been employed by economists, geographers and planners to identify and study a variety of phenomena. There are two sorts of interrelated criteria which are generally associated with hierarchy studies: (1) functional organization and (2) spatial distribution. Christaller presented a central place model which incorporated the notion of an "ordering principle" in the distribution, size and number of towns.[33] The functional organization was determined by the order of goods supplied by a given place. In the Christaller model, the resulting spatial distribution was essentially uniform, with higher order central places more widely spaced than lower order places, and with the lower order places "nested" in the trade areas of higher order central places. This trade area is based on the range of goods and services which was later defined in more detail by Berry and Garrison.[34] The resulting spatial distribution, a system of nested hexagonal trade areas, has been supported to some extent in empirical studies, although it is generally agreed that this configuration is a too rigid reflection of the abstract concept of ideal market areas based on

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[33] As quoted in R. J. Chorley and P. Haggert (Eds.), Models in Economic Geography, London: Methuen and Co., 1967, pp. 307-315.

[34] B. J. L. Berry and William L. Garrison, "A Note on Central Place Theory and the Range of a Good," Economic Geography, Vol. 34, No. 4 (October, 1958), pp. 304-311.

unreal assumptions of demographic and geographic homogeneity.[35]

Lösch elaborated on Christaller's hexagonal model to allow various spatial distributions of lower order places and posited a sectional pattern of development where there is a concentration of settlement into pie shaped sectors separated by interstitial areas in which settlement in less dense.[36] Functional organization was also amended to the extent that Lösch asserted (1) higher order places do not necessarily provide all the functions typical of lower order places and (2) settlements performing the same number of functions do not necessarily provide the same kind of function.

Functional differentiation and size have already been noted in the study of Kolb and Polson.[37] Davidson, also, found a correlation between town size, function and distance from an urban center for retail services.[38] Logan found areal development in small towns in the midwest, although the correlation of growth to urban center was less clear.[39] Schnore, who looked mostly at areas close to urban settlements, posited the evolution of two distinct functional types of lower order communities: "suburbs of consumption" and more outlying "satellites of production."[40]

Friedmann and Miller incorporated the basic premises of central place theory into a more realistic and less rigid overview of urban development in their description of the urban field. They observed the tendency

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[35] A study which to some degree supports the hexagonal configuration is that of P. Haggett, Locational Analysis of Human Geography, London: Methuen and Co., 1965. For other studies see B. J. L. Berry and Allen Pred, Central Place Studies: A Bibliography of Theory and Applications, Regional Science Research Institute, Bibliography Series I, 1961.

[36] In Chorley and Haggett, op. cit., pp. 314-320.

[37] See Garrison, et al., op. cit., p. 12.

[38] Claud M. Davidson, A Spatial Analysis of Submetropolis Small-Town Growth, Research Monograph, Bureau of Business Research, The University of Texas at Austin, 1972.

[39] M. I. Logan, "The Spatial Dimensions of Economic Development," Regional Studies, Vol. 4, No. 1 (May, 1970), pp. 117-125.

[40] Leo Schnore, "Satellites and Suburbs," in Urban Sociology, Baali, Faud, et al. (Eds.), New York: Meredith Corporation, 1970, pp. 137-149.

of the dispersion of certain economic functions from urban center to the hinterland and beyond:

> The present dominance of the metropolitan core will become attenuated as economic activities are decentralized to smaller cities within the field or into the open country . . . . The urban field will be a coherent region.[41]

Berry suggests that one might view the nation as a whole as a system of cities each of which is a critical point in the collection and circulation of increasingly specialized goods produced in its hinterlands.[42] Fox suggests that this system has evolved in part due to the role of transportation:

> Since 1945 the automobile, the truck and the airplane have had a full generation to exert forces that tend to strengthen the central place system. The automobile has strengthened the FEA (Functional Economic Area) pattern, the regional shopping plaza, and the metropolitan subarea; the truck has strengthened central place patterns in wholesale distribution at the two hierarchical levels next above the FEA; and the airplane has strengthened central place patterns at the level of approximately 24 large regions . . . .[43]

In studying spatial distribution and socioeconomic characteristics of large cities in the U. S., Fox goes on to delineate 24 national metropolitan regions, each with a central city.[44]

Little empirical analysis has been done, however, on the "function" of manufacturing in the hierarchy approach. Central place studies have been devoted almost exclusively to retail goods and services. Manufacturing has been assumed to be largely an urban activity given the increased

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[41] John Friedmann and John Miller, "The Urban Field," American Institute of Planners Journal, Vol. XXXI, No. 4 (November, 1965), pp. 312-320.

[42] B. J. L. Berry, "Approaches to Regional Analysis: A Synthesis," Annals of the Association of American Geographers, Vol. 54, No. 1 (March, 1964), pp. 2-11.

[43] Carl A. Fox, "Delimiting of Regions for Transportation Planning," in Perspectives on Regional Transportation Planning, by Joseph DeSalvo (Ed.), Lexington, Massachusetts: D. C. Heath and Co., 1973, p. 133.

[44] Ibid., pp. 91-137.

concentration and growth of fast growing industries in urban centers over the last century. This concentration has been largely attributed to the benefits of external agglomeration effects. Agglomeration effects are those forces which reduce costs of production and/or increase market outlets due to proximity to other industries and/or the market. These advantages accrue to a given industry when, for example, it locates near an auxiliary industry from which it purchases a service. The sharing of that service among many industries tends to reduce its cost. There are institutional agglomerative advantages as well. The availability of capital in urban centers, tax adjustments, and low interest rates are inducements of an agglomeration. Greenhut suggests that "these agglomerating advantages are the governing factors in location whenever transportation and labor differentials at alternative sites are relatively slight."[45] Hansen criticizes traditional location theory for not illuminating sufficiently the extent of the impact of agglomeration:

> It should be emphasized that the advantages of larger urban areas cannot be simply explained by the traditional economic base approach because it really never came to grips with the dynamics of the process by which an area amasses overhead capital and by which it acquires new export bases. Similarly, classical location theory, including central place theory, relied too heavily on static analyses . . . .[46]

More recent data, while not unqualified support of a reversal of this trend, suggest the viability and growth of certain kinds of manufacturing in rural areas. Nationally, rural and partly rural counties, with only a tenth of the manufacturing jobs in 1960, accounted for about a fifth of the gain in manufacturing workers in the 1960-70 decade.[47] See figure 1.

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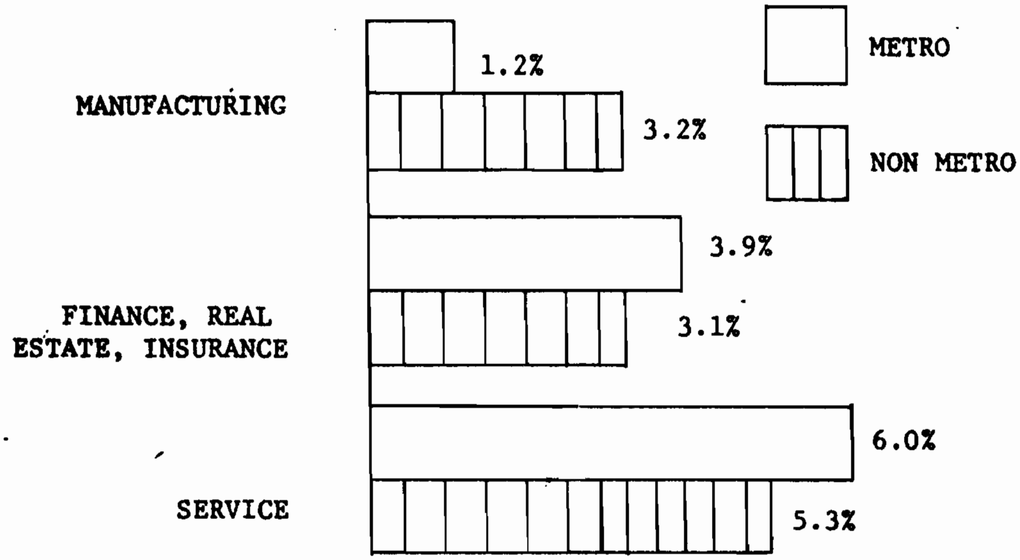
[45]Greenhut, op. cit., p. 11.

[46]Hansen, op. cit., p. 8.

[47]U. S. Department of Agriculture, The Economic and Social Condition of Rural America in the 1970's, prepared for the Senate Committee on Government Operations, 1971, p. 55.

Figure 1

EMPLOYMENT GAINS FOR SOME INDUSTRY GROUPS 1960-1970[48]



Between 1960 and 1970 the nonmetropolitan South actually outstripped the metropolitan South in absolute manufacturing employment gains.[49] Furthermore, Duncan's study of the correlation of city size and 14 manufacturing SIC classifications throughout the U. S. suggests some degree of hierarchical arrangement of cities, the tendency being most notable in the South.[50]

The growth of the manufacturing function in some rural towns and not others is, for the purpose of this study, presumed to be accounted for by a variety of factors, not all of which are tested by the model. There may be personal preference, production, or marketing factors which lie beyond the scope of this study. Within the context of urban hierarchy, however, what is being tested at heart is the relationship between functional organization and spatial distribution when the "functions" are defined as

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[48] Ibid.

[49] Niles Hansen, Factors Determining the Location of Industrial Activity in Metropolitan and Nonmetropolitan Areas, Discussion Paper Number 50, Center for Economic Development, The University of Texas at Austin, July, 1972, pp. 17-20.

[50] Dudley Otis Duncan, et al., Metropolis and Region. Baltimore: Johns Hopkins Press, 1960, pp. 65-75.

basic (export) economic activities. The importance of the role of the basic sector in stimulating the secular growth of areas has been suggested by Hoyt, who found strong correlations between manufacturing gains and population growth in predominantly urban areas in the nation as a whole.[51] Likewise, Thomas has described the dynamics of regional growth as a function of the development of its basic sector.[52] This development encourages service sector growth as well as increased quality of service, which in turn attracts more industry. Garrison notes the positive multiplier effect of the location of basic industry on rural towns in a study undertaken in Kentucky.[53]

The Independent Variables

The variables used in this analysis, then, are essentially based on an assumption of interrelatedness between each rural town and its nearest SMSA and/or next larger town. Distance in terms of miles was chosen in part to avoid problems of multicollinearity among the accessibility variables. It has, in any case, proven to be a useful measure in other studies. In terms of population growth, for example, DeAre and Poston found in their study of nonmetropolitan incorporated areas in Texas that nonmetropolitan incorporated areas closer to urban centers have shown a greater potential for growth due generally to "an economic link to that center . . . as a place of residence . . . or it may attract activities away from the larger center . . ."[54]

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[51] Homer Hoyt, "The Importance of Manufacturing in Basic Employment," Land Economics, Vol. XLV, No. 3 (August, 1969), pp. 344-358.

[52] Morgan Thomas, "Regional Economic Growth: Some Conceptual Aspects," Land Economics, Vol. XLV, No. 1 (February, 1969), pp. 43-51.

[53] Charles Garrison, "The Impact of New Industry: An Application of the Economic Base Multiplier to Small Rural Areas," Land Economics, Vol. XLVIII, No. 4 (November, 1972), pp. 329-337.

[54] Diane DeAre and Dudley L. Poston, Jr., "Growth of Non-Metropolitan Incorporated Places in Texas, 1960-1970," Texas Business Review, January, 1973, p. 17.

Population is chosen for its importance to most growth models, and its correlation with manufacturing, already noted in Hoyt.[55] Lachene describes a basic gravity model in which population and a notion of accessibility are the two essential determinants of growth in a delineated region.[56] Hale and Walters use essentially the same concept in their analysis of the Appalachia region.[57] Davidson's study of small-town distribution and growth within 25 miles of the Dallas area, while finding some support for Lösch's theory of sectoral distribution, suggests that in the evolution of the infrastructure, proximity to a high order central place and population were the two most important growth determinants.[58] In this study, distance to the next larger town is included as a variable to identify lower order central place relationships which may exist in the area.

Integral to the view of central place, urban field, and "functional economic area" is the interconnectivity of the hinterland and its central place. This notion of interconnectivity might be described as the ease with which goods, information, etc., can flow from hinterland to central place and the reverse. For this reason, while the distance to central place is measured in miles, access to the transportation networks is measured in terms of "functional distance." Lathrop and Hamburg found that at the metropolitan level development patterns were most accurately predicted by viewing accessibility not in gravity flow terms, but rather (1) on an assumption of growth from a central point and (2) on a measure of accessibility based on reduced travel times.[59]

Accessibility to U.S. Highways and the Interstate System is measured in terms of travel time from each town. This measure of accessibility is only one of several possible measures. It measures accessibility to key networks

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[55] Hoyt, op. cit.

[56] Rene Lachene, "Networks and the Location of Economic Activities," Regional Science Association Papers, Vol. 14, 1964, pp. 183-196.

[57] Hale and Walters, op. cit.

[58] Davidson, op. cit.

[59] George Lathrop and John Hamburg, "An Opportunity-Accessibility Model for Allocating Regional Growth," American Institute of Planners Journal, Vol. XXXI, No. 2 (May, 1965), pp. 96-102.

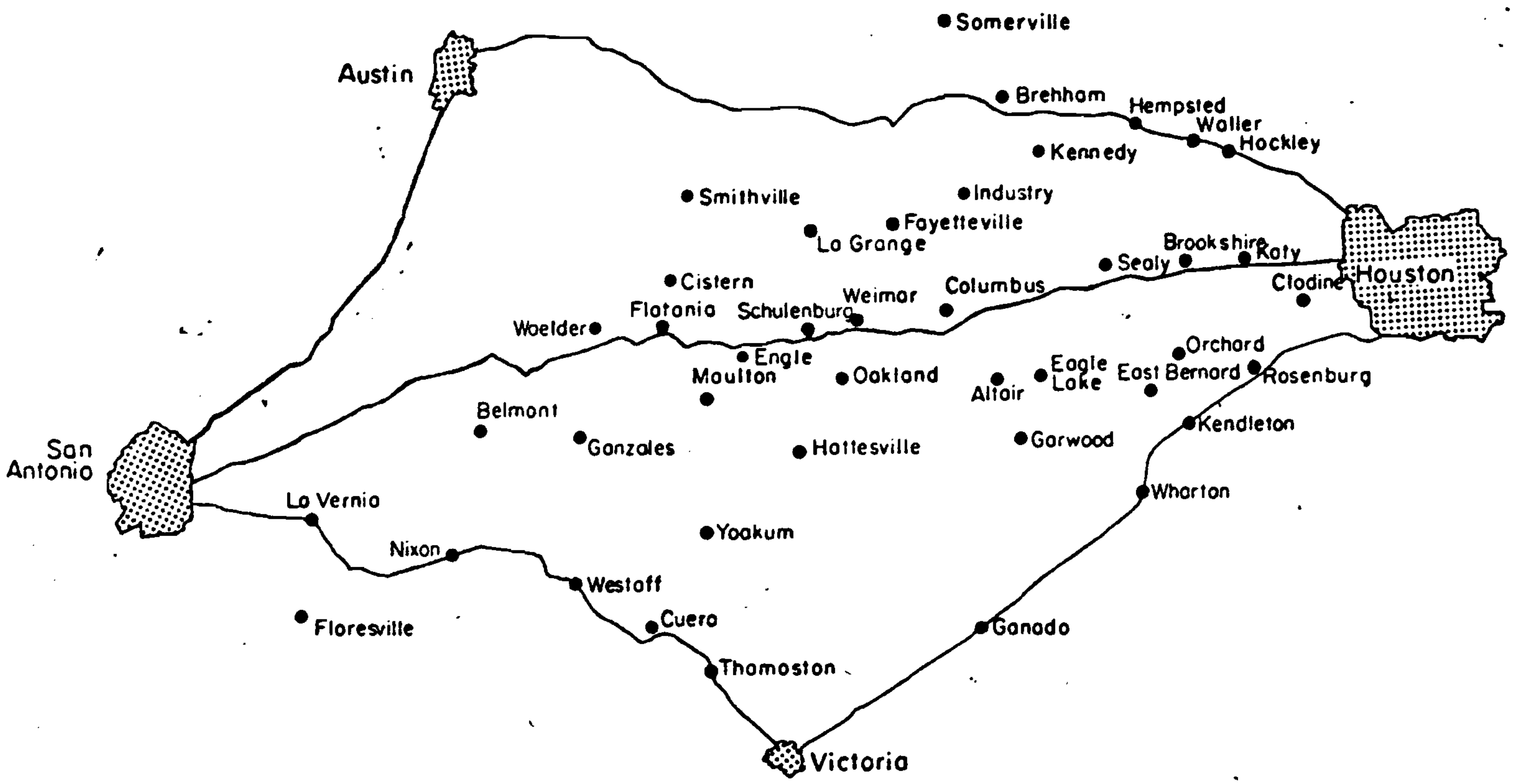
of the transportation system itself. It is, to that extent, an absolute measure of accessibility to the infrastructure, not a relative index as are those regional accessibility indices which incorporate accessibility as a function of linkage to all other centers in a closed system. This is not inconsistent with the concept of urban hierarchy and along with the other variables will tend to aid in isolating statistically the impacts on the improved network.

Access to the rail network is measured in terms of the number of main trunk lines which pass through each town. Although quality of service might afford a more sensitive measure, such data are hard to quantify. Moreover, links to rail lines are direct measures of links with markets and resources.

The Study Area

The towns chosen for study lie within an area which extends up to 60 miles from Interstate 10 and stretches between San Antonio and Houston (see Figure 2). The area chosen is not construed to conform to any notion of a region, and in fact is quite arbitrary. However, the choice of this area, while ignoring some production-market linkages, which some economists feel are basic to regional definition, nevertheless assures a certain validity to any findings of spatially differentiated growth patterns in the hierarchical scheme. Significantly, only about 15% of the industries in the area serve other than local or regional markets, and even in these cases it cannot be assumed that centrality or accessibility had no influence on their chosen locations. Likewise, the distinction between "hinterland" and purely interstitial agricultural areas, while not considered in delimiting the area studied, may nonetheless evidence itself in the findings. Constraints considered in delimiting the area are based on the need for screening out variables not being tested. For example, towns near the Gulf Coast are accessible by water transport routes and may assume specialized manufacturing characteristics. The towns were chosen because of their lack of homogeneous characteristics, i.e., their differential population and accessibility.

Figure 2. The Study Region



There are three SMSA's located at the peripheries of the area studied: San Antonio, Houston, and Austin, each with a population of over 150,000. Bryan and Victoria are located at the north and south edges of the area, respectively, with populations of between 25,000 and 50,000 and are not considered as SMSA's in this study. Distance from town to nearest SMSA and next larger town was measured in miles from maps supplied by the Texas Highway Department.

Highway I-10, which links San Antonio and Houston, was begun in 1958, with the major portion near San Antonio being completed in 1966 and the portion near Houston in 1968. I-10 was essentially an upgrading of the old U. S. Highway 90. The two measures of accessibility were computed as travel time by secondary road network to I-10 or to the nearest and next nearest U. S. Highway using 50 mph as the base speed.

Data on manufacturing employment was obtained by several means. A survey was sent to Chambers of Commerce of selected towns to determine total manufacturing employment for 1960 and 1974. In almost all cases the respondents noted the procedure they used as direct telephone contact with industries in the selected town. In those cases where a town did not have a Chamber, a direct telephone survey was conducted by the authors with industries listed in local telephone directories. In some cases 1960 data were adjusted after cross checks with data from the Texas Directory of Manufacturers (data on the dependent and independent variables are in the Appendix, Tables 1-3).

IV. PRELIMINARY MODELS AND INVESTIGATIONS

Methodology

A series of models was tested to determine the "best" model or set of models to explain the growth of manufacturing employment in the rural towns studied. Ten models in all were evaluated. The first four used data on the entire 40-town data base. The remaining two sets of three models were broken down to analyze towns of different population ranges. The second set was chosen as the most appropriate set of models. The dependent variable in all but Model D was the net change in manufacturing employment from 1960-1974. In Model D, percentage change was tested.

The STEP-01 Regression Analysis

Multiple regression analysis is a statistical tool which measures the linear relationships between sets of data. In this study, the object is to determine the relationships, if any, between increases in manufacturing employment (the dependent variable), on one hand, and the factors (independent variables) discussed in the previous section on the other.

Among the criteria used to evaluate the resulting equations in this study is the coefficient of correlation, R^2, which is calculated as

$$R^2 = \frac{\text{Sum of Squares Due to Regression}}{\text{Total Sum of Squares About the Mean}}$$

The R^2 expresses the amount of variation of the dependent variable that is "explained" by the regression model. The R^2 is expressed as a percentage from 0 to 1.0. The significance of the R^2, i.e., whether it differs from zero due to randomness, can be measured by analysis of the F-ratio for the equation and its corresponding degrees of freedom. The R^2 and this significance measure are overall indicators of the success of the model.

The standard error is also an important measure of the model in that it expresses the accuracy with which the model generates estimates. In each of the models the R^2, the significance of the F-test, and the standard error for each equation are presented and analyzed.

In addition, two other measures are utilized. The first is a measure of collinearity, i.e., the measure of correlation among the independent variables, which, to achieve a meaningful equation, must be minimal. The second, called the T-value, is a measure of the significance of the coefficients of the independent variables, much like the F-test of significance for the equation as a whole. It is computed for the coefficient of each variable in each equation and is expressed as a level of significance. The pertinent data for each model are presented in the Appendix, Tables 4-13.

Description of the Preliminary Models

Four models were tested using the entire 40-town data base. These models are referred to as A, B, C, and D. It was determined that these models incorporated a wide population variance, and the data base was subsequently divided into three population ranges and tested again with the variables in models A in order to isolate the effects of I-10.

The independent variables used in Models A, B, C, D and the E series are shown below:

Model A

Population
Distance to SMSA
Travel time I-10
Rail links
Distance to next larger town

Model B

Population
Travel time to next nearest U. S. Highway
Travel time I-10
Travel time to nearest U. S. Highway
Distance to SMSA
Distance to next larger town
Rail links

Model C

Population
Travel time to next nearest U. S. Highway
Rail links
Distance to next town
Distance to SMSA
Travel time to nearest U. S. Highway
Transgenerated variable

Model D

Population
Distance to SMSA
Travel time I-10
Rail links
Distance to next larger town

E Models

Population
Distance to SMSA
Travel time I-10
Rail links
Distance to next larger town

Model A, The General I-10 Impact Model

The first regression model incorporated the entire 40-town data base and was developed with five variables: population 1960, travel time to I-10, distance from the nearest SMSA, number of main rail line connections, and distance to the next larger town. After the first test, it was found that the population variable and the distance to next larger town variable were fairly highly correlated, suggesting a certain hierarchy of towns in the region. After further testing, the distance to next town variable was found to add less to the model and was dropped as a variable. The three variables found significant in the final equation were: population, access to I-10 and distance to an SMSA. The model produced an R^2 of .7776, of which the population variable alone accounts for about .69 of the R^2. Distance from an SMSA was positively correlated with growth, thus paralleling the findings of the Department of Transportation's study in Iowa.[60] Access to I-10 added about .07 to the R^2 of the model, suggesting that those towns

[60] Engineering Research Institute, Iowa State University, op. cit.

closer to I-10 benefited slightly more than others in terms of manufacturing employment gains.

It was felt that this model, while hlepful in describing the overall distribution of manufacturing gains in the region over the 14-year period, tended to understate the role of transportation in contributing to that growth. There were three possible reasons considered for this marginal influence: that (1) the access to I-10 variable alone was insufficient in delineating the accessibility of the towns in the region, (2) net manufacturing change might not be the best indicator of trends, and (3) the range of population of the towns (50 to 10,000) was so great as to bias the results.

Model B, The Extended Accessibility Model

Model B attempted to address the first possible reason noted above by introducing accessibility to other major highways in the region. Two variables were simply added to the equation: travel time to the nearest U. S. Highway and travel time to the next nearest U. S. Highway (I-10 was considered a U. S. Highway). The resulting R^2 of the model increased to .8178. The impact of the population variable on the R^2 declined slightly, to about .67, and the second most important variable became the accessibility to a second U. S. Highway, accounting for about .12 of the R^2. The importance of this variable suggested that accessibility to one major highway alone in the region was an insufficient measure in calculating the impact of highway accessibility on manufacturing growth. The significance of the I-10 variable diminished in this model to less than .02 of the R^2.

Although producing an increase in the R^2 and a decrease in the standard error over Model A, Model B incorporated the problem of auto-correlation between the I-10 variable and the U. S. Highway variables where they coincide, and the model still exhibited a heavily weighted population variable. To eliminate the problem of auto-correlation, another model was tested, dropping accessibility to I-10 as a separate variable.

Model C, The Refined Accessibility Model

In Model C accessibility to I-10 was dropped as a variable. Essentially, then, this model tested the importance of the accessibility of towns in the region to two major U. S. Highways (I-10 was counted as a U. S. Highway).

An extra variable representing the sum of travel times to the nearest and next nearest U. S. Highways was also introduced and tested. This "transgenerated" variable was tested as an index of highway accessibility but was found to be insignificant and was not entered into the equation. Population and access to a second highway still assumed about the same importance as in Model B. Accessibility to rail links was the third significant variable although it added very little to the equation. This model tended to reaffirm the findings in Model B that the accessibility measures to one highway might be insufficient in the final model. The emergence of the rail variable also seemed to indicate that the combination of accessibility variables might be important in explaining growth. The variability of rail and distance to SMSA, i.e., the deletion of the distance to SMSA variable and the emergence of the rail variable in Model C, also were felt to be indicative of their conflicting degree of importance to towns of various populations. However, before the data base was broken down into population ranges, another model was tested to address the question of whether percent manufacturing change might not be a better indicator of growth than net manufacturing change.

Model D, The Percentage Change Model

Model D substituted percent manufacturing employment increase for net manufacturing employment gain as the dependent variable (and used the original independent variables). This change was found to produce an unsatisfactory model not significant at any level according to the F-test. Skewed results derive most likely from the cases where small towns occasionally increased manufacturing employment by a small amount, which, due to the total or almost total absence of previous manufacturing employment, registered as an inordinate percentage growth (results are nevertheless presented in Table 7 in the Appendix).

Models E1, E2, E3, The Population Sensitive Models

In the preceding models the population variable carried by far the most weight in increasing the correlation coefficient. The shifting importance of the distance to SMSA variable and rail link variable, as well as the question of wide population variance (see below), suggested that a further breakdown of the data base into population groups might provide for a more insightful analysis.

Variable	Mean	Standard Deviation
Employment	68.8	95
Distance SMSA	58.2	21
Population	2033	2,361
Travel time to I-10	20	16
Rail links	1.6	4.5

The towns were then divided into three groups as shown below, based on 1960 populations:

50-700	701-3,000	3,001-10,000
Cistern	Smithville	Cuero
Engle	Flatonia	La Grange
Moulton	Halletsville	Rosenberg
Warda	Schulenburg	Wharton
LaVernia	Katy	Gonzales
Fayetteville	Nixon	Edge Lake
Belmont	Ganado	Yoakum
Altair	Floresville	Brenham
Kenney	Waelder	Columbus
Industry	East Bernard	
Garwood	Sealy	
Clodine	Hempstead	
Orchard	Somerville	
Addicks	Waller	
Hockley	Brookshire	
	Weimar	

It was decided to first test the three groups using the original set of variables to isolate the impact of I-10. (This series will be referred to as E, with E1 being the population groups 50-700, E2 701-3,000, and E3 3,001-10,000).

In Series E, access to I-10 proved to be a fairly important variable in the resulting equations, accounting for between .13 and .22 of the increase in the value of R^2. Population was still the most significant variable in each model. The series is summarized below:

Variable	E1 Increase in R^2	E2 Increase in R^2	E3 Increase in R^2
Population	.2628	.2798	.5391
Travel time to I-10	.1401	.2204	.1412
Distance to SMSA	.1099	.2261	----
Rail links	----*	----	----
Distance to next larger town	----	----	----
Total R^2	.5168	.7262	.6802

The standard errors for the models are:

E1	17
E2	41
E3	84

*----denotes insignificant coefficient

The F-test showed Models E1 and E2 significant at 5% and E3 not significant at either 1% or 5%. This is partially explained by the mix of variables used and also by the limited number of towns in the Group (9). Nevertheless, the E series indicated differential importance of the variables for each population group. The size of the town was relatively less crucial to growth in manufacturing in the largest group than in the two smaller groups. Accessibility to I-10 contributed significantly more to towns with populations of 701-3,000 than to either the smallest or largest towns, suggesting a potential for stimulation by improved facilities in this size town. In the case of the two smaller population ranges, the greater the distance from an SMSA the more manufacturing growth tended to occur. On the other hand, although exhibiting an unreliable coefficient, the model still indicated that for the largest towns studied proximity to an SMSA was beneficial and that the manufacturing base of those larger towns farther from an SMSA increased less.

These models still failed to incorporate rail as a significant variable despite its appearance in Model C, and since in both B and C the accessibility to a second U. S. Highway was the second most important variable accounting for about 5% of the increase in the R^2 in B and 10% in C, the next step was then to integrate these variables and to test more broadly the growth of manufacturing in the context of access to other major highways in the region. The next series (F) deleted I-10 as a single variable and incorporated instead the two U. S. Highway variables. This combination of variables was found to produce significant increases in the R^2 of each equation, as well as improve the corresponding F-ratio and reduce the standard error. This resulting Series F is examined in the following section.

V. THE MODEL OF GROWTH IN MANUFACTURING EMPLOYMENT

The next series of models is presented as the final set which best accounts for the growth of manufacturing employment in the rural area studied. The pertinent data of the models are presented first, and the interpretation of the findings follows.

Description of the Models, The F Series

The F Series incorporates the accessibility to more than one major highway as suggested by Models B and C and retains the population breakdown, which, as evidenced in the E series, points out the differing importance of the variables to towns of different sizes.

Three equations have been generated from the F Series. Each fits a subset of the total data base and corresponds to a population range as shown below. (Coefficients, standard errors, etc., for each variable are in Tables 11-13 in the Appendix).

F1 (50-700)

(Change in manufacturing employment) = 19

+ .3290 . (Distance from SMSA)
+ .0327 . (Population 1960)
-1.3622 . (Travel time to next nearest U. S. Highway)
-1.3688 . (Travel time to nearest U. S. Highway)

F2 (701-3,000)

(Change in manufacturing employment) = 33

+ .7658 . (Distance from SMSA)
+31.5542 . (Rail link)
- 5.0899 . (Travel time to nearest U. S. Highway)
- 4.5359 . (Travel time to next nearest U. S. Highway)

F3 (3,001-10,000)

(Change in manufacturing employment) = 327

- 2.8143 . (Distance from SMSA)
+ .0192 . (Population 1960)
- 8.2911 . (Travel time to next nearest U. S. Highway)

Given below is a summary of the models, including the results of the F-test for significance.

SUMMARY OF FINAL MODELS

Model	Towns	No. Variables	R^2	F-test	Standard Error	Mean of Dep. Variable	Standard Deviation
F1	15	4	.6760	5%	14	17	20
F2	16	4	.8083	1%	33	62	66
F3	9	3	.7994	5%	75	187	121

The relative weights of importance of the independent variables may be partially gleaned from an examination of the increase in the value of the correlation coefficient as the variable is added to the equation. For each of the coefficients of the independent variables of the three equations, the T-value has been computed and a level of confidence assigned using the double-tailed T-test:[6];

Group I

Variable Entered	Increase in R^2	T-level of coefficient
Travel time to next nearest highway	.4169	99%
Population	.1424	80%
Distance from SMSA	.0503	80%
Travel time to nearest highway	.0664	80%
	.6760	

[61]See George W. Shedecor and William G. Cochran, Statistical Methods, Ames: Iowa State University Press, 1972, pp. 569-571.

Group II

Variable Entered	Increase in R^2	T-level of coefficient
Distance to next nearest U.S. Highway	.6455	99%
Distance from SMSA	.0530	90%
Rail link	.0524	95%
Distance to nearest U.S. Highway	.0574	95%
	.8083	

Group III

Variable Entered	Increase in R^2	T-level of coefficient
Population	.5391	80%
Travel time to next nearest U.S. highway	.1588	95%
Distance from SMSA	.1015	80%
	.7994	

Interpretation of the Results

The resulting equations suggest that the growth of the manufacturing sector of rural towns may be described as a function of several factors relating to the position of that town in the hierarchy of the region and its accessibility to transportation facilities. The regression model does not, it must be noted, prove a causal relationship. Nevertheless, the linear relationship between the growth of manufacturing employment and the independent variables may be useful in describing and predicting growth over time.

The models show that the most important factor correlated with manufacturing growth differs with the size of the town. In the case of the smallest towns analyzed, the single most important factor was accessibility to a second U. S. Highway. The importance of this variable seems to derive from the fact that the region is quite well served by U. S. Highways. Upon examination it appears that most of the towns of all sizes are near or next to a U. S. Highway. The analysis shows that those towns which enjoyed better access to a second major highway obtained a larger increase in manufacturing gains. In Model F1, accessibility to U. S. Highways accounted for approximately .49 of the increase in the R^2 for the model, with about .19 being accounted for by distance from an SMSA and population.

In Models F1 and F2, which deal with the two groups of smaller towns, distance from an SMSA is positively correlated with manufacturing growth, while the larger towns (population 3,001-10,000) tended to benefit from proximity to an SMSA. This may be partly explained by the type of manufacturing concerns involved.

A higher incidence of "footloose" and especially resource-based manufacturing growth might account for this correlation. Supportive findings were documented in a previous study of the area, where it was found that for the resource-based concerns locating in small towns proximity to the Houston SMSA was not a critical factor in location.[62]

In the case of the larger towns, the negative correlation between distance from an SMSA and manufacturing growth suggests growth of market-based, and perhaps transport-cost-sensitive concerns as well as the "spin-off" effect supported by other growth studies.

The second model (F2) also exhibits a high correlation (.65 of the R^2) between manufacturing growth and accessibility to a second U. S. Highway. Accessibility to transport in general (including rail) accounts for about .75 of the R^2 observed. For towns of this size access to rail lines also becomes a significant variable. The smaller towns lack rail connections for the most part (a mean of .4 versus a mean of 1.25 for the second range). Population drops out as a significant variable in the F2 model. This may be partially explained by the fact that the population variable itself may represent to differing degrees a number of other variables, including the size, quality, and specialization of the service sector of the town. In the case of the second range, these underlying variables may not be sufficiently dissimilar in each of the towns to mitigate the effect of the population variable.

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[62] See Ronald Linehan, C. M. Walton and Richard Dodge, Variables in Rural Plant Location: A Case Study of Sealy, Texas, Research Memo 21, The Council for Advanced Transportation Studies, The University of Texas at Austin, 1975.

The third model reincorporates the population variable which, in fact, accounts for the largest increase in the R^2 (.54). Access to a second U. S. Highway and distance from an SMSA are the other two significant variables. As has been suggested, the development of a higher quality and specialized service sector to serve more market-oriented concerns may account for the re-emergence of the population variable and the reversal of correlation with the distance to an SMSA variable. The data suggest that this range of towns already has fairly extensive access to rail and highway.

The E-Series models tend to show that the relationship between the improvement in the highway facility and the growth of manufacturing concerns is most tenuous in the case of larger towns. Likewise, the F Series indicates that what seems to be occurring in the area is manufacturing growth distributed fairly evenly among those towns situated on a U. S. Highway and having access to a second highway. This suggests that the growth of manufacturing in towns closest to I-10 has only slightly outstripped growth in other towns which have similar locations on U. S. Highways and similar access to a second highway, rail, etc. This fact may be due to the relatively high quality of highways available in the area. The improvements to I-10 have not been of such magnitude as to greatly increase its ability to attract manufacturing employment relative to other major highways in the region. Nevertheless, the importance of highway access is underscored in both the E and F Series models.

VI. CONCLUSIONS

Summary

This study examines the spatial pattern of growth in manufacturing employment in a rural region and correlates that growth with recent transportation improvements, the existing transportation system, and the hierarchical characteristics of the towns. This study differs from many others in that it is not limited to aggregated data at the county or regional level, but rather attempts to delineate manufacturing growth on a town-by-town basis in a rural area. Although not purporting to prove a cause/effect relationship, the study nevertheless indicates a manufacturing growth pattern corresponding to linear relationships with the variables studied. These results suggest the adaptability of measuring projected shifts in the basic economic growth within the context of these variables.

Findings

The study shows that for rural towns of different sizes, different factors may assume more or less importance in influencing the growth of an economic base. Most outstanding of the examples is the importance of the nearest large population center or SMSA. Proximity to an SMSA is found to favor manufacturing growth in the larger rural towns while the reverse is true for smaller rural places (under 3,000). Likewise, the importance of rail is evident in that range of towns with a population of 701-3,000 while not differentially significant to manufacturing growth in the smaller or larger towns. Since in the larger towns studied rail service is ubiquitous, this suggests the developmental importance of the rail factor. Whereas highway access is most critical to smaller rural town manufacturing gains, gains in the larger rural towns were most influenced by population. Population, as has been noted, is a consistently important variable and may, to a certain extent, represent the attractability of the service sector of the town.

Highway Impact and Manufacturing Growth

One aspect of this study is the attempt to isolate the impact of the upgrading of U. S. Highway 90 to Interstate 10. In general, the impact of upgrading the highway seems to have had only a slightly more positive effect on towns near I-10 over and above the growth of manufacturing in towns on other U. S. highways in the region, and presumably over what would have occurred along the old U. S. 90. This result is attributable to the high quality transportation infrastructure which already existed throughout the area studied before improvements began. This is not to undermine the importance of major highways in contributing to the growth of manufacturing employment. In fact, access to a second major highway proved to be an extremely important contributing factor to manufacturing gains in each of the final models. The accessibility to highways was relatively more important to growth in the smaller towns.

Recommendations

It is hoped that this study will be helpful in providing insight into the growth of manúfacturing and the role of transportation in rural areas. The report should be useful

(1) as a transportation-manufacturing growth model for projected regional impact evaluation,

(2) for local-plan transportation-need assessment, and

(3) in developing growth probability and constraint factors in larger models.

APPENDIX

Table 1.

TOWNS, POPULATION 1960, MANUFACTURING EMPLOYMENT GAINS 1960-1974

Town	Population 1960*	Manufacturing Employment Gains 1960-1974**
Brookshire	1339	3
Waller	900	15
Somerville	1177	12
Hempstead	1505	10
Sealy	2328	122
Floresville	2126	0
Nixon	1751	20
Katy	1569	60
Weimar	2006	62
Halletsville	2808	232
Schulenburg	2207	172
Waelder	1270	37
East Bernard	900	65
Ganado	1626	8
Smithville	2933	70
Flatonia	1009	110
Hockley	300	7
Cistern	150	7
Altair	200	0
Belmont	100	0
Moulton	646	50
Orchard	200	6
Garwood	500	46
Warda	120	15
Clodine	170	25
Addicks	120	31
Industry	600	8
Engle	250	62
La Vernia	500	8
Fayetteville	394	0
Kenney	200	0
Wharton	5734	112
La Grange	3623	64
Brenham	7740	134
Eagle Lake	3565	80
Cuero	7338	200
Rosenberg	9698	470
Gonzales	5829	188
Yoakum	5761	234
Columbus	3656	200

*Figures taken from The Texas Atlas, 1970.

**Data from survey and Texas Directory of Manufacturers.

Table 2.

TOWNS, DISTANCE MEASURES

Town	Distance to SMSA, Miles	Distance to Next Larger Town, Miles
Brookshire	35	12
Waller	38	10
Somerville	74	18
Hempstead	48	20
Sealy	48	25
Floresville	30	25
Nixon	48	26
Katy	27	22
Weimar	83	15
Halletsville	96	23
Schulenburg	92	18
Waelder	49	11
East Bernard	45	10
Ganado	88	32
Smithville	38	20
Flatonia	52	20
Hockley	33	17
Cistern	45	9
Altair	68	7
Belmont	53	10
Moulton	84	22
Orchard	36	11
Garwood	66	10
Warda	50	8
Clodine	19	8
Addicks	15	12
Industry	70	15
Engle	92	7
La Vernia	25	12
Fayetteville	66	10
Kenney	60	10
Wharton	53	28
La Grange	55	42
Brenham	66	36
Eagle Lake	60	15
Cuero	78	28
Rosenberg	30	30
Gonzales	65	32
Yoakum	81	32
Columbus	68	21

Table 3.

TOWNS, ACCESSIBILITY MEASURES

Town	Travel Time in Minutes to I-10*	Rail Links	Travel Time in Minutes to Nearest U. S. Highway*	Travel Time in Minutes to Next Nearest U. S. Highway*
Brookshire	4	1	4	19
Waller	15	1	0	30
Somerville	48	2	12	24
Hempstead	27	1	0	22
Sealy	2	3	2	16
Floresville	40	1	0	15
Nixon	30	0	0	22
Katy	2	1	3	15
Weimar	3	1	6	6
Halletsville	19	1	0	0
Schulenburg	2	1	0	2
Waelder	2	1	3	15
East Bernard	17	1	0	10
Ganado	62	1	0	28
Smithville	28	2	10	15
Flatonia	0	2	0	10
Hockley	18	1	0	20
Cistern	12	0	11	22
Altair	8	0	6	12
Belmont	9	0	6	13
Moulton	9	0	6	8
Orchard	16	1	9	9
Garwood	19	1	5	10
Warda	18	0	0	10
Clodine	4	1	4	7
Addicks	0	1	0	6
Industry	29	0	15	21
Engle	9	0	4	5
La Vernia	18	0	0	22
Fayetteville	20	1	12	25
Kenney	23	0	7	35
Wharton	35	3	0	19
La Grange	15	1	0	20
Brenham	33	2	2	17
Eagle Lake	13	0	0	13
Cuero	55	1	0	0
Rosenberg	17	3	0	0
Gonzales	11	1	0	0
Yoakum	40	1	0	7
Columbus	1	1	1	10

*Travel times computed in minutes at 50 mph.

Table 4.

Model A

Variable	No.	Mean	Standard Deviation
Employment	1	73.6250	95.4040
Distance SMSA	2	55.7250	21,3829
Population	3	2121.20	2386.1519
Distance Next Town	4	18.525	9.0836
Access I-10	5	18.775	15.14288
Access Rail	6	1.0500	.87559

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	.216	.822	.533	-.002	.484
2		1.000	.153	.206	.254	-.129
3			1.000	.754	.320	.574
4				1.000	.402	.409
5					1.000	.078
6						1.000

Variables in Equation

(Constant: 5.6144471)

Variable	Coefficient	Standard Error	Increase in R^2
Population	+ .03885	.00546	.6750
Access I-10	- 1.96021	5.61594	.0784
Distance SMSA	+ .77190	.38495	.0243
			.7776

F. Ratio: 24.612

Standard Error of Residuals: 47.5409

Table 5.

Model B

Variable	No.	Mean	Standard Deviation
Employment	1	73.6250	95.4040
Distance SMSA	2	55.7250	21.3829
Population	3	2121.20	2386.1519
Access I-10	4	18.7750	15.1429
Access Rail	5	1.0500	.87559
Access 1st U.S.Highway	6	3.20000	4.2317
Access 2nd U.S.Highway	7	14.0000	8.6824

Correlation Matrix

Variable Number	1	2	3	4	5	6	7
1	1.000	.216	.822	-.002	.484	-.385	-.616
2		1.000	.153	.254	-.129	.108	-.200
3			1.000	.320	.574	-.381	-.362
4				1.000	.078	.016	.296
5					1.000	-.231	-.121
6						1.000	.281
7							1.000

Variables in Equation

(Constant: 41.1918361)

Variable	Coefficient	Standard Error	Increase in R^2
Population	+ .02908	.00464	.6750
Access 2nd U.S.Highway	+2.82494	1.05379	.1164
Access to I-10	-1.20548	.59470	.0186
Distance SMSA	+ .50077	.32722	.0078
			.8178

F Ratio: 25.153

Standard Error of Residuals: 43.93

Table 6.

Model C

Variable	No.	Mean	Standard Deviation
Employment	1	73.6250	95.4040
Distance SMSA	2	55.7250	21.3829
Population	3	2121.20	2386.1519
Distance Next Town	4	18.5250	9.0836
Access Rail	5	1.0500	.87559
Access 1st U.S.Highway	6	3.2000	4.2317
Access 2nd U.S.Highway	7	14.0000	8.6824
Transgenerated Highway Access	8	1.7200	10.6751

Correlation Matrix

Variable Number	1	2	3	4	5	6	7	8
1	1.000	.216	.822	.533	.484	-.385	-.616	-.653
2		1.000	.153	.206	-.129	.108	-.200	-.120
3			1.000	.754	.574	-.381	-.362	-.446
4				1.000	.409	-.411	-.107	-.250
5					1.000	-.231	-.121	-.190
6						1.000	.281	.625
7							1.000	.925
8								1.000

Variables in Equation

(Constant: 56.243435)

Variable	Coefficient	Standard Error	Increase in R^2
Population	.02778	.00585	.6750
Access 2nd U.S.Highway	-3.64943	1.01719	.1164
Access Rail	9.05464	1.07396	.0030
			.7944

F Ratio: 22.242

Standard Error of Residuals: 46.18

Table 7.

Model D

Variable	No.	Mean	Standard Deviation
Percentage Change Employment	1	1.114	1.9149
Distance SMSA	2	55.3829	21.3829
Population	3	2121.20	2386.1519
Distance Next Town	4	18.525	9.0836
Access I-10	5	18.775	15.14288
Access Rail	6	1.0500	.87559

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	-.146	-.093	-.160	-.141	.142
2		1.000	.013	.052	.243	-.228
3			1.000	.751	.204	.600
4				1.000	.315	.437
5					1.000	-.028
6						1.000

Variables in Equation

(Constant: 1.853033)

Variable	Coefficient	Standard Error	Increase in R^2
Access Rail	.57464	.455971	.0533
			.0533

F Ratio: .690

Standard Error of Residuals: 1.9541

Table 8.

Model E1

Variable	No.	Mean	Standard Deviation
Employment	1	17.66666	20.04438
Distance SMSA	2	52.13333	23.17284
Population	3	296.66666	184.21364
Distance next town	4	11.2000	4.074309
Access I-10	5	14.13333	7.69848
Access Rail	6	.400000	.50709

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	.352	.286	.119	-.374	.033
2		1.000	.411	.078	.269	-.473
3			1.000	.654	.468	-.073
4				1.000	.158	.028
5					1.000	-.143
6						1.000

Variables in Equation

(Constant: 12.44783)

Variable	Coefficient	Standard Error	Increase in R^2
Population	.06357	.04214	.2668
Access to I-10	1.88426	.697185	.1401
Distance SMSA	.37762	.25834	.1099
			.5168

F Ratio: 2.280

Standard Error of Residuals: 17.2150

Table 9.

Model E2

Variable	No.	Mean	Standard Deviation
Employment	1	62.37500	66.84397
Distance SMSA	2	55.68750	23.02960
Population	3	1715.8750	636.65583
Distance Next Town	4	19.18750	6.37932
Access I-10	5	19.93750	18.46246
Access Rail	6	1.25000	.68313

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	.518	.529	.097	-.465	.243
2		1.000	.283	.228	.173	-.046
3			1.000	.480	.008	.178
4				1.000	.457	.080
5					1.000	-.157
6						1.000

Variables in Equation

(Constant: -67.309734)

Variable	Coefficient	Standard Error	Increase in R^2
Population	.03507	.02069	.2798
Access I-10	-2.07131	.69686	.2204
Distance SMSA	1.48408	.49580	.2261
			.7262

F Ratio: 5.748

Standard Error Residuals: 41.5945

Table 10.

Model E3

Variable	No.	Mean	Standard Deviation
Employment	1	18.68888	12.12687
Population	2	5882.6667	2109.5009
Access I-10	3	24.4444	17.19819
Rail Access	4	1.77777	.97182
Distance	5	61.77777	15.14742

Correlation Matrix

Variable Number	1	2	3	4	5
1	1.000	.734	-.009	.159	-.431
2		1.000	.445	.278	.125
3			1.000	-.061	.225
4				1.000	-.683
5					1.000

Variables in Equation

(Constant: -33.820974)

Variable	Coefficient	Standard Error	Increase in R^2
Population	.05599	.01680	.5391
Access I-10	-3.18453	1.98413	.1412
			.6803

F Ratio: 3.838

Standard Error of Residuals: 84.4025

Table 11.

Model F1

Variable	No.	Mean	Standard Deviation
Employment	1	17.66666	20.44388
Distance SMSA	2	52.13333	23.17284
Population	3	296.6666	18.42136
Access 1st U.S.Highway	4	5.6666	4.65474
Access 2nd U.S.Highway	5	15.0000	8.66849
Access Rail	6	.4000	.50709

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	.352	.286	-.280	-.646	.062
2		1.000	.411	.433	.012	-.473
3			1.000	.268	.135	-.073
4				1.000	.361	-.121
5					1.000	-.211
6						1.000

Variables in Equation

(Constant: 18.989543)

Variable	Coefficient	Standard Error	Increase in R^2
Access 2nd U.S. Highway	-1.36224	.46484	.4169
Population	+ .03273	.02217	.1424
Distance SMSA	+ .32907	.19106	.0503
Access 1st U.S. Highway	-1.36877	.95611	.0664
			.6760

F Ratio: 5.217

Standard Error of Residuals: 13.7680

Table 12.

Model F2

Variable	No.	Mean	Standard Deviation
Employment	1	62.375	66.84397
Distance SMSA	2	55.6875	23.02960
Population	3	1715.875	636.6558
Access Rail	4	1.25000	.683130
Access 1st U.S.Highway	5	2.5000	3.81226
Access 2nd U.S.Highway	6	15.5625	8.60208

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	.518	.529	.243	-.192	-.803
2		1.000	.283	-.046	.002	-.380
3			1.000	.178	.148	-.464
4				1.000	.410	-.037
5					1.000	.101
6						1.000

Variables in Equation

(Constant: 33.211136)

Variable	Coefficient	Standard Error	Increase in R^2
Access 2nd U.S. Highway	-4.53588	1.22413	.6455
Distance SMSA	.76588	.41633	.0530
Access Rail	31.55420	14.23303	.0524
Access 1st U.S. Highway	-5.08989	2.57261	.0574
			.8030

F Ratio: 9.690

Standard Error of Residuals: 33.8627

Table 13.

Model F3

Variable	No.	Mean	Standard Deviation
Employment	1	186.8888	121.2687
Distance SMSA	2	61.7777	15.14742
Population	3	5882.66	2109.500
Access 2nd U.S.Highway	4	9.5555	8.26303
Access 1st U.S.Highway	5	.33333	.70710
Access Rail	6	1.77777	.97182

Correlation Matrix

Variable Number	1	2	3	4	5	6
1	1.000	-.431	.734	-.712	-.135	.159
2		1.000	-.334	-.057	.171	-.683
3			1.000	-.500	.125	.287
4				1.000	-.328	.220
5					1.000	-.061
6						1.000

Variables in Equation

(Constant: 32.689115)

Variable	Coefficient	Standard Error	Increase in R^2
Population	.01922	.01464	.5391
Access 2nd U.S. Highway	-8.29116	3.52916	.1588
Distance SMSA	-2.81432	1.76921	.1015
			.7994

F Ratio: 6.641

Standard Error of Residuals: 68.7049

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APPENDIX I
Exhibit 3

VARIABLES IN RURAL PLANT LOCATION: A CASE STUDY OF SEALY, TEXAS

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FEBRUARY 1975

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NOTICE

PREFACE

This is the twenty-first in a series of research memos describing activities and findings as part of the work accomplished under the research project entitled Transportation to Fullfil Human Needs in the Rural/Urban Environment." The project is divided into five topics; this memorandum is a description of part of the on-going research conducted under the topic, "The Influence on the Rural Environment of Inter-Urban Transportation Systems."

This represents the first phase of an effort to define the most important factors determining individual location in rural areas, especially those factors related to transportation. Based on a review of location theory and a case study of four industries in one rural community, this study lays the foundation for an expanded effort to examine locational factors on a regional basis.

ACKNOWLEDGEMENTS

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INTRODUCTION

It has been the general tendency in the last few decades for small rural towns in the United States to experience a falling population rate and, in many areas, an absolute decline in population, while large and intermediate cities have been successful in attracting industry and displaced rural "migrants." While this is generally true, there have been exceptions. The goals of this study are to examine several industries which chose to locate their plants in one rural town and, within the framework of general location theory, to study those factors which made the rural town an expedient choice of plant location.

Of particular importance is the role that transportation has played and can play in the encouragement of industrial location in rural areas. The enormous investment in transportation facilities, such as the Interstate Highway System, has been in part justified by benefits to small communities. An understanding of the actual influence transportation has exerted on plant location is needed in order not only to clarify the question of how beneficial past investment has been, but also to help determine future priorities in transportation planning.

This memorandum reports on a first step in a general study undertaken to examine plant location factors within a regional context. The case study itself is intended to serve in the formulation of a hypothesis for more general testing.

The case study is divided into three sections. The first section describes relevant location theory dealing with the manufacturing sector and plant location and reviews some previous case study approaches to evaluating plant location in rural areas. The second section will give a general background of Sealy, Texas, the site of the case study.

The third section will be comprised of particular studies of four industries which located in Sealy in 1960 and 1970. Each of these industries will be studied in light of the following factors:

(1) Location of raw materials

(2) Labor supply, wages, skills

(3) Sites available

(4) Tax structure

(5) Transportation facilities, transportation costs

(6) Market (time, distance)

(7) Services (water, power . . .)

(8) Other amenities (housing, etc.)

(9) Capital

Furthermore, an attempt was made to contact each industry in order to determine other (personal) factors involved in site location. To this end a survey was developed and sent to the industries in the case study community (see Appendix for example of the survey).[1]

---

[1] The survey is based on a combination of two design approaches. The first was developed by Melvin Greenhut in his study of manufacturing concerns (see Plant Location in Theory and Practice, Chapel Hill: University of North Carolina Press, 1956) and the second was developed by Sarah C. Orr and J. B. Cullingworth (see Regional and Urban Studies, Beverly Hills, California: Sage Publications, 1969).

SECTION I

A REVIEW OF SOME FACTORS OF INDUSTRIAL LOCATION

The investigation of economic activity in a spatial context has produced seemingly as many models as individual economic activities themselves. Despite the variety of approaches, they all tend to espouse the theoretical framework of traditional economic theory and, until recently, build upon the first approaches presented by J. Von Thünen and Alfred Weber.[1] The goal herein is is not to present the body of location theory, but rather to define and explain some of the factors which are common to traditional models and are incorporated in this report in analyzing locations of the case study plants.

One factor of particular importance in examining the location advantages of various sites is the effect of agglomeration. Agglomeration effects are those forces which reduce costs of production and/or increase market outlets due to proximity to other industries and/or the market. These advantages accrue to a given industry when, for example, it locates near an auxiliary industry from which it purchases a service. The sharing of that service among many industries tends to reduce its cost.

There are institutional agglomerative advantages as well. The availability of capital in urban centers, tax adjustments and low interest rates are inducements of an agglomeration. Greenhut suggests that "these agglomerating advantages are the governing factors in location whenever transportation and labor differentials at alternative sites are relatively slight."[2] Hansen criticizes traditional location theory for not illuminating sufficiently the extent of the impact of agglomeration:

---

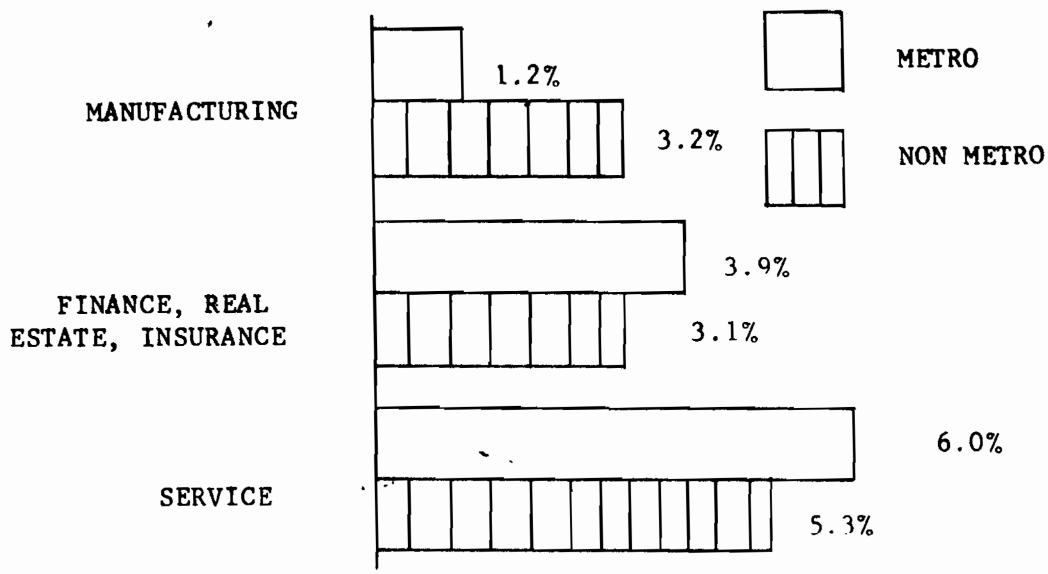
[1]See Peter Geoffrey Hall,ed., Van Thünen's Isolated State (Oxford, New York: Pergamon Press, 1966); and Alfred Weber, Theory of the Location of Industries (Chicago, Illinois: The University of Chicago Press, 1929). For an overview of their impact on location theory see Peter Dicken and Peter E. Lloyd, Location in Space: A Theoretical Approach to Economic Geography (New York, New York: Harper and Row, 1972).

[2]Melvin L. Greenhut, Plant Location in Theory and in Practice (Chapel Hill, University of North Carolina Press, 1956), p. 11.

> It should be emphasized that the advantages of larger urban areas cannot be simply explained by the traditional economic base approach because it really never came to grips with the dynamics of the process by which an area amasses overhead capital and by which it acquires new export bases. Similarly, classical location theory, including central place theory, relied too heavily on static analyses . . .[3]

However, this appears to be only one side of a complicated coin, for not all industries are found in large agglomerations. Variability in labor costs and resource location are two "deglomerative" factors, and recent data suggest that urban agglomerations are, in essence, attracting industry at a rate that is slowing relative to rural areas. Rural and partly rural counties, with only a tenth of the manufacturing jobs in 1960, accounted for about a fifth of the gain in manufacturing workers in the 1960-70 decade (see Figure 1 below).[4]

FIGURE 1. EMPLOYMENT GAINS FOR SOME INDUSTRY GROUPS 60-70



[3]Niles M. Hansen, The Future of Nonmetropolitan America (Lexington, Massachusetts: Lexington Books, 1973).

[4]The Economic and Social Condition of Rural America in the 1970's, prepared by the U. S. Department of Agriculture for the Committee on Government Operations (U. S. Senate), 1971, p. 55. For S.I.C. breakdowns, see 1970 Census Supplementary Report, Industry of Employed Persons for the U. S., 1970.

The trend to decentralization from the central city may have its roots in a combination of 2 hypotheses as stated by Orr:

> " . . . first, that changes in communications, in the methods of costs of transport, and in production technology have freed plants from the necessity to take advantage of central locations. Consequently, alternative locations may become suitable for production but markedly less expensive in terms of initial capital investment for site preparation, land costs or rent, and perhaps recurring overhead costs such as local taxes and insurance."
>
> "Another explanation is that manufacturers wishing to redevelop would still prefer to take advantage of centrality benefits but find that the costs of redevelopment there are greater than in the urban fringe . . ."[5]

The effects may impact certain industrial typologies more rapidly than others. Industry size, dependence upon materials, labor, etc., may dictate a loosening of locational constraints. A further question is the extent to which constraints are loosened--are purely rural areas becoming a more attractive location for industry vis a vis the suburbs? Despite aggregative data which show a tendency for the decentralization of industry from the central city, there has been little analysis of industrial types most sensitive to locational shifts.[6] Of special interest in this study are (1) whether the location preferences of industry are fairly static and predictive as regards the industries in the case study and (2) to what extent transportation in particular has influenced location preferences vis a vis urban and rural choices.

The factors to be studied are generally derived from Greenhut's analysis of certain industrial plants in Alabama.[7]

Greenhut classifies two general theoretical approaches in location theory and uses a synthesis of factors of the two in his evaluation. The first approach is that of "least-cost" location, which has attempted to

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[5] See Sarah C. Orr and J. B. Cullingworth, Regional and Urban Studies (Beverly Hills, California: Sage Publications, 1969). p. 250.

[6] For preliminary view of plant size and characteristics see P. S. Florence, Economics and Sociology of Industry, 1969.

[7] Greenhut, op. cit.

evaluate industrial location in terms of the rational choice of the locator to minimize the costs of transportation, labor, production, etc., while generally assuming a homogeneous market. This approach was advanced by Launhardt and popularized by Weber in the early 1900's and is incorporated in most studies of industrial location even now. The least-cost approach, while a valuable starting point, has been criticized as a model based on its unreal assumptions about the importance of optimum production, market variability and transportation costs.

The second general theoretical approach to location noted by Greenhut (also described by Ian Hamilton) is that of locational interdependence which has emphasized the size, shape and variability of the market as an influence on location. This approach includes consideration of pricing policies, differential transportation rates, distribution of consumers, etc., as critical criteria in establishing a market area within which each concern is essentially a "spatial monopolist."[8] The importance of the market-demand approach is that it essentially expands the number of considerations which dictate a maximum profit location (not simply costs). Other approaches have tried to define location problems within the context of production theory

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(see Leon Moses, Urban Economics), as allocation problems (see Dorfman, Linear Programming for Economic Analysis), or as subjects of gaming techniques (see Chorley and Haggart, Models in Economic Geography).

Greenhut suggests a synthesis of some of the factors of both approaches in his survey of industries in Alabama which fall into three broad categories: demand factors, cost factors, and personal factors. The factors utilized in this report are outlined below.[9]

TABLE 1. Factors for Analysis of Plant Location Choice

Demand	Cost	Personal (by survey)
1. Demand curve for product	1. Tax on land	1. Contacts
2. Size of market	2. Availability of capital	2. Other preferences
3. Proximity to market	3. Power availability	
	4. Transportation costs, facilities	
	5. Labor	

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[8] Ibid., p. 74.

[9] Ibid., pp. 279-280.

SECTION II

THE CASE STUDY COMMUNITY

Sealy, the site of the case study, is a small town approximately 50 miles from Houston, Texas, and has a current population of about 3000. It is considered here as a rural town, even though the U. S. Census of 1970 has given up that classification;[1] its place in the hierarchy of the region, as mapped by Huff and DeAre, scores the sphere of interaction between Sealy and Houston as tertiary (the 3rd of 4 decreasing levels).[2]

Sealy and Austin County have grown fairly rapidly in the last decade. The recent growth of Austin County in general is reflected by the fact that of all housing in the county in 1973, between 15% - 29.9% was built between 1960 and 1970.[3] In terms of population, Sealy grew by about 16% between 1960 and 1970.[4] This growth is fairly rapid compared to many Nonmetropolitan Incorporated Areas (NMI's) in Texas in general. Although between 1950 and 1970 NMI's declined from 18% to 16% of Texas' total population, their absolute population has increased by over 400,000.[5] Those NMI's closer to urban centers have shown a greater potential for growth due to " . . . an economic link to that center . . . as a place of residence . . . or its attractiveness to activities away from the larger center . . ."[6] There are indications that Sealy has benefitted from its proximity to Houston in the three categories above.

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[1]According to the 1970 U.S. Census the rural population lives in towns of fewer than 2500 inhabitants; over 2500, they are considered urban population.

[2]See David L. Huff and Diana R. DeAre, Principal Interaction Fields of Texas Metropolitan Centers, Bureau of Business Research, University of Texas, 1974.

[3]Texas Business Review, January 1973, pp. 17.

[4]Texas Industrial Commission, Site Selection Report Number 3, Sealy, 1973.

[5]Diane DeAre and Dudley L. Poston, Jr., "Growth of Nonmetropolitan Incorporated Places in Texas 1960-1970," Texas Business Review, January 1973, pp. 17.

[6]Ibid, pp 18.

In addition, Sealy has been impacted by the construction of a major highway. The town is located on Interstate 10, which was completed in 1968. The planning and construction of the highway paralleled the development of a community interest in attracting industry to the town, which hitherto had been an agricultural service-oriented town with three small manufacturing concerns.[7] In September of 1956 the Sealy Chamber of Commerce conducted a survey of the town to gather information on the available sites for the possible location of new industry.[8] In 1957 a credit association was formed by retail merchants to provide assistance to beginning or expanding businesses, and the first booklet touting the advantages of Sealy as a choice industrial location and a nice-place-to-raise-the-kids was published. During this period, however, no industries were sufficiently impressed to locate in Sealy. With the completion of the highway, there came about a proliferation of organizations interested in influencing industries to locate in Sealy, including the Sealy Development Corporation, the Sealy Industrial Foundation and the Sealy Investment Club. The Chamber of Commerce continued to be active in the period following completion of the section of I-10 to Houston in 1968. In 1970, for example, a further survey was undertaken of the extant labor force and data were submitted to the Texas Industrial Commission (to become a part of the intra-site program). In addition, the town's business clubs set about operating a continuing program to beautify Sealy. However, as noted by Hunter, the community development efforts of the various social-economic groups had a minimal effect on attracting the industries which decided to locate in Sealy and "an overwhelming majority of Sealy's new industries settled there without any direct assistance from the community."[9]

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[7] See Directory of Texas Manufacturers (Bureau of Business Research, University of Texas at Austin, Austin, Texas, 1971), p. 320.

[8] Graham C. Hunter, Rural Communities and Inter-urban Transportation Systems: A Study of The Stages of Interaction, (Master's Thesis) U. T., 1974, pp. 41. Much of the history of Sealy is gleaned from this report.

[9] Ibid, pp. 88.

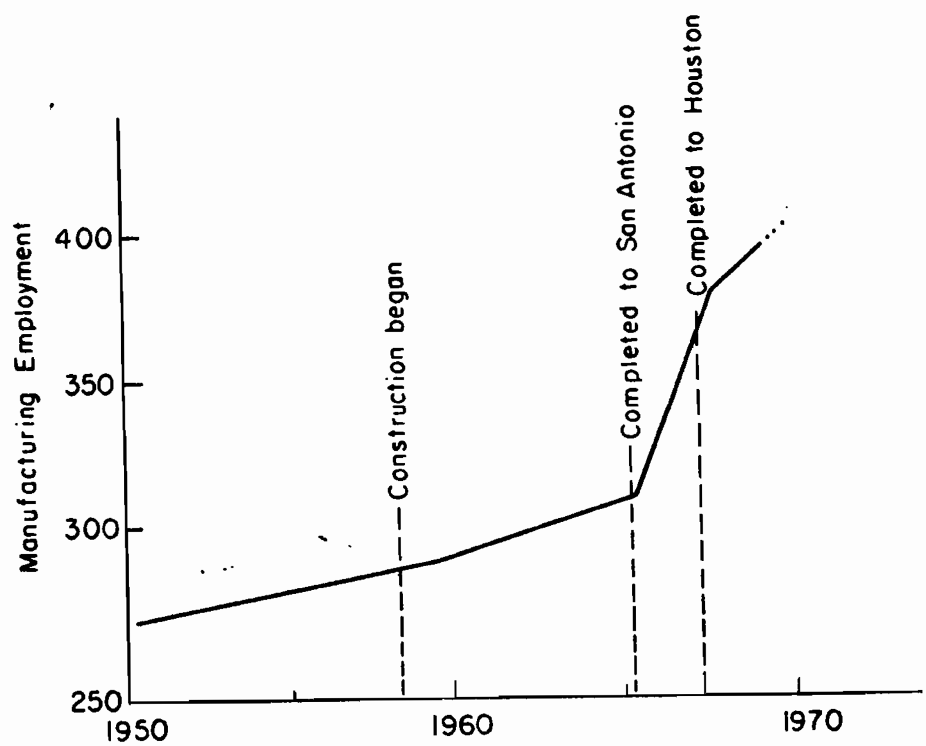
Just prior to and after the completion of I-10 the following industries located or expanded significantly their operations in Sealy:

TABLE 2. Industries Locating in Sealy Since 1966

Industry	Year	New/Moved Plant
Hollow Metal Specialties Corp.	1966	Moved from Houston
Schindler Brothers Steel	1967	New
Herlon Industries	1969	New
Imperial Farms	1969	New
Atlas Steel Culvert	1969	Moved from Conroe
Rendrang Steel Barge	1973	New

Figure 2 shows the growth of Sealy in terms of basic employment in relation to the construction of the Interstate 10:

FIGURE 2.



10These figures are averages of the employment figures given in the Texas Directory of Manufacturers (Sealy), 1974. The figures are probably slightly too high, but do reflect shifts.

Sealy's rural character nevertheless has remained pretty much intact--much of its retail commerce is predominantly agriculture-service oriented, and it remains a chief cattle market for the region. This rural character is obviously being impacted by the arrival of new industries and the increased mobility of Sealy residents with more rapid access to Houston. For example, several suburban sub-divisions have been built, attracting those who work in Houston but prefer the small town environment as a place to live. In addition to an increase in the number of commuter residents, there has also been an influx of industrial workers and managers in connection with the new industry. The city government of Sealy is presently concerned with the changing character of the town, and, in response to the problems generated by growth, the citizens and the government are attempting to develop a new master plan for the city.

SECTION III
RESULTS

Four industries were chosen for study and each was surveyed to determine the extent to which personal contacts and preferences influenced the choice of Sealy as a location. The four industries are analyzed in this section in light of the selected factors outlined in Section I. Although ideal data on each factor in many cases are impossible to obtain, the data sources used were felt to be indicative on the whole. These data include:

1. Demand - National Investment Trends in New Plants, Income[1] and Market; Regional Growth of Linked Industry
2. Land and Tax - Land Value Comparisons, Site Size, County Taxes, City Taxes
3. Labor - Size, Median Income, Skills
4. Capital - Bank Deposits
5. Power - Resources, Rates
6. Transportation - Type per Industry, Structure in Area, Costs
7. Personal Preferences

The industries are listed below showing size, number of employees, and general range of their product:

TABLE 3. CASE STUDY INDUSTRIES[2]

Industry	SIC Code[a]	No. Employees	Market Range
A	34	200	Regional
B	34	32	State
C	36	8	National
D	20	6	Local

[a]Since some information is confidential, only the general categories from the Standard Industrial Classification (SIC) Code are used to identify the case study industries.

[1]See Lloyd and Dicken, Location in Space: A Theoretical Approach, op. cit. p. 110.

[2]See Texas Directory of Manufacturers, 1974.

Demand

One of the industries chosen, D, serves only the local market. As such, it is assumed that the growth of Sealy created a demand threshold for its product that made the plant location a profitable one. The primary value of the data from this industry lies in location factors other than those treated under "demand."

Industry A is a subsidiary of a Houston based corporation, and its plant at Sealy processes steel bars from scrap that are used in reinforcing concrete. Industry B produces steel door frames, rods, etc. As such both are classified under the general SIC Code (34) of fabricated metal products. Industry C produces one product also under the general SIC Classification (34) and electrical machinery classified (36). Like 80% of all U. S. industries, most of these goods are used in turn by other industries in processing a final product which makes a market potential analysis based on population difficult at best. The pressure of growing demand might be gleaned from national figures reflecting tremendous growth in the fabricated metals industries and electrical machinery industries between 1960 and 1970 (see Table 4).

TABLE 4
Expenditures for New Plant[3]
And Equipment (millions)

	1960	1965	1970
Fabricated Metal Products	483	805	1,287
Electrical Machinery	616	1,047	1,520

TABLE 5.
National Income by Industrial Origin[4]
(billions)

	1960	1965	1970
Fabricated Metal Products	8.1	11.5	14.6
Electrical Machinery	10.5	14.9	20.2

[3] See Statistical Abstract of the U. S., U. S. Department of Commerce, Bureau of the Census, July 1973, Table 1192, p. 703.

[4] Ibid., p. 325, Table 527.

The growth, and particularly the increasing investments in new plants may suggest increased competition in the 60's for land and sites close to market areas that would minimize transportation costs. However, an interesting fact is that, of the persons employed in fabricated metal industries in 1970, almost 50% worked in plants in areas classified as "not urbanized" with the largest percentage of those in locations wholly outside metropolitan areas.[5] Since corresponding data are lacking from 1960, one can only conjecture as to national shifts in the last decade.

In part, the spatial variations of demand might be reflected in the growth of manufacturing industries as a whole in the country due to the forward and back linkages of the industries. Growth in the U. S., as reflected in employment in manufacturing sectors, shows the South Atlantic and West South Central regions (Texas is located in the latter) as the largest gainers between 1965 and 1970 (see below).

TABLE 6. Employees on Manufacturing Payrolls, by Region: (Thousands)[6]

	1960	1965	1970
New England	1451.7	1459.6	1457.8
Middle Atlantic	4126.9	4163.4	4147.0
East North Central	4495.2	4894.1	5032.1
West North Central	1001.4	1084.9	1226.2
South Atlantic	2040.1	2348.8	2698.4
East South Central	844.1	1022.7	1223.2
*West South Central	820.4	969.2	1218.2
Mountain	263.7	290.9	364.8
Pacific	1709.7	1827.2	2003.9

In terms of sub-state demand, linkages through manufacturing sectors would suggest two strong focal points influencing location, Houston and Dallas. The growth of employment--particularly in the case of fabricated metals--underscores Houston's dominance. (See Tables 7 and 8.)

[5] 1970 Census of Population Supplementary Report, "Industry of Employed Persons for the U. S: 1970".

[6] Handbook of Labor Statistics 1973, U. S. Department of Labor, Bureau of Labor Statistics, 1973, pp. 112-113.

TABLE 7. Employment in Manufacturing (Thousands)[7]

	1965	1970
Amarillo	4.6	7.1
Austin	6.3	11.8
Beaumont-Port Arthur	33.8	36.5
Corpus Christi	10.2	11.4
Dallas	121.6	158.2
Houston	118.3	147.5
Lubbock	6.6	7.2
San Antonio	26.4	35.0

TABLE 8. Employment in Fabricated Metals (Thousands)[8]

	1965	1970
Texas	39.3	54.6
Beaumont-Port Arthur	2.5	3.0
Dallas	7.6	9.5
Houston	15.5	20.7

Strong back linkages are an important influence dictating location according to the preliminary study of the survey. In the case of Industry A, for example, 60% of the raw materials used in processing comes from Houston. Forward linkages are particularly strong as regards the construction industry since most of the products are used in building. A look at the construction industry again shows Houston and Dallas by far as the largest gainers in employment between 1965 and 1970.[9]

Land Costs

A selective look at some sale prices of various parcels sold or offered for industrial use of land between 1960 and 1973 in Sealy reveals the rapid rise in values attributable in part to the impact of the Interstate Highway.

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[7] Employment and Earnings States and Areas 1939-1972, U. S. Department of Labor, Bureau of Labor Statistics, Bulletin 1370-10, p. 622.

[8] Ibid.,pp. 628-633.

[9] Ibid.,pp. 628-633.

TABLE 9. Land Value of Certain Vacant Sites Sold for Industrial Development[10]

Site	Acres	Year	Land Value[a] ($)	$ Per/Acre
1	23.34	1964	18,000	771.20
2	46.65	1966	31,500	675.24
3	50.3	1970	59,500	1182.90
4	33.3	1972	70,000	2102.10
5	105.5	1973	321,600[b]	3048.34

[a]Figures obtained from insurance policies issued on land value.

[b]This site is the only one on which development has not yet taken place.

For industries locating in the area, the initial capital outlay for land may seem considerable. However, when one considers comparable sites in Houston, there is little doubt of the advantage of the Sealy location. Houston realtors, specializing in industrial properties, informed us that comparable lots in the Houston area, when obtainable at all, would have a cost 6 to 8 times greater than that in Sealy.

In the case of Industry A, a fairly large tract of land was purchased. Although not usually considered in the category of land intensive industries, metal fabricating plants may in fact find the need for land a constraint on location. The size of the lot may be considered close to minimum when consideration is given to truck access, storage, and processing. Thus, in terms of both cost and size of available lots, Sealy would seem more attractive than corresponding urban sites.

These generalizations are in part supported by survey data. Alternate sites considered by Industry A included other rural towns in the area, and

[10]The sites listed in Table 9 are all relatively large tracts of land and exhibit similar characteristics (i.e., access to highway, and rail, topography, distance from CBD, etc.). For a more detailed discussion of land values in Sealy, see Lidvard Skorpa, *et al.*, *Land Value Modelling in Rural Communities: A Case Study*, Council for Advanced Transportation Studies, University of Texas at Austin, Research Report No. 3 (Publication pending).

"inexpensive land for location and expansion" was a factor rated as fairly important by comparison with most others. Industries B and C are both smaller concerns, and hence less land intensive. The surveys indicated that land costs, though fairly important, were less significant than other factors, in particular labor costs and the area's reputation for "good" labor-management relations. On the other hand, Industry D is land intensive, and its executives rated land cost as among the most important reasons for choice of location.

Tax Structure

For tax sensitive industries, such as land intensive industries or those which must locate on more costly land to acquire access to CBD or transportation facilities, property tax may be a consideration in the location decision.

Data on taxes are somewhat misleading but are presented in a comparative sense in any case. They are misleading due to (1) exceptions or reductions which may be included as an enticement to industry and (2) differences in assessing procedures in different cities (there are no standardized methods in Texas as there are in California). A comparison of county taxes does reveal a relatively favorable position of Austin County in comparison to other rural counties and Harris, a predominantly urban county.

A look at the per capita tax of some counties shows an inverse relationship between per capita tax and distance from Houston. The lowest per capita taxes are to be found in the most rural counties. Once outside the city of Houston, the lowest levels of assessed value are generally to be found in the towns farthest from Houston, the nearest major SMSA. (See Tables 10 and 11, p. 17. The counties or cities, as the case may be, are arranged in order of increasing distance from Harris County or the city of Houston.) Although Houston does have a lower taxed percentage of assessed value, it is assumed that the values themselves are much higher than in rural towns.

TABLE 10. Comparison of Selected County Tax Rates[11]

County	Property Tax $ (per capita)	
Harris (Houston)	121	(The city of Houston's per capita tax is an additional $53)
Fort Bend	110	
Wharton	129	
Waller	100	
Austin (Sealy)	66	
Washington	55	
Colorado	97	
Lavaca	40	
Fayette	41	

TABLE 11. Taxed Level of Assessed Value[12]

Houston	37.1%	(1972)
La Porte	76%	(1972)
Angleton	50%	(1971)
Sealy	40.4%	(1971)
Bellville	33.3%	(1972)
Columbus	30%	(1970)
Crockett	33.3%	(1972)

[11] County and City Data Book 1972, U. S. Department of Commerce, Bureau of the Census, March 1973, pp. 440-484.

[12] Texas Municipal Reports, Municipal Advisory Council of Texas, Austin (for various years).

It should be noted that in the urban to rural arrangement, the most significant tax gap among counties within a 75 mile radius of Houston, is between Harris and Austin Counties. Whereas the difference between Austin and Harris County is in excess of $50 (not including city tax), the difference between Austin County and other rural counties is less than half of that figure. When consideration is given to the tax structure in Austin County vs. other rural counties, the relative advantage in tax reduction diminishes with distance from Houston. In the more distant counties, other costs related to the reduced accessibility to Houston will probably rise, suggesting some point of equilibrium between accessibility and any benefits gained from the tax advantage.

In the absence of hard comparative data throughout the state, the only reasonable conclusion to be drawn is that the tax structure was probably a marginal consideration in the decision to locate in the study area rather than an urban area.

Labor

The metal industry is highly labor intensive, and one would expect the labor market to be an important influence on its location. Since it requires only a small number of skilled workers, the critical factor is the cost of labor, although certain minimum skills may be needed. Preliminary data from the survey suggest that a perceived notion of experienced workers in the Sealy area was of importance in location choice as regards the metal fabricating products. As for Industry C (SIC code 36), there are two important considerations of the labor market--cost and skill or, perhaps, skill potential (which is a difficult variable at best to evaluate). For this industry, the survey indicates that high consideration was given to "low labor costs" and "area's reputation for good labor management relations."

In terms of labor costs, a comparison of skill and wage levels once again indicates Austin County has a reasonable advantage especially in craftsmen:

TABLE 12. Median Incomes 1969[13]

County	Professional-Managerial	Craftsmen	Operatives
Austin	7,990	5972	5213
Brazoria	11,364	9558	8631
Colorado	8,107	5920	5161
Harris	11,645	8192	6788
Waller	9,049	6606	5105
Walker	8,036	5267	3500
Wharton	8,250	6053	5272
Washington	8,294	5436	4639
Lavaca	6,789	4635	4160
Fayette	7,110	4023	3890

Perhaps some insight as to skill potentials may also be gleaned from the education levels achieved in various rural towns in the region as presented in the 1970 census.

TABLE 13. Comparison of Selected Education Levels in Study Region[13]

Town	Median School Years	% Completed High School
Sealy	9.9	38.5
Karnes City	8.4	27.4
Bastrop	9.3	30.2
Columbus	9.5	30.8
Cotulla	6.3	21.2
Giddings	8.8	24.6

Industry D is in some ways the most interesting in terms of labor as a location factor. High-rankings on the survey were given to all categories under labor except "availability of skilled labor." Since the industry does not require highly skilled labor, this was to be expected, but what seemed of extreme importance were the qualitative factors "high productivity of local labor" and "area's reputation for good management-labor relations." "Low labor rates" was also given the highest ranking score.

[13] 1970 Census of the U. S., Department of Commerce, Bureau of the Census, Table 122.

Capital

Preliminary data indicate that availability of rural capital was not a determining factor in the location decisions of the major industries which chose to locate in Sealy. However, some of the smaller and later arriving concerns have made use of local loans, and Industries C and D rated "local financial assistance" as an important factor. For comparison, and as an indicator of economic health in general, deposit totals for various surrounding counties are shown below:

TABLE 14. Total Deposits for Various Counties (millions)[14]

County	Bank Deposits (June 1970)	Savings and Loan (December 1970)
Austin	18.2	----
Colorado	13.9	34.1
Fort Bend	11.6	47.6
Fayette	19.2	----
Lavaca	2.7	----
Waller	3.7	----
Washington	25.8	18.0
Wharton	16.6	21.0

As is to be expected, capital availability seems to be a significant factor predominantly in those cases where small firms (not a subsidiary) have chosen to locate in the area.

Power

The metals industry is a power intensive industry due to the input of fuels and electricity necessitated by furnaces in the melting and shading process. Data from the survey indicate a high importance given to the availability of fuels and electric power in the choice of plant location in all cases. While a comparison of utilities rates throughout the region is not available, and should be a part of a complete analysis, a rough estimation of rates was obtained for some cities in Texas.

[14] County and City Data Book 1972, op. cit. pp. 440-484. These data show time deposits by individuals, partnerships, and corporations.

TABLE 15. General Rates Per KWH over 12,000 KWH[15]

Amarillo (S. W. Public Service Co.)	.80
Lubbock (S. W. Public Service Co.)	.92
New Braunfels (New Braunfels Utilities)	.80
Austin (LCRA)	.90
Houston (Houston Lighting and Power)	.78
Sealy (Houston Lighting and Power)	.78
Conroe (Gulf States Utilities)	.68
Dallas (Dallas Power and Light)	.90

These rates do not reflect total cost due to both energy charge and demand charge nor do they take into account minimum payments. They are a very rough estimation, but they tend to bear out the power-cost sensitivity reflected in the preliminary survey data. Not shown, and also important in rate analysis, is whether the utility company is owned by the city, a public organization or a private concern. The importance is that often cities may offer utility rebates to induce industries to locate there. Unfortunately, accurate and complete data are not available at this time.

Fuels, while scarce in many parts of the country as a whole, are abundant in the East Texas Region near Houston. The region lies in a railroad commission district which is classified as an "energy surplus" district due to the natural gas and oil extracted, processed and exported from the area.[16]

Transportation

Specific transportation data of a comparative nature which might reveal spatial variations and inducements on a regional and state level are not available at this time; however, there are general implications which can be drawn from the preliminary survey data. There are three interesting factors of transportation cost which impact location in rural vs. urban areas:

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[15] Estimations are based on general published rates of varying scale from The National Electric Rate Book, Federal Power Commission, Washington D. C., 1973.

[16] Robert M. Lockwood, "Energy Consumption in Texas," Texas Business Review, Bureau of Business Research, University of Texas, August 1973, p. 179.

(1) The historical decrease in transportation costs due to technology, etc.

(2) The administrative structuring of rates (I.C.C. and The Texas Railroad Commission)

(3) The increased cost of congestion

I-10 is an example of the impact of technology in reducing transportation costs in the long run. Some of the effects as outlined in a report done for the Texas Division of Planning Coordination of the Governor's Office include:[17]

(1) Reduction of time (maximum utilization of vehicles, wages)

(2) Savings in fuel costs

(3) Savings in equipment costs (lower hp. vehicles for example)

(4) Savings through safety (lower insurance rates)

The overall impact is to free plants from market and resource locations and especially to reduce the cost of congestion--which was rated on all surveys extremely high as a consideration for location in a rural area.

It has been argued that the administrative structuring of rates has generally been prejudicial to rural locations in Texas.[18] The effect has been to favor long hauls, which in a sense has discouraged intermediate rural areas from being utilized, and has also encouraged full load hauls, thus inducing smaller load producers to locate near the market and penalizing small lot shippers situated in non-metropolitan areas.[19]

Despite these deterrents, the three case study plants (A, B, C) which are sensitive to transportation costs for both resource and market did locate in rural areas, and, in the case of Industry A, executives considered sites even

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[17]J. Edwin Becht, Rural Transportation Problems and Rural Development in the State of Texas, University of Texas of the Permian Basin, 1973, p. C-14.

[18]Ibid. pp. C-15 - C-20.

[19]Ibid. p. C-23.

farther from their major market and resources. Significantly, other sites considered were also on I-10 and had rail connections. All four plants rely most heavily on motor truck transport, both for materials used in processing and for moving the final product. However, rail was in at least one case (Industry A) one of the three most highly rated factors in location.

The survey of the one plant with only a local supply and market, and thus the one least dependent upon interurban modes of transportation, provided an interesting answer to the question, "What effect has the development of I-10 had on your firm?" The answer was "increased labor costs"; the reason given was that higher salaries had to be paid local labor because I-10 had increased the access to other job markets.

Personal Factors

In two industries (B and D), personal contacts with a local resident were listed as important. For larger industries, Industry A, for example, this was not the case. The most important factor that could be called "personal" which received a rating of "very important" on the surveys was "Attractiveness of local environment for transferred executives." Since Sealy offers a variety of housing and has access to several types of outdoor recreation, the qualitative aspect of the rural environment cannot be overlooked.

Preliminary Conclusions

Previous studies have emphasized different factors as being of the greatest importance. The availability of land which is both relatively inexpensive and of sufficient size to meet the requirements of the locator was found to be the most important determinant in Bone's study of Route 128 near Boston.[20] Next in importance were labor supply and them some notion of "accessibility." Breese concluded that transportation was of pri-

[20] A. J. Bone and Martin Wohl, "Massachusetts Route 128 Impact Study," Highway Research Board Bulletin 227 (January 1959), pp. 21-49.

mary importance in a strictly comparative study of Burlington County, New Jersey, while taxes, labor, etc., were marginal influences.[21] Kiley's survey rates availability of a "good highway" as the most important determinant--moreover, his study included a larger number rural-based industries than the other two which involved mostly developed areas.[22]

The variations in the results in our own study suggest that differences in the size of the operation and the nature of the product need to be accounted for when generalizations are made about the relative importance of different factors. For the largest concern, the combination of energy resources, rail, and highway was the important determinant. For the smaller companies, labor costs and labor relations seemed to be more important than other factors, and, in the case of the one land intensive industry (D), a combination of labor costs and land costs was a determinant.

The relative rankings on the survey instrument do not, however, serve as a perfect measure of the role played by transportation in influencing plant location. Even though access to transportation facilities ranked relatively low on the surveys from smaller companies, it may be the case that the availability and reasonable cost of transportation were necessary, though not sufficient, conditions of choice in all cases. "Freedom from congestion" was given the highest ranking on all surveys, indicating that this transportation-related factor is of greater significance than is usually considered to be the case. At any rate, further research should incorporate more accurate ways of evaluating "accessibility" as a location factor.

Generally, the locational criteria in the study may be related to industrial typology as well. Though to differing degrees, all but one were labor intensive, and each was subject to minimum lot-size constraints. In terms of demand, the plants with extra-local markets were in fast growing industries with forward linkages to construction or to construction-oriented industry.

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[21] Gerald Breese, Industrial Site Selection, the Bureau of Urban Research, Princeton University, 1954.

[22] Edward Kiley, "Highways as a Factor in Industrial Location," Highway Research Record, Number 75 (1964), pp. 48-52.

In the process of this study, the difficulty of making a comparative locational analysis on a limited geographic area became apparent. Data, in many cases, were not available in any form. The study has, however, illuminated critical factors which, when incorporated in a regional impact model, may provide a more quantified overview of manufacturing growth in a rural area. Work is currently underway in developing such a model, and this effort will be reported on in a subsequent document.

APPENDIX

STRICTLY CONFIDENTIAL

Questionnaire

Description of Company

Name of Company ____

Year the Plant was Established in Sealy ______________________________

Approximate Weekly Payroll ___________________________________

Is your Company a Branch of, or a Subsidiary of, an Older Company?
(check one) Yes ____________ No ____________

A. If yes, what is the name of the company of which you are a branch or subsidiary? ______________________________________

B. What is the relationship? ______________________________

C. Where is the parent company located? ______________________

The Product

Briefly describe your product, and the raw materials needed for this product.

Who are the principal users of this product: Please specify. (check one)
The general consumer__________ Industrial users__________ Others__________

If other manufacturers use your product, what are the principal final products?

Previous Location

(a) When did you start production at Sealy? ______________________

(b) What were your principal products at that date?

(c) What factors made you pick Sealy as a suitable location?

(d) What were the main economic advantages of this location?

(e) What were the main economic disadvantages of this location?

(f) Prior to your relocation, what type of factory did you occupy? (e.g. one story, tenement, standard, etc.)

Choice of New Location

Which sites did you consider for relocation? (please name)

The Location Process

Who makes the decisions on plant location for your company? (check one or more) Company executives____________ Outside consultants______________
Others (please specify)____

If company executives influenced the location decision, what were the official positions held by these executives?

Workers

How are the numbers of your present labor force divided among the following categories?

	Male	Female
Administrative staff		
Technical staff		
Clerical		
Skilled operators		
Semi-skilled		
Unskilled		
Apprentices		

Costs and Production

What were your annual costs of production in dollars and percent of total cost under the following headings in the last financial or calendar year?

Item	Average Annual Cost ($)	Percent (%) of Total Cost
Labour Wages		
Raw materials		
Semi-finished manufactured goods		
Utilities (gas, water, electricity, fuel)		
Transport		
Rates		
Rent		
Depreciation		
All other (please specify)		
TOTAL		

Transport

How are your transport costs spread amongst the following types of transport?

Transport Method	Percentage	
	Raw Materials	Finished Products
Road		
Rail		
Air		
Water		

Materials/Markets

What percentage, by value, of raw materials and semi-finished manufactured goods come from

Area	%
Local	
Houston	
Texas	
U.S.	
Other	

What percentage, by value, of your finished products go to

Area	%
Local	
Houston	
Texas	
U.S.	
Other	

Please rank on a scale of 1 to 7 the relative importance of the following factors on your decision to locate in Sealy (1 is most important, 7 least) Circle the appropriate number.

Factors	Ranking Very Important			Unimportant			
Availability of skilled labour	1	2	3	4	5	6	7
semi-skilled labour	1	2	3	4	5	6	7
unskilled labour	1	2	3	4	5	6	7
Low labor rates	1	2	3	4	5	6	7
High productivity of local labour	1	2	3	4	5	6	7
Area's reputation for good management-labor relations	1	2	3	4	5	6	7
Access to rail	1	2	3	4	5	6	7
canals or river	1	2	3	4	5	6	7
port(s)	1	2	3	4	5	6	7
major roads	1	2	3	4	5	6	7
airport(s)	1	2	3	4	5	6	7
Availability of transport services for goods	1	2	3	4	5	6	7
Freedom from traffic congestion	1	2	3	4	5	6	7
Proximity to linked producers	1	2	3	4	5	6	7
sub-contractors	1	2	3	4	5	6	7
central city services	1	2	3	4	5	6	7
suppliers	1	2	3	4	5	6	7
major markets	1	2	3	4	5	6	7
Suitable factory available	1	2	3	4	5	6	7
Low factory rents	1	2	3	4	5	6	7
Fully serviced site	1	2	3	4	5	6	7
Inexpensive land for location and expansion	1	2	3	4	5	6	7
Community co-operation over housing, roads planning permission, etc.	1	2	3	4	5	6	7
Local co-operation with financial assistance (grants, loans, subsidized rents, rate reductions, etc.)	1	2	3	4	5	6	7
Attractiveness of local environment for transferred workers/executives	1	2	3	4	5	6	7
Local technical education facilities	1	2	3	4	5	6	7
Personal preferences (please specify)	1	2	3	4	5	6	7

The Effect of Comprehensive Development

What effect has the development of H10 had on your firm?

What do you most like/dislike about your new location?

Like | Dislike

Name and Title of person completing this form:

APPENDIX I
Exhibit 4

LAND VALUE MODELING IN RURAL COMMUNITIES

by

Lidvard Skorpa
(Graduate Research Assistant)

Richard Dodge

C. Michael Walton

(Principal Investigators)

Report

Prepared for
U. S. Department of Transportation

by the

Division of Research
Council for Advanced Transportation Studies
THE UNIVERSITY OF TEXAS AT AUSTIN

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PREFACE

This study attempts to review and experiment with appropriate modeling techniques for describing and explaining variation in land values within small rural communities affected by changes in the interurban transportation systems which serve them. As a test case, data from one community, Sealy, Texas, have been used to construct regression models with land value as the dependent variable and with numerous community characteristics and time-related factors as independent variables.

The study has three objectives:

1. to describe the variation in land value in one community over a twenty-year period;
2. to develop appropriate indices and modeling techniques which could have general application to other small communities; and,
3. to identify the areas where further research and evaluation are required.

In keeping with these objectives, the study represents a preliminary step, and thus it offers a basis for further work rather than a set of final conclusions.

Initially, an effort was made to develop a single model for variation in land values. However, it was concluded eventually that a series of local models would be of greater value than one general model for all categories of land use. It was also recognized that the number of variables originally included may be reduced.

The next phase in this study will involve performing a sensitivity analysis on the form given the independent variables, the development of a series of local models (for different categories of land use and parcel location), and the analysis of individual transactions which seem to be unaccounted for by the initial models.

For transportation planning to be effective, it requires an understanding of how changes in an existing system will affect a community. The effect on land values is important not only because of their direct bearing on a community's fiscal structure and economic development, but also because of the psychological weight which people attach to an externally induced change in property values. It is hoped that this study will contribute to the general understanding in the field as well as provide potential direction for future research.

The substance of this study was originally submitted as a master's thesis in Civil Engineering at the University of Texas at Austin in 1974.

Lidvard Skorpa
Richard Dodge
C. Michael Walton

ACKNOWLEDGEMENTS

Special thanks go to Mr. John Huddleston for his assistance in data gathering and processing and for his editing. Professional interaction with the other members of the research team has been invaluable, and the authors wish to express their appreciation to Messrs. Terry Watson, Graham Hunter, and Gordon Derr.

June 1974

ABSTRACT

Investment in transportation systems has mainly been directed at the goal of reducing the cost of travel and increasing user benefits. This has been considered the best way to enhance production activities and thereby growth within the sphere of influence of the transportation system. In the recent years, however, the need for studies of all facets of transportation impact has been stressed, but until now impact studies have not been able to reveal the complex cause/effect relationship that exists between growth and development in a rural community and changes in the transportation system.

This report concentrates on the impact on land values. It discusses why land values can be used as an indicator of community impact and evaluates a technique for modeling land values in a rural community. The technique is used in a case study of Sealy, Texas.

Land value is expressed as a function of factors describing characteristics both of the transportation system provided and the community itself. Indices are evaluated in order to measure or rank qualitative levels of the factors, and the best regression models are found by regression analysis.

In the case study a total of 611 land transactions in Sealy, Texas, are analyzed. These transactions took place between 1955 and 1973, throughout the entire community. Conclusions about how variance in land values can best be described are drawn, and areas where future research is needed are specified. For the convenience of the reader an annotated list of previous studies is included.

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CHAPTER I. INTRODUCTION

Transportation facilities are constructed for the benefit of people. The facility is not a goal in itself; it has to serve actual needs and desires in order to justify the spending of public or private funds. During the planning process, transportation demand, construction and operation costs, annoyances, damages, and benefits have to be evaluated in order to find the best solution in terms of mode, location and design. However, all of the different factors will vary according to who are considered to be the group of people influenced in some way by the facility. In this project, the people considered are those living in a rural community with some degree of connection to the interurban transportation system.

The effect of changes in the transportation system on a defined area or group of people is frequently referred to as "transportation impact." Yet there is no exact definition of transportation impact. Most previous impact studies have concentrated on economic impact, but the term may be used to describe any kind of effect. In this study, transportation impact on a community will be defined as the community response both to the transportation system as it exists at a particular time and to changes in that system. According to this definition, impact in the broadest sense includes any type of influence from the transportation system, whether it is to be measured quantitatively or qualitatively. The term may also be used in a narrower sense, when so defined, describing a specific community response, e.g., changes in the land value distribution.

A change in the transportation system does not necessarily result in any change in the community. Transportation provides a potential or stimulus to change, and response will depend upon many factors. One important factor is the nature of existing human resources in and outside the area. Thus, there should be a differentiation between "potential for development" and "impact," the latter being dependent on the existence of the former.

This also implies that a great variance might be expected in any statistical analysis of community impact as long as the human factor cannot be included in the analysis. With equal "potential" for growth and development in a number of communities, the impact in terms of response might be expected to vary considerably according to the human resources in each community. No technique whereby all human resources or potential responses can be measured is known to the authors.

The term impact implies a change, but the impact cannot be said to be positive or negative without specifying who is affected and under what criteria it is measured. A positive impact is generally the case when the change implies a desirable response in the community. If one of the responses in a community to changes in the transportation system is an increase in land values, then the impact on land values is positive only if an increase in land values is desirable from the viewpoint of the community.

Even if one assumes that a given change represents a benefit to the community, another problem arises which should be noted here. It is usual in impact studies to separate user and non-user benefits. Since the residents of a community usually constitute a minority of the users, the non-user benefits might be considered to be of greater importance. However, non-user benefits are the more difficult to define, and some researchers claim that all non-user benefits are derived from user benefits. At present no one has been able fully to prove or refute this view.[1*] For the purpose of this study, it will be assumed that non-user benefits may be separated from the sum of user benefits, subject, however, to the foregoing reservations.

This particular study is a part of a comprehensive research project called "The Influence on the Rural Environment of Interurban Transportation Systems" under the auspices of the Council for Advanced Transportation Studies, The University of Texas at Austin, sponsored by the U. S. Department of Transportation. The overall methodology for the entire research project involves two phases:

1. A case study phase to develop a descriptive model; and,
2. A general study phase to verify and expand the results from the case study phase.

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[*] Footnotes are listed at the end of each chapter.

This paper is a part of the case study phase of one specific subject -- land values. The ultimate goal is to evaluate a descriptive model for land values in a given community with specific characteristics and served by a specific transportation system. No general model can be evaluated from such a case study as every community has its own characteristics in terms of resources, traditions, economy, and so on, and each is served by a transportation system with specific development characteristics. The land value model from this case study, however, could possibly be refined and expanded to a general descriptive model in the general study phase.

The purpose of the case study phase is not only to evaluate the descriptive model, but also to identify appropriate techniques to be used in similar studies. This identification may be considered to be as important as evaluating the model itself. Consequently, it is also a study of what information is generally desired, what information is generally available in rural communities, and what adjustments in study techniques are necessary given the available information.

The descriptive model in this case study phase will be given the form of a function. The dependent variable will be land value; the independent variables will be the different factors causing land value to vary: use, location, access, and so on. In addition, a specific technique will be used for evaluating the regression model to be analyzed. Before the regression models are set up an available program package for statistical analysis will be used to find the most significant factors in the data set and the interaction between them. Thus the model potentially should explain why and how land value varies from one parcel to another. Because of the human factor involved in all land evaluation, depending on the individual seller or buyer, such a mathematical model is not expected to be anything but a general expression for what an objective value of a specific piece of land should be, based on real life observations in a specific area.

FOOTNOTES

[1]For a discussion of the nature of transportation impact and of the problems involved in separating user and non-user benefits, see A. S. Lang, "Evaluation of Highway Impact," Highway Research Board, Bulletin 268 (1960), National Academy of Sciences, pp. 105-119.

CHAPTER II. LAND VALUES AND TRANSPORTATION EFFECTS ON COMMUNITIES

LAND VALUES

In order to understand why land values vary and how they are influenced by changes in the community or in the transportation system, it is necessary to have some basic knowledge of land values and how to measure them.

Basic Principles of Land Value

A piece of land does not have any value unless it satisfies someone's specific needs or desires. Land has a value when an individual desires it and can use it according to his needs. The value is fundamentally based on the elements of utility, scarcity, access, and purchasing power of the buyer. Generally land values are related to the potential for future land use and also the economics of the neighborhood, the community and the region.

The value is related to supply and demand. The demand is related to the potential for a specific category of land use. This potential may derive from the existing situation or from an anticipated future situation. Thus the buyer and seller may set the value as the present worth of future anticipated benefits derived from the ownership and use of property, and not according to what comparable properties have sold for in the past.

The effect of any change which might influence land values is not always immediate. Usually, a neighborhood tends to reach a reasonable degree of conformity with regard to land use and socio-economic characteristics. This tends to make property values uniform and to act as a buffer against change, whether induced internally or externally. Sub-division and deed restrictions may also prevent changes in land use and land value that might otherwise occur.

Measurements of Land Value

There might be said to be two ways of measuring land value. When a transaction takes place, the value of a parcel can be defined as the actual sales price. At any other time, the value will have to be determined by an appraisal, i.e., an estimate or opinion of the value.

The most commonly used evaluation technique is the "market data comparison approach," employed for both public and private assessment purposes.[1] In using this technique, the appraiser examines previous land sales and offerings presently on the market. These data are then compared and adjusted for such factors as time of sale, location, topography, size of tract, accessibility, demand for available sites, future land use, etc.

Another valuation technique is the "income approach" in which the value is based on the "capitalization of the net annual income derived from projections of the gross income; from these are deducted real estate expenses and vacancy reserves."[2] This method, too, should reflect the market demand for a property at a given location and time, which conversely reflects changes in the economic trend, community characteristics, and the transportation system.

Evaluation of Land Value Approaches

In this study, the changes and variation in land values are to be used as measures of the combined influence of community characteristics and the transportation system. Therefore, it is important to use an expression for land value that reflects the real value as it varies with time and with changes in use and location relative to the existing transportation system. Appraised market value such as that used for tax assessment might be taken as a measure of real value since appraisers take time, location, and other factors into consideration. However, there is one major fallacy in this approach. The appraised land value reflects the appraiser's evaluation of how a piece of property differs from a supposedly comparable property and how these differences influence the market value. In other words, the appraiser actually estimates the value by making assumptions about the very aspects of the cause/effect relationship which this study seeks to define. Appraised land values thus would bias the statistical analysis designed to determine the actual cause/effect relationship.

For this reason only market values from actual transactions will be used in the analysis. Thus, the data will not be influenced by any presumption about which factors are important or how they influence land values. Unfortunately the sales will reflect factors which are irrelevant in this study, like family-relationship between buyer and seller, forced sales and so on, where the actual sales price is not the actual market value.[3]

LAND VALUE AS AN INDIRECT INDICATOR OF IMPACT

Land values are to some extent affected directly by changes in the transportation system. Indirectly, however, they will reflect the many facets of impact on the community. Even though the impact on a specific community characteristic is not of economic character, the impact might have measurable economic consequences. Land value might be an indicator of non-economic impact also. For example, if one aspect of the social impact is increased housing segregation, this will have an influence on the distribution of land values within the residential land use category. As the total community impact is the sum of different types of impact in different locations, land value as an indicator might be used to describe both individual parcels and the entire community.

Indication of Overall Effect

The total land value in a community generally will reflect the economic characteristics of the area. Expressed in terms of dollars per capita or units per area at different times, it might be used to describe the changes which have occurred or the vitality of the community relative to that of other communities. Changes relative to the general land value trend in the area might indicate whether the community is doing "better" or "worse" than the rest of the region. When land use changes to a "better" use, e.g., from agricultural to industrial or commercial, this is generally reflected in land values. Thus a change from an agricultural economic base to an industrial or manufacturing base possibly caused by changes in transportation system can result in an increase in total land values in the area. In other cases, the increase may be localized, or there may even be a net decrease in land values in the community as a whole.

Indication of Spatial Effect

When new transportation facilities are constructed, more land is usually opened for development, thus increasing the supply. If there is no change in demand, or if demand for certain land use categories is merely transferred from one area to another, land values may actually decrease or, in net terms, remain unchanged. In studying individual parcels or neighborhoods, one may assume that changes in land use and land values may reveal the spatial distribution of the total effect. Local changes in both land use and intensity together will determine the growth pattern in the community.

For example, highway-related commercial activities seem to depend upon a location close to the highways with good visibility and accessibility. If the highway facility changes location, these activities will also have to change location. In small communities this consequently means a transfer of an existing activity. Thus, by comparing changes of land values for different categories of land use, the effect of the transportation system change on each land use category may be revealed. The spatial distribution of each land use category will reflect this land use category's dependence upon accessibility to and the quality of the transportation system.

Indication of Social Effect

Changes in social conditions in the community will also be reflected in land values. Shifting social status in a neighborhood may cause land values to decrease or increase. Such a change in social conditions might be a consequence of changes in overall economic structure in the community which again might be an impact from the change in the transportation system. Disruption of a neighborhood, dislocation and so on may cause a shift in residential location of social groups, and thereby influence land values.

DIRECT EFFECTS ON THE COMMUNITY TAX BASE OF CHANGES IN LAND VALUES

It should be expected that changes in land values would have a direct bearing on the annual total tax revenue. However, this is not always the case. Two factors determine whether a change in land values will affect tax revenue: the tax rate and frequency of re-assessment.

As long as the tax rate is lower than the legal maximum tax rate, the total tax revenue is mainly determined by the needs of the budget. Total revenue has to balance total expenditures, and this consideration will determine the amount needed from taxes on local real estate. Both tax rate and total assessed land values might in this case be subject to political manipulation and have no influence at all on the final total tax revenue. In the case of maximum legal tax rates, on the other hand, the total income from local property taxes will be directly proportional to the total assessed property values within the community. Any change in total assessed land values thus may influence the tax income and the economic viability of the community depending on whether the assessed values are adjusted in order to reflect the real market values.

Right-of-way for railroads is subject to local taxes, but no taxes are paid for land when acquired for public roads. This may be a considerable part of a city, frequently ranging from 20 to 25% of the total area. Almost any kind of improvement of the transportation system includes additional taking of right-of-way for the facility. Thus less land is taxed, and, in the case of maximum legal tax rates, the result is a reduction in total tax revenue, unless otherwise compensated for. Perhaps the most frequently used way of compensating for this loss is to extend the community limits, and thus add taxable land.

In some cases the local government has to pay a part of or the entire cost for purchase of right-of-way as needed for improvement of the transportation system. In order to have a net economic gain (when only expenses of right-of-way and loss of revenue from real estate are considered), the increase in annual taxes has to be equal to or greater than the annual amortization of the expenses of right-of-way purchase. It should be noted that the entire purchase of right-of-way has to be finished some years before the main increase in value of the adjacent properties takes place and before there can be an increase in tax revenue caused by the impact of the improvement of the facility.

The intent of this brief discussion has been to show that there is no given answer as to whether or not changes in the real land values, caused by a change in the transportation system, have a direct effect upon local tax revenue. Taxation of real estate is to a high degree a question of local policy and of the need for revenues from taxation. If taxation is based on the real value of the land at a given time, then any fluctuation in land values will be reflected in the tax incomes. However, taxation policies can also be used to stimulate or force a desired land use pattern and are therefore not exclusively a way of providing revenues for public expenditures in the community.

The purposes of this chapter have been to outline and evaluate techniques of measuring land value and to suggest the potential usefulness of land value studies in the general area of transportation impact research. Potentially, changes in land value can serve as indirect indicators of other kinds of impact as well as directly affect the fiscal resources of a community. The next chapter will consider the results and techniques of previous research efforts as a prelude to the proposed methodology for this study.

FOOTNOTES

[1]Stanley F. Miller, Jr., "Effects of Proposed Highway Improvements on Property Values," National Cooperative Highway Research Program Report No. 114, Highway Research Board (1971), p.7.

[2]Ibid., pp. 7-8.

[3]As other discussions of impact on land value indicate, the "true value" of all land within an impacted area is difficult to determine or even define. (See, e.g., the discussion by Paul Zickefoose in "Economic Survey of Raton, New Mexico," New Mexico State Highway Department, Bulletin 37, May, 1968, pp. 39-40.) In choosing to base the measurement of land value on sales data alone, one must ignore the fact that land which is not sold also has a value. Sales prices may cause either under-estimates or over-estimates of property values, depending on the economic situation. For example, if only the marginally effected properties in an area change hands, sales prices can under-represent true value; on the other hand, if only the most viable are sold, sales prices can exaggerate average property values.

Nevertheless, since land value is a function of supply and demand, sales prices are indicators of a real market situation for land in a given category. Thus it may be said that although sales price is not an adequate indicator of "latent" or "unrealized" value, it does serve as a description of the actual market at a given time.

CHAPTER III. PREVIOUS RESEARCH

A complete review of the literature has been prepared previously and issued as a Research Report of this project.[1] The review focuses on impact on land use and land values and contains a detailed discussion of the methodologies used in previous research projects. No specific findings will be discussed here, but it is necessary to provide brief comment on the findings and methodologies most commonly used.

So far, practically all of the impact studies deal exclusively with the effect of interurban highways, mainly the interstate system and with the effect of circumferential or through routes in urban areas. Thus limited-access highways have received the most attention. Highway improvements studied are in most cases construction of new highways. Most of the previous research has concentrated on new interchange areas or bypass routes, locations where the most obvious changes take place. The primary investigators of highway impact are state and federal highway agencies and universities.

COMMENTS ON THE FINDINGS

The impact studies reviewed concentrate on impact from highway improvement. Even though the private automobile is the major mode of transportation today, these studies cannot reveal any information about the consequences of changes in air, rail or bus services. The studies show clearly that highway improvements have a significant impact, and usually a positive impact, on the areas along the facility, but not one of the studies reviewed evaluates the consequences of a reduction in service, as has been the case with rail service in most areas during the last two decades.

The previous highway impact studies provide a wealth of information, but some of their limitations should be noted. Many studies are more directed towards showing an impact, and the magnitude of the impact, than examining the cause/effect relationship. These studies are of great value in showing the impact of the investment in highway improvement, and consequently they justify the spending of public funds in terms of "non-highway user" cost and benefits. However, they are of less value as a tool for highway or community planners, as they cannot be used to predict impact of future changes in the highway system in a particular community. All of them support general observations about the development of adjacent land, the increase in business activity and increasing land values close to the new facility, but few of them are aimed at showing the impact on the community as an entire unit.

The fact that each community has its own characteristics in terms of economic and human resources, geographical location, etc., makes it difficult to use observed highway impact in one community to forecast impact of highway improvement in another community. This is possible only in the cases where community characteristics are included in the study, which is, unfortunately not generally done.

COMMENTS ON THE METHODOLOGIES USED

Different methodologies have been used to study impact of highway improvement, each of them having advantages and disadvantages. The most simple and most frequently used is the "before and after" technique. Here the impact simply is measured as the difference between the values of the characteristics studied before and the values after the changes. The major disadvantage is very obvious: the technique cannot relate the measured effect to a specific cause. With observations only at two time periods very little information is revealed about changes in the trend of the studied characteristics, and it is not possible to show the long term effect.

In an effort to isolate the effect of the highway improvement, the before-and-after technique is often combined with the "survey-control area" technique. However, in practice, the survey-control area technique has severe inherent limitations. The major problem is to find a control area which is similar to the survey area, in every respect except the influence of the highway improvement. This requirement is almost impossible to meet since the spatial distribution of the highway impact is not known in advance, and the entire area may be influenced in some way. Construction of a new facility may have a negative effect some distance from the facility where the control area has usually been chosen, thus causing the measured positive impact in the areas adjacent to the facility to be higher than the actual effect. If a valid control area could be found, there is no warranty that the study of the limited survey and control areas would give reliable information about the effect on a larger area, e.g., an integral small community. Consequently it is very questionable that this technique can be used to isolate the highway-induced impact on an area.

The "before and after" technique is also combined with a "multiple regression" technique in order to reveal cause/effect relationships behind the changes that took place between the two periods. This methodology requires more information about non-highway related factors, as highway related effect cannot be isolated before the analysis starts. In practice, it has been impossible to include all relevant factors in the analysis, partly because of the lack of information and partly because of lack of knowledge about how to determine the relevancy of, and how to quantify qualitative factors. However, these limitations do not apply to the methodology as such, but rather to its present state of development.

Techniques other than the above mentioned are also used in previous studies. The "case study" approach usually deals with rather detailed analysis of single events that have taken place nearby a highway facility. By examining selected cases with emphasis on their relationship to the highway, the case studies may indicate the variety and the extent of significant relationships attributable to the highway, but the results of such studies cannot be generalized and applied to other situations.

This brief discussion of the most commonly used methodologies in the previous transportation impact studies has revealed several shortcomings which should be observed when reviewing the findings from different studies. For future studies, the methodology should be carefully chosen according to the character of the study. The many shortcomings, however, clearly indicate the need for refined procedures when planning more comprehensive impact studies.

COMMENTS ON MODELING EFFORTS

Very little effort has been made to model the impact of highway improvement. This is probably caused by the complex cause/effect relationship between highway improvement and community characteristics and also by the fact that many important variables are qualitative or not quantifiable. As modeling efforts in most cases depend upon information for previous years from local records, available data may limit the number of different factors included in the analysis.

Mathematical models have been used to describe the influence on land development and land values of highway improvement. The modeling efforts have concentrated on regression models. Models describing changes in land values caused by highway improvements seem to have been the most successful, but these, too, have severe limitations.

As an example, one previous study will be discussed.[2] Two different sets of data, one from Indiana and another from Florida, were used to run a regression analysis of the change in land value as a function of different variables. The predictor variables included in this study were:

1. Parcel size (acres)
2. Time elapsed between completion of highway improvement and sale of parcel (months)
3. Type of highway improvement (interstate, primary or secondary highway)
4. Type of land use (residential, commercial, agricultural or vacant)
5. Type of area (urban, urban fringe or rural)
6. Type of access control (full, partial or none)

All but four of the 100 parcels in the Florida data included interstate highways with full access control. The regression analysis showed that the variables included in the regression equations gave an R^2 varying from 0.24 to 0.46 depending upon the form of the regression equation. Consequently, at most only 46% of the change in land values could be explained by the above mentioned variables.

The Indiana data (30 parcels) indicated a much stronger relation between change in land values and the independent variables. The regression analysis gave an R^2 of 0.87 and a coefficient of variation of 110%. Since some classes of the variables contained only a few observations, the regression equation is not presented as a reliable predictive model. According to the analysis, the type of highway improvement is the most important variable, followed by type of area, land use type, type of access control, time elasped after highway improvement, and size of parcel.

Even though the model based on the Indiana data rendered a relatively high correlation (R^2), the small number of transactions included in the analysis reduces the reliability of the model. Land values in general are not described by the model, as only the change in value was analyzed. Also, the model fails to include changes in land use and seems to be limited to cases where a new highway facility is constructed. Another consideration was the fact that this study was limited to "remainder parcels" which sold some time after the highway improvement. No information is available about the factors that influence an owner's decision to sell or not to sell a remainder parcel. The model, consequently, is not of general use for describing the changes in value of parcels adjacent to or in the proximity of highway improvement.

The study methodology outlined in the next chapter is dependent upon previous research. Both the limitations and the progress of other studies have been the source of the method to be developed and tested in this case study.

FOOTNOTES

[1] Lidvard Skorpa, Richard Dodge, C. Michael Walton and John Huddleston, "Transportation Impact Research: A Review of Previous Studies and a Recommended Methodology for the Study of Rural Communities," Council for Advanced Transportation Studies, University of Texas at Austin.

[2] Edward I. Isibor, "Modeling the Impact of Highway Improvements on the Value of Adjacent Land Parcels," Joint Highway Research Project, Purdue University.

CHAPTER IV. STUDY METHODOLOGY

WORKING HYPOTHESIS

The working hypothesis for this study is that land values generally reflect certain qualities of each property in an area. It is further assumed that this relationship may be described as a functional relationship between the factors in a set of the most significant qualities and characteristics of the parcel and the area. Hopefully, therefore, a study of a number of factors over a long enough time period will yield information about which factors are the most significant, how they can be used to model the functional relationship, and what are the parameters in a descriptive land value model for a certain area. The model is assumed to be general in terms of the factors needed to describe the property and its qualities, but it is specific for one area in terms of the parameters in the model. Thus, if the parameters for one specific community are known, the model will describe land value for any property in that area. At least, it is assumed that the land value of a group of properties, e.g., those with the same land use, can be described in a model.

More specifically, the hypothesis is that land value can generally be expressed as a function of qualitative or quantitative characteristics of the parcel, the community, existing or planned transportation system, and time. Empirical studies of land values and the corresponding factors should, hopefully, give the necessary information to evaluate such a descriptive model.

STUDY REQUIREMENTS

For a comprehensive study of the relationship between land use or land values and changes in transportation system, a series of requirements have to be met. These requirements deal mainly with the study area, the transportation system, and time.

1. Study area: The study area must include the entire community in order to determine the total effect on the community. In addition the methodology must make it possible to study the spatial distribution of the effects within the community. In order to study the cause/effect relationship in detail, information must be gathered and analyzed based on the individual properties.

The analysis should be based on real, comparable land values. To eliminate any subjective influence by the researchers, only market values as obtained in land property transactions should be used.

As transportation system characteristics in most cases are correlated with community characteristics, the study must include the factors needed to describe the specific community.

2. Transportation systems: The transportation system considered must include all transportation modes available in the study area during the study period. Also, the study should consider both regional/statewide systems and the local system in the area down to the accessibility to the parcels included in the study. Both increases and decreases in transportation services in the study period must be included. The analysis must include a sufficient number of factors describing the transportation system.

3. Time: The study period must be long enough to include important changes both in the community and the transportation system. Not only physical or operational changes should be considered, but also decisions about future changes in transportation services.

   The study should be continuous over time to show variation as a change of the trend, not merely single indications of the state before and the state after the change took place.

METHODOLOGY TO BE USED

This study is one part of a more comprehensive study of various categories of transportation impact on a small city in a rural area. Consequently the methodology used in this study has to be chosen in such a way that the results from this particular study can be tied to the results from the other separate studies in the research project to form one general comprehensive study. However, above all the methodology in this particular study must be able to reveal information about the specific study subject: changes in land value.

Specific Methodology

The community selected in the research project for the case study phase is Sealy, Texas, located in the highway corridor between Houston and San Antonio. The specific techniques to be used in this study will have to meet the requirements for study methodology listed previously. Thus the entire community will have to be included in the study area. This includes not only what is inside the city limits, but also the areas adjacent to the community potentially influenced by the changes in transportation system. This area is shown in Figure 4.1. As no "survey-control area" technique is involved, there is

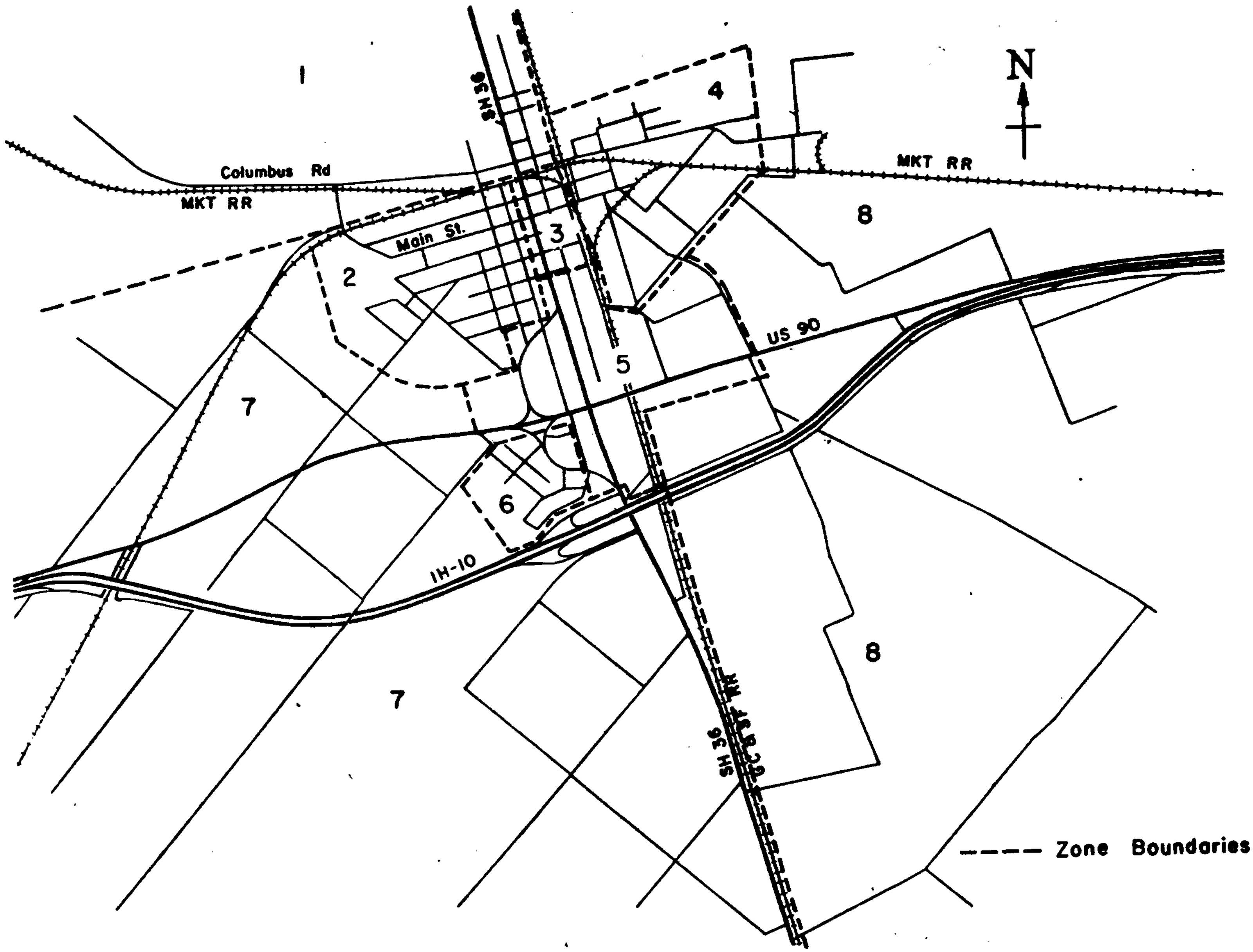


FIGURE 4.1. STUDY AREA, SEALY, TEXAS

just one geographical area examined in the study. However, in order to find the spatial distribution within the study area, the information will, with the exception of some area-wide variables, be tied to each individual property transaction studied. This will make it possible, by selection of the information to be entered in the statistical analysis, to study the property transactions with a set of common specified qualities or location. This can easily be done by means of a computer when the complete information from the case study is stored on tape in an appropriate data management system.

A rather detailed description of the existing transportation system for each period of time will be included. This information will be related partly to each property transaction and partly to the entire community. All factors that are common for the entire community, e.g., development stages of Interstate 10 from Houston to San Antonio and changes in railway services, will be included as functions of the time when the transaction took place. Information describing each particular parcel's connection to the interurban transportation system will be related to the individual transaction studied.

As the "survey-control area" technique is not involved, and the study does not deal only with repeated sales, the transportation impact on the community may be determined only by including in the model factors describing community characteristics. These factors are also included because of the close relationship between transportation development and community characteristics. With this technique transportation impact may not necessarily be explicitly expressed in the model, but the form of the model and the parameters may implicitly show the importance of the provided transportation system.

The study will be continuous in time over the entire 19 year study period. Each property transaction will be related to elapsed time after major decisions or actions in community or transportation development. Thus, the continuous trend in land values over the study period will be examined. Figure 4.2 shows the continuous study approach. To make corrections for general changes in the purchasing power of the dollar, each transaction will be adjusted according to the Consumer Price Index for the region.

The descriptive model for land values will be derived in two steps of statistical analysis, determining, first, which factors are the most significant, and secondly, what function of these factors can best describe the cause/effect relationship between land values and changes in transportation system. A standard statistical computer program will be used to find which factors, and what

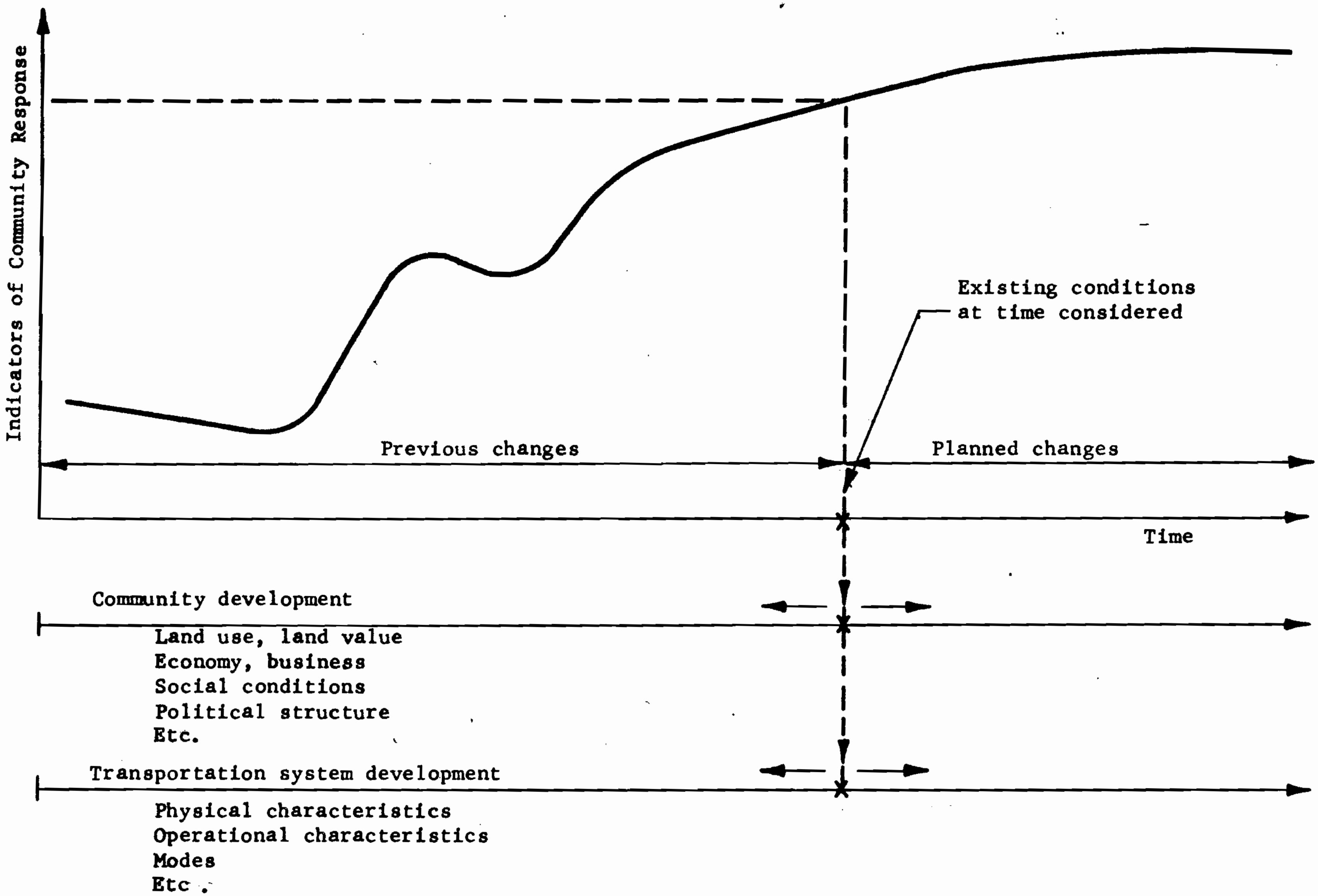


FIGURE 4.2. CONTINUOUS STUDY APPROACH

levels of these have the most influence on land values. Also interaction between the factors will be revealed. When this step is completed, multiple regression analysis will be used to determine which model, out of several possible models, can best describe the observed variations in land values in the study area over the study period.

As only information from one community is used in the empirical evaluation of the model, the model derived from this case study cannot be claimed to be of general character. Nevertheless, even though the model at this time will be used strictly as a descriptive model, it has a general form that would make it easy to use as a predictive model as well. In order to use the model for predicting land values, one would suppose a case where no transportation change had occurred. Then such factors as land use and population growth would be predicted for the "do nothing" situation and entered in the model. The total impact from any actual change in the transportation system on land values could then be measured as the difference between the areas under the "change" and "no change" curves for land value. This is illustrated in Figure 4.3.

Study Procedure

A study according to the methodology as outlined may be divided into six major steps as shown in Figure 4.4.

1. Evaluation of descriptive models for the factors to be included. Because the different factors may be either quantitative or qualitative, or a combination of several characteristics, some will have to be expressed in terms of indices or levels of quality. To determine the value of the indices or levels, descriptive models will have to be evaluated for the individual parcel, the entire community, and the interurban and local transportation system. The evaluation of these descriptive models, mainly because of limited time and resources available, will have to be based on experience from other studies and on subjective judgement about the relative importance of the factors involved.

2. Collection and processing of the necessary information, based on what is available in the selected community. The data processing will include calculation of indices and levels of quality according to the descriptive models.

3. Statistical analysis of the information by means of the AID program package. This is a statistical evaluation of the importance of the different factors according to homogeneous "sub-spaces" in the data, and consequently not biased by any assumed model.

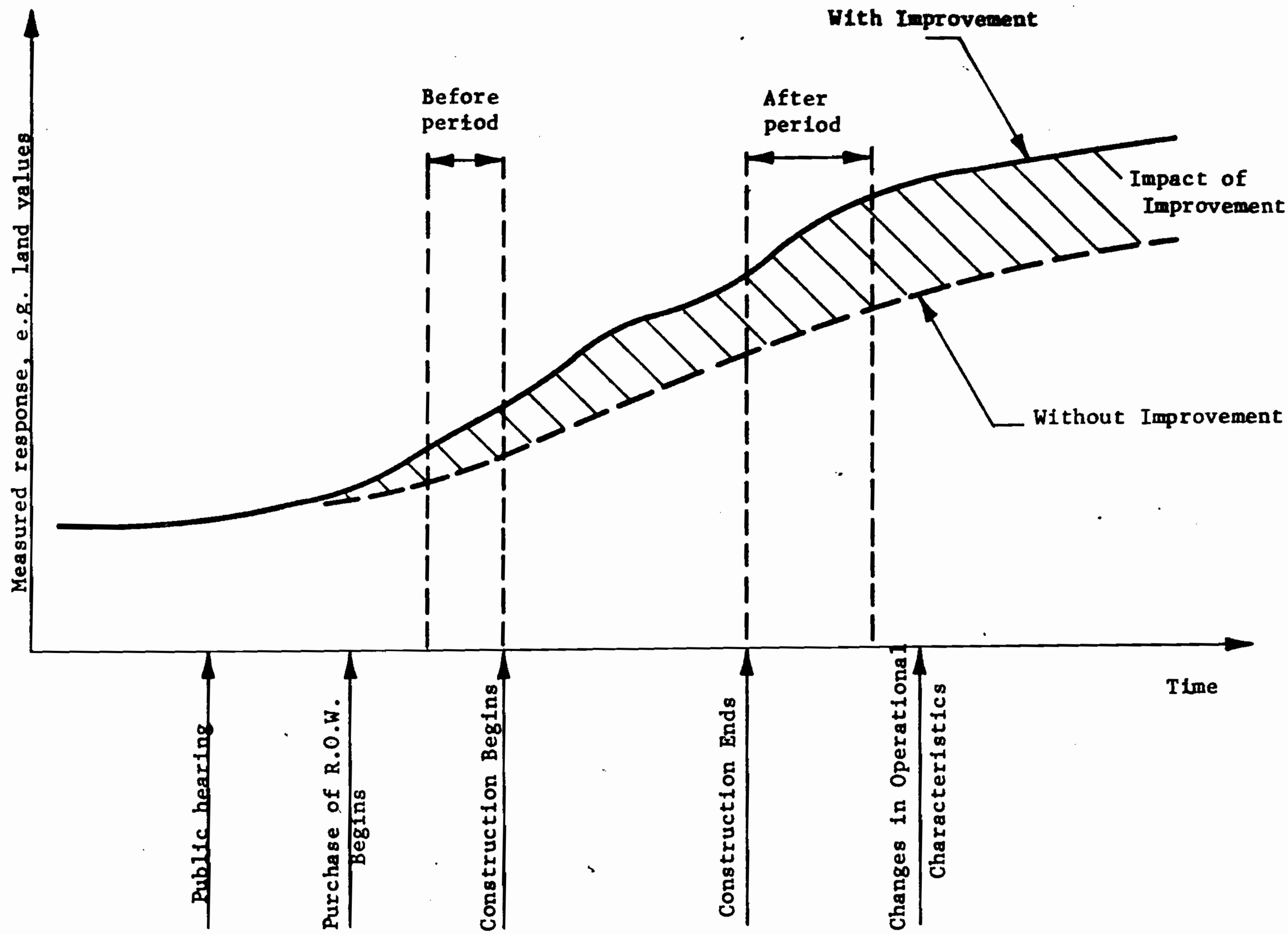


FIGURE 4.3. POSSIBLE EFFECT OF DIFFERENT PHASES IN HIGHWAY IMPROVEMENT

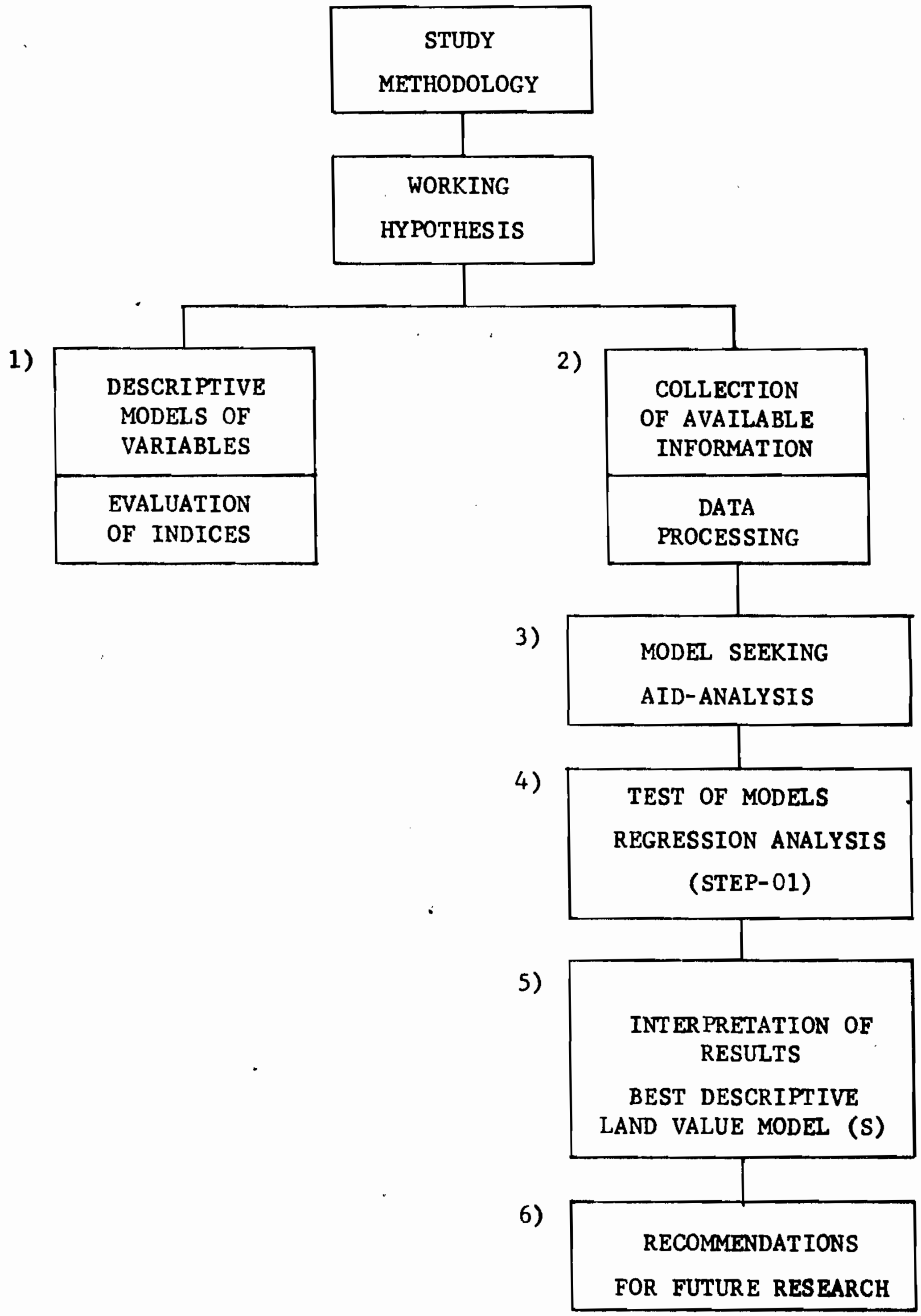


FIGURE 4.4 STUDY PROCEDURES

4. Multiple linear regression analysis by means of the STEP-01 program package. In this step the forms of the model will have to be assumed, and the "best" model in terms of statistical criteria can be found.

5. Interpretation of the research from the analysis and selection of the "best model." The findings must be checked against results from previous research and discrepancies explained. A descriptive model for land value in the community studied, and its limitations can be presented.

6. As a final step the experience from this case study should be summarized and recommendations for the general study phase outlined.

CHAPTER V. DESCRIPTIVE MODELS OF VARIABLES

The term "descriptive model" will be used describing the qualities and characteristics of a composite variable or a set of variables. The use of models, or indices, to express variables is necessitated by the complexity of the many factors influencing land values. In order to get an easily understandable expression for variation in land values, it will be helpful to group logically-related factors in sets of indices. This has been judged a feasible technique when it is necessary to combine quantitative and qualitative terms, assigning ratings and weights to different factors according to their importance.

In this part of the study, the most significant characteristics of the transportation system and of the community to be included in the analysis of land values must be determined. This step is very important since no statistical analysis can be better than the input data. Each of the individual variables has to be expressed in a meaningful way in order to reveal both their significance and the true cause/effect relationship between the factors and land values. The evaluation and testing of these indices is suggested as the subject for a separate study. Being a part of the land value study, this step cannot be given the desired degree of attention. It is hoped, however, that the different analysis in this study will reveal any major shortcoming of the indices and consequently make it easier to refine the indices to be used in the later general study phase.

In this continuous study of market land values, it is reasonable to focus the attention on two major subjects, each consisting of two parts:

1. The transportation system serving the community
    a. The interurban transportation system
    b. The local transportation system
2. The community
    a. Area-wide community characteristics
    b. Individual parcel characteristics

This grouping of the individual factors in the cause/effect relationship will make it easier to handle the complex problem. As the task of this study is not to prove an impact on the community caused by a preordained set of factors, the first task is to determine what factors should be included. The experience from previous impact studies, however, has made it possible to make a preliminary selection of factors.

DESCRIPTION OF THE INTERURBAN TRANSPORTATION SYSTEM

The history of development of rural communities has a close connection to the development of the transportation system. Rural cities, being focal points for marketing of agricultural products, grew up along existing interurban transportation systems. For rural cities the two most important transportation modes are normally railroad and automobile. Although some rural areas are served by air transport, interurban air traffic is not at present of major significance in many rural areas. This is particularly true in our study. The increasing importance of air travel has had its impact on small communities, as in the cases where regional air terminals are located in rural areas, and any future shift in interurban travel from rail or highway to air may have great impact, especially in currently inaccessible areas.

Consequently, all transportation modes serving in, or having previously served the area, must be included in such a study. Because not all modes are important in every case, and in order to simplify the description of the interurban transportation system, it seems reasonable to describe each mode separately. This will also make it easier to see the connection between the community development and the impact from changes in individual modes. The descriptive model for each mode must be able to describe physical and operational characteristics at a given time, as well as changes in these characteristics over time.

The demand for different transportation modes compared to the actual supply at any given time may be critical for a small community. In most cases, demand will be reflected in the actual use of the different facilities. However, a transportation system serving mainly interurban traffic may not necessarily serve the individual community's demand for a regional transportation system. There is no current information concerning the transportation demand in the case study area. For this reason it will be assumed that throughout the study period the existing supply of transportation facilities has always exceeded the demand.

Quality of Interurban Highway Facilities

This index is meant to express the quality of a highway corridor as experienced by an interurban driver or passenger. To a large extent this index will also express the level of service for long distance traffic with origin or destination in the community, as this traffic tends to use the primary highway system. Entering this index in the analysis will possibly show whether or not the community impact from the highway facility is influenced by the quality of the facility as well as its presence and relative location.

General Requirements for the Index. The quality of the interurban highway corridor in most cases varies over time. Due to the continuous wear on the highways, seasonal climatic variations and specific maintenance procedures, there may be a cyclic variation in the quality. In addition, there usually will be an ongoing improvement of the corridor in terms of upgrading existing facilities and construction of new ones. Some conditions not fully explained in terms of the physical characteristics of the highway may also influence the quality of the facility. The best example of such a condition is the roadside development which directly influences facilities with no or partial access control.

Consequently, the model for the interurban highway quality index in principle should meet the following requirements in describing physical and operational characteristics:

1. Be able to describe any type of facility;
2. Be able to describe changes in provided service, including both improvement and reduction in service over time; and,
3. Be able to describe the entire route, not a section only.

A number of factors may be used to describe physical and operational characteristics of a highway facility. The three most commonly used are speed, capacity and traffic volume. The reason for using these characteristics is that they are affected by several other characteristics including design features and traffic characteristics. These three characteristics may also be used to derive an expression of the "level of service" provided by a specific facility at a given time. Generally it will be found that neither the physical nor the operational characteristics alone can provide a complete description of the quality of a facility as experienced by the user.

The physical characteristics are dependent on the actual design of the facility. These characteristics include horizontal and vertical alignment (as determined by curvatures and grades), sight distances, lane width and number of lanes, shoulders and lateral clearances, separation of traffic lanes, type of pavement surface, interchange spacing, access control, and special safety features.

Operational characteristics also have a close connection to the actual design. Characteristics like speed, driving economy and safety are perhaps the ones with the closest connection. Other characteristics are riding quality, traffic volumes, freedom to maneuver, traffic interruptions, changes in legal speed limits, and traffic composition in terms of percentage of truck traffic and the ratio between local and long distance traffic. Most of these characteristics can be measured in quantitative terms, but characteristics like freedom to maneuver or riding quality may largely depend on the subjective judgement of the individual driver.

Evaluation of the Form of the Index. The term "level of service" is established in the Highway Capacity Manual.[1] This measure of the quality of the driving conditions is mainly based on two criteria, speed and volume/capacity ratio. Thus both physical and operational characteristics are included. This expression for the quality of the driving conditions on a facility at a given time is well established, and it seems reasonable to base the interurban highway quality index in this study on level of service. However, this term alone is not sufficient, and different correction factors will be proposed in order to account for other important factors.

A variety of correction factors may be added depending on the actual study. Such factors may include facility type, pavement riding quality, roadside development, level of maintenance, climatic conditions and so on. The most important factor seems to be facility type. It is evident that different facility types, e.g., divided and undivided, have different qualities even though the level of service might be the same. Both highway links in this study, U.S. 90 and IH 10 between San Antonio and Houston, have been operational during part of the period at level of service B. In spite of this, IH 10 must be considered a facility of higher quality than U.S. 90. One major source of contrast between different types of facilities is different accident rates. The lower the accident rate, the higher is the quality of the facility. The classification in "highway type" will also generally describe access control. However, for facilities with no or partial access control, the degree of roadside development will have to be taken into account since it will effect the ratio between local and through traffic, speed reductions, and accident rates. Information about the riding quality of the route is not included in this study, as the pavement serviceability index is currently being evaluated.

For this particular study the final highway quality index will be based on level of service, highway facility type and roadside development. The general form will be:

$$I_{route} = I_{LS} \cdot I_{FT} \cdot I_{RD}$$

where I_{route} = interurban highway route quality index

I_{LS} = index describing "level of service"

I_{FT} = index describing facility type

I_{RD} = index describing roadside development

According to this model, all of the partial indices are given equal weight. However, in determining each of them, the relative influence of each factor is determined by the values chosen.

Variation of Indices over Time. Each of the indices will have to be given a form appropriate to describe improvement of the route over time. Graphically this is shown in Figure 5.1. This simplified figure does not show reduction in quality due to increased traffic volume, temporary reduction during the construction period, deterioration of the surface, and so on. The quality index at a given time, I_D, will depend on the percent of completion, D, of the new facility (or the improvement at that time). When the new facility replaces the old, I_D may be expressed as $I_D = (1-D)\ I_{OLD} + D \cdot I_{NEW}$. When a new facility comes in addition to the old, I_D may be expressed as $I_D = I_{OLD} + D \cdot I_{NEW}$. Degree of completion may be measured in different ways; in this particular study the number of miles completed will be used.

Partial Index, Level of Services. In order to use the six levels of service as evaluated in the Highway Capacity Manual as an index, each level has to be assigned a certain value. A proposed set of values is shown in Table 5.1.

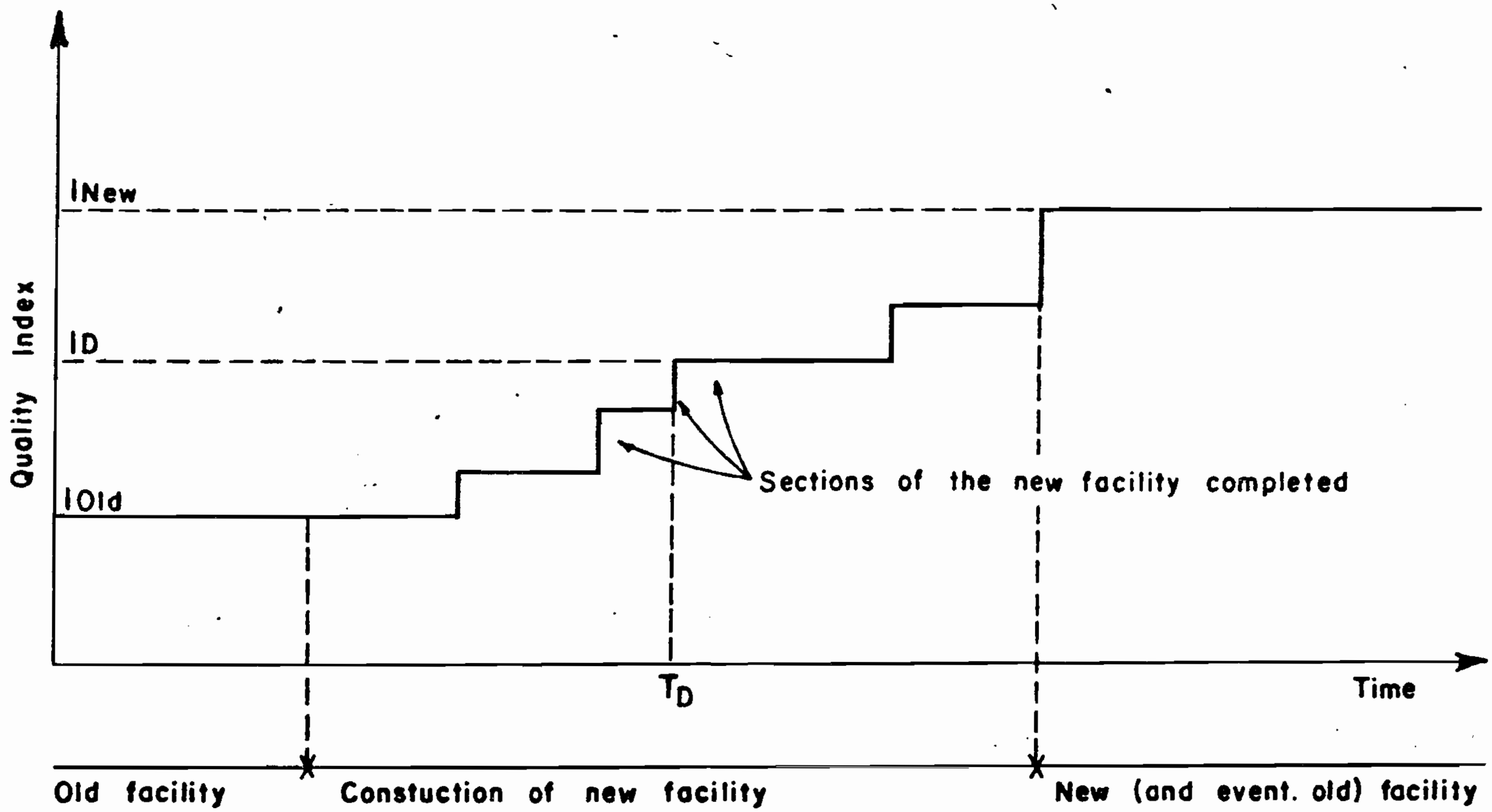


FIGURE 5.1.: VARIATION IN QUALITY INDEX OVER TIME
FOR INTERURBAN HIGHWAY ROUTE

TABLE 5.1.

PROPOSED INDICES, I_{LS}, FOR DIFFERENT LEVELS OF SERVICE

ON INTERURBAN HIGHWAY ROUTE

Level of Service as Defined in HCM	Proposed Index, I_{LS}
A	1.0
B	0.9
C	0.75
D	0.5
E	0.25
F	0.05

The indices should express the relative difference in driving conditions as experienced by the average driver. One way of determining the indices, therefore, would be to let a panel of drivers rate driving conditions under varying levels of services on the same facility. This is beyond the scope of this particular study, and the proposed indices are evaluated on the basis of the general description of the different levels of service as given in the Highway Capacity Manual and general driver experience.

The degree of freedom to maneuver is considered to be the most important quality in rating level of service. The superior driver condition, level of service A, with no or little restrictions in maneuverability due to presence of other vehicles, is given the value 1.0. Level of service F, with extremely bad driver conditions due to forced flow, is given the value 0.05. The other levels of service will be somewhere in between these two extremes. Level of service B gives the driver reasonable freedom to choose speed and lane, and there is little restriction due to other drivers. For this reason, this level of service is rated 0.90. Level of service E, with volumes near the capacity of the highway, represents driving conditions wherein the individual driver has very little or no freedom to choose his own speed. Compared to the index for level of service A, this driving condition is rated 0.25, thereby assuming that the conditions under level of service A generally can be judged four times better than the conditions under level of service E. Levels of service C and D represent the conditions between level of service B and level of service E. The indices chosen are 0.75 and 0.5 for level of service C and D respectively.

Partial Index, Facility Type. The most obvious difference between a two-lane and a divided four-lane highway facility might be capacity. However, capacity is implicitly included in level of service and will consequently not be used to distinguish between different types of highway facilities. For this reason the evaluation of an index to characterize facility type mainly will be based on safety considerations. Since such characteristics as driving economy and driving comfort are different for various types of facilities, they will be included as far as possible.

Traffic accident records from all over the nation show a substantial difference in accident rates, expressed in terms of accidents per 100 million vehicle miles, for different types of highways. Table 5.2 shows the most characteristic differences.

TABLE 5.2

ACCIDENT RATES ON RURAL HIGHWAYS RELATED TO DESIGN STANDARDS. (SOURCE: SOLOMON: "ACCIDENTS ON RURAL HIGHWAYS RELATED TO SPEED DRIVER AND VEHICLE." BPR, USSPC. JULY 1964.)

Facility Type	Rate, total reported accidents
Freeway	1.00
Divided, controlled access(1)	1.69
Four-lane, divided(2)	2.91
Four-lane undivided	4.09
Two-lane	2.38

1) Primarily four-lane roads
2) No access control

As can be seen, a freeway may generally be considered almost 2.5 times as safe as a two-lane facility Also, facilities with controlled access show a lower accident rate than highways with no access control. Consequently it seems reasonable to differentiate between both facility types in terms of whether the facility is divided or undivided, the number of lanes, and the degree of access control.

Driving cost is mainly a function of highway design. Generally the cost decreases with increase in design standard. A freeway in most cases is designed with better horizontal and vertical alignment than a two-lane facility and thus has lower operating costs. In addition, traffic flow generally is smoother, which also contributes to lower driving expenses. Frequent traffic interruptions on a two-lane facility with no or little access control causes the driver to be alert all the time. Compared to a high class freeway, a two-lane road has less driver comfort. For these reasons the facility type index will be proposed as a modified expression of the relative accident rates. The proposed indices are shown in Table 5.3.

TABLE 5.3 PROPOSED INDICES, I_{FT}, FOR DIFFERENT TYPES OF INTERURBAN HIGHWAY FACILITIES

	Facility Type		Access Control Full	Access Control Partial	Access Control None
Divided	Freeway		1.0	-	-
Divided	Primary	4 lanes	0.8	0.6	0.4
Un-divided	Primary	4 lanes	-	0.5	0.35
Un-divided	Primary	2 lanes	-	0.3	0.25
Un-divided	Secondary	2 lanes	-	0.25	0.2

The proposed modification reduces the relative quality of a two-lane facility compared to a freeway from 1/2.5 to 1/4. Depending on access control and separation of lanes for traffic of opposite direction, other primary roads are rated in the range from 0.25 to 1.00. The modifications should be based on calculations of differences in driving costs for various types of facilities, and different sets should be made for different types of terrain. The values chosen in this particular study are subjectively derived and should consequently not be considered of general character.

Partial Index, Roadside Development. To adjust for the influence of roadside development on roads with partial or no access control, the following simple formula is proposed:

$$I_{RD} = \frac{K-N}{K}$$

where I_{RD} = roadside influence index

N = number of cities the highway originally passes through

K = constant

As the other partial indices are multiplied by this index in order to find the resulting highway route quality index, I_{RD} has to be 1.0 when there is no roadside development, which is normally the case when $N = 0$. The value of the constant, K, will have to be based on a judgement of the individual route, size of the cities and so on. For this particular study $K = 50$ is chosen. In Sealy the old U.S. 90 passed through ten small cities between San Antonio and Houston. This reduces by a factor of 0.8 the quality of U.S. 90 compared to a hypothetical interurban route, identical to the real U.S. 90 in terms of design and traffic volumes, but bypassing all the cities enroute. To reduce the influence from roadside development the constant, K, would have to be increased.

Interurban Highway Use

Traffic volumes and traffic composition are parts of the operational characteristics of a highway. These characteristics are two of the factors determining level of service and are, consequently, implicitly expressed in the interurban highway route quality index. These two characteristics, however, are considered to be of importance in more than the determination of the quality of the interurban route. The continuous flow of potential customers for goods and services is perhaps of greater importance for the communities along the highway than the quality of the route by itself. The interurban travelers may increase the demand for goods and services beyond that created by the inhabitants in the area. The specific location of these potential customers will have an influence on the location and intensity of business activities and consequently on land values in the area.

Generally it can be said that the potential demand increases as the traffic volume increases. Traffic volume on the highway facility may therefore be considered the most important characteristic. Such other traffic characteristics as distribution of vehicle types and trip purpose probably also affect the degree of influence exerted on business activities by long distance travelers.

The role of highways in the movement of goods has been increasing over the last decade. The number of trucking companies serving the area and the total volume of freight are important aspects of the total level of service provided by the transportation system. In order to simplify this particular study, it is assumed that the provided freight services have developed at the same rate as the increase in total traffic volume on the interurban highway route.

No information about Origin-Destination for the traffic on U.S. 90/IH 10 in the vicinity of Sealy is available. In this particular study highway use will, therefore, be expressed in terms of total average daily traffic volume. The traffic volume varies over the route according to the variation in local traffic using the interurban facility. To get an approximate figure for the average traffic volume over the route, traffic volumes crossing the county line between Colorado and Austin Counties, approximately 7 miles west of Sealy, will be used.

Interurban Public Transportation Services

The only public transportation services available in Sealy during the study period are rail and bus. These two transportation modes have different characteristics and history of development. Although separate indices should be used for each of them, in principle, the two indices may have the same form. Both modes operate on fixed schedules along certain routes. Rail routes are fixed by location of tracks, while bus routes follow existing highways. Bus routes consequently have a greater flexibility in serving the existing demand at a given time. Four factors are considered relevant to a description of provided public transportation services: type of service, frequency, number of routes serving the community, and relative travel speed.

Bus Service Index. There has been no change in bus service to Sealy during the study period in terms of number of routes or number of daily stops. Travel speed has increased because of highway improvement, and the freight service on buses has also been improved. These changes, however, are considered to have had a minor effect since the number of routes and frequencies are constant. Being a constant over time, this index will have no effect in the regression analysis. For this reason, no bus service index is included.

Rail Service Index. While highway-related services have increased, rail services in most areas have declined sharply the last two decades. Reduced traffic volumes have resulted in abandonment of routes and reduced service on still existing routes. In order to describe the reduction in provided rail services the following index will be proposed:

$$I_R = \sum_{\text{routes}} \cdot \sum_{\substack{\text{types of} \\ \text{service}}} R \cdot F$$

where I_R = rail service index

R = type of service available

F = frequency of stops in the community

The two different types of services provided by the railroad are passenger and freight traffic. The relative importance of these services may have changed over time, but in order to simplify, each type will be given a certain weight for the entire study period. Passenger traffic is assumed to have been of the greatest importance for the community of the two types of service provided. This conclusion is reached on the basis of interviews with railroad employees and the local reaction to changes in the services as expressed in the local newspaper. In this particular study, the values $R = 2$ and $R = 1$ are used respectively for passenger and freight services.

The frequency of the provided service can be measured in terms of number of daily stops in each direction on each route. One daily stop in each direction is considered a minimum requirement for any service provided, and the following values for frequency are chosen to represent the difference in service:

More than one stop daily:	$F = 2$
One stop daily:	$F = 1$
Less than one stop daily:	$F = 0$

This grouping is based on the actual frequencies on the lines serving Sealy in the study period, and the same values are assumed for both types of services.

Connection to Nearest SMSA

No information is available about the existing connection between Sealy and the surrounding urban areas over the study period in terms of origin and destination, number of daily commuters, trade, recreational activities and so on. The connection may be said to have two aspects: the dependence upon services outside the community and the ease with which they can be reached. As the demand is not known, the index should express how changes in the transportation system have influenced the effort needed to reach the services.

Houston is the dominating urban center in the area, and for that reason only the connection to Houston will be included in the index for this case study, It should be stressed that this index is not included in the analysis only because of Sealy's dependence upon services in Houston. It might be of equal importance to take into consideration the possibilities for people in Houston to fulfill their needs and desires in Sealy. These needs and desires may include opportunities for housing, land ownership, business expansion and recreational activities. The ease of travelling between Sealy and Houston, may be expressed in terms of available modes, travel time and possible capacity restraint. Private automobile and bus may be considered together the most important modes during the study period. For both of them, travel time is a function of the improvement of the highway route between Sealy and Houston. As there has been no capacity restraint during the time period under consideration, the average travel time in minutes will be used as an index of the connection between Sealy and Houston in this study.

DESCRIPTION OF THE LOCAL TRANSPORTATION SYSTEM

In most of the small cities in rural America no local public transportation is available. In individual communities, walking and bicycling may be of significance, but these would be exceptions rather than the general case. Consequently the private automobile may be considered the predominant mode of local transportation, and the different indices will refer primarily to accessibility by automobile and driving conditions.

Connection between Community and Interurban Transportation Systems

This index should describe the connection between the local and the interurban transportation system and be able to reflect all major changes. Traditionally bus and rail services have had a very good connection to the community in terms of location to central activities. In most cities the bus and the railroad depots are located within, or very close to the CBD. The connection to the rail system is usually inflexible, since railroad depots have a fixed location, regardless of the direction of city growth. In Sealy neither existing bus nor railroad depots have changed location during the study period. For this reason no index is included for connection to public transportation facilities.

Influence of Highway Connection. A community's connection to the interurban highway facilities, on the other hand, is likely to change when improvements of the facility are undertaken. In the extreme case where no physical connection between a new facility and the community exists at all, the influence on the relative spatial distribution of land value may be negligible. However, there may still be an effect in terms of changes in absolute land values or changes of the normal land value trend. This is illustrated in Figure 5.2.

A possible change in the spatial distribution of land values in the case of a good connection to the new highway facility is also shown in Figure 5.2. Because of the attraction from the new facility, location of central activities tends to shift over toward the new facility. This may result in an increase in land values adjacent to the new highway and a decrease in land values on the other side of the city. Thus the new facility tends to cause a specific change in normal development patterns.

Design of Highway Connection. Many factors will possibly affect the actual changes of the connection in each individual case. The two most obvious factors to be included in the connection index are distance between the new facility and the community, and the actual design of the connection. The design of the connection will include both interchange type and degree of access from the adjacent land. Some of the more common types of interchanges are sketched on Figure 5.3. The two at-grade interchanges, here called types A and type B, are the only ones where there is a direct conflict between local and through traffic. Consequently these two types reduce the quality of traffic conditions of the interurban highway drastically. However, these two interchange types allow all turning movements and give good access to the highway facility. Interchange B on the figure is the better of the two, as crossing traffic on the main highway is kept to a minimum.

The interchange types C, D, and E in Figure 5.3 are all grade-separated, and there is no direct conflict between local and through traffic. The degree of access varies for the three types. The grade-separated Y-interchange, type E, gives good access in one direction, but no access in the other direction.

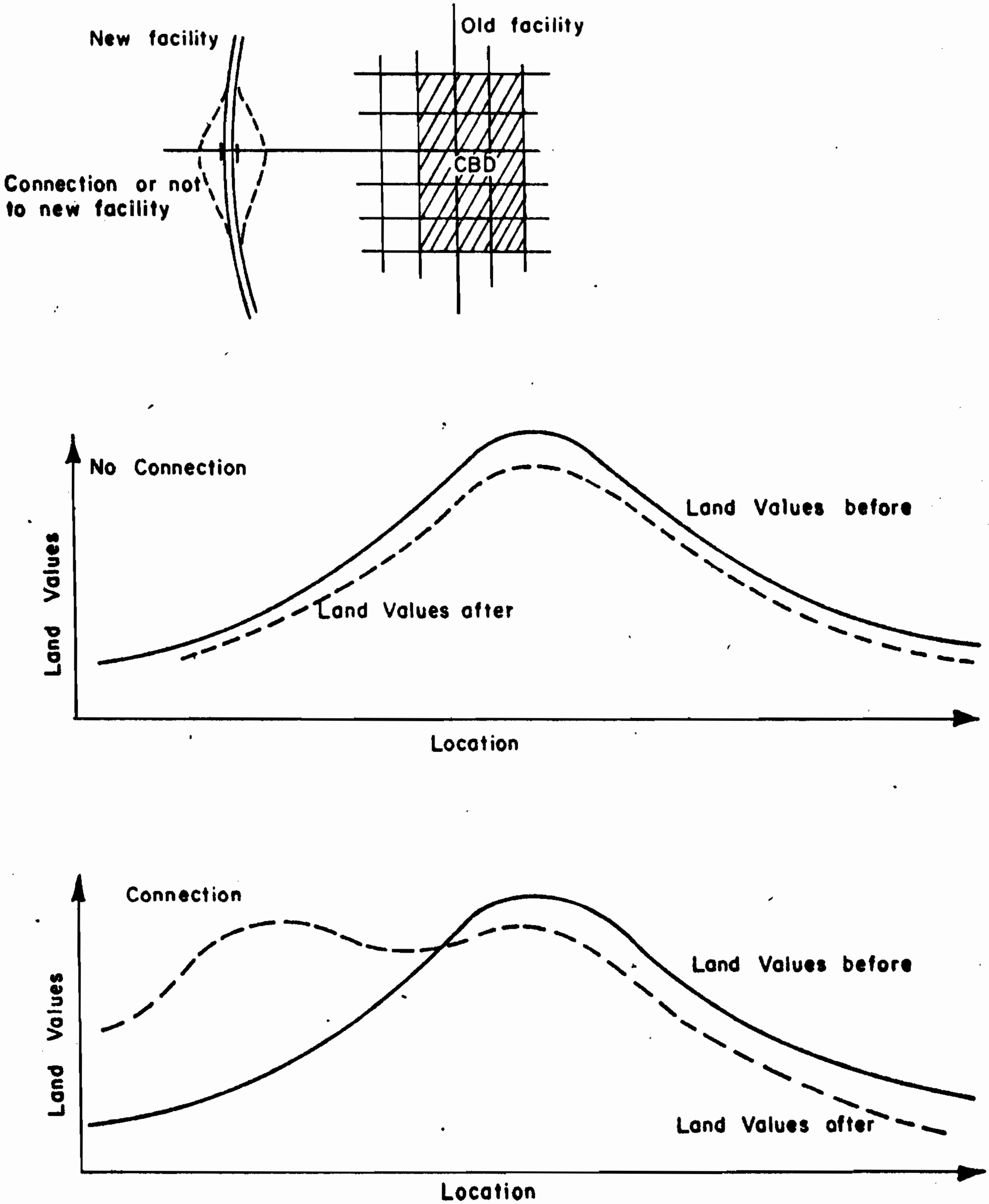


FIGURE 5.2 INFLUENCE ON SPATIAL DISTRIBUTION OF LAND VALUES BY DEGREE OF CONNECTION TO NEW FACILITY

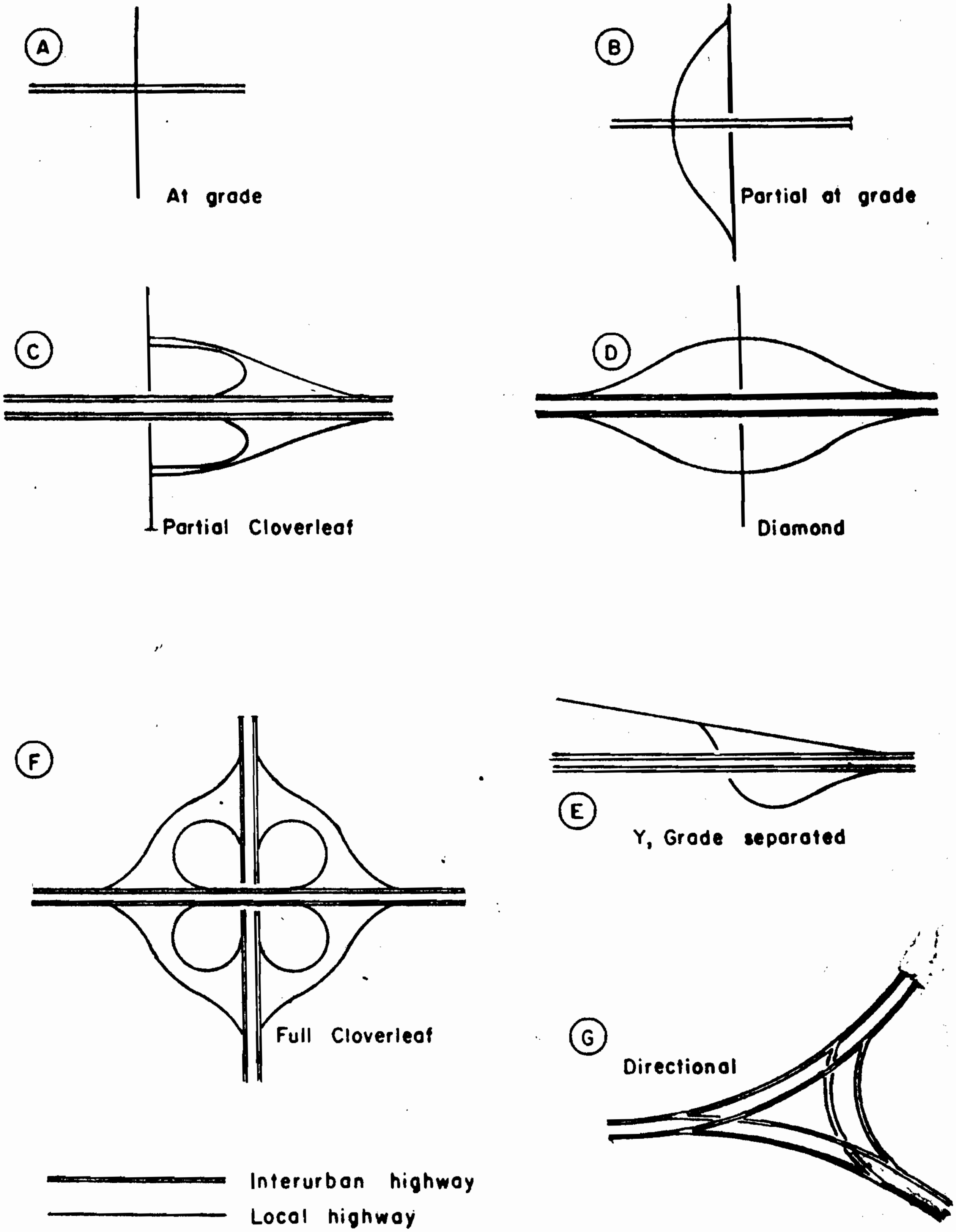


FIGURE 5.3. DIFFERENT TYPES OF INTERCHANGES

This type is commonly used where a new bypass route takes off from the old route. Types C and D provide for all turning movements. Diamond interchange type D gives the most direct access to that quadrant of the interchange first approached on the driver's right. The ramps of the diamond provide more accessibility to this quadrant than the partial cloverleaf.

Interchange types F and G are normally used for interchanges between two major highways. With the ramps connected to the local arterial network, the full cloverleaf, type F, gives very good access. On the contrary, directional interchanges, see type G, usually give no access to either highway from adjacent land.

The degree of access is also a function of access control on the major highway. Most two-lane rural highways have no access control and consequently provide direct access to all adjacent properties. Four-lane divided interurban highway facilities usually have full access control. However, access from adjacent properties to a freeway may be provided by means of frontage roads. Continuous frontage road along a freeway can provide very good access to abutting land.

Highway Connection Index

Given the above considerations, it is expected that four important factors in the highway connection index will be 1) number of interchanges, 2) interchange type, 3) distance from the community and 4) degree of access control to the facility. Although no single case study can explain the effect of different combinations of these features, a general form for a connection index is proposed and used to describe the connections between Sealy and U.S. 90 and Sealy and I.H. 10.

To simplify the index, interchange types are divided into two categories: at-grade and grade-separated. (Even though different types of grade-separated interchanges considered individually may provide different degrees of connection, the effect of all interchanges serving the community is not considered dependent on the design of an individual interchange). The degree of access to the highway is assessed subjectively according to one of three levels. The level in each case depends on the kind of access control, the existence or lack of frontage roads, and the presence of any natural barriers. Distance to the community is rated according to whether or not the facility is within or outside a one mile radius of the CBD area.

Thus, the general index proposed for highway connection takes the following form:

$$I_c = \frac{N}{2}(A+G) + D$$

where

I_c = connection index

N = number of interchanges

A = degree of access to the highway

good = 3

fair = 2

bad = 1

G = interchange type

at grade = 1

grade separated = 2

D = distance rating

1 - outside a one mile radius

2 - within a one mile radius

(The number of interchanges is divided by two simply to adjust for the relative importance of this factor).

The following calculations were made for the two highway connections in Sealy:

$$\text{U.S. } 90 \quad \frac{5}{2}(2+1) + 2 = 9.5$$

$$\text{I.H. } 10 \quad \frac{3}{2}(1+2) + 1 = 5.5$$

General Local Traffic Conditions

For some communities changes in the local traffic conditions may be more important for land use and land values than changes in the interurban facilities. This index is meant to describe the overall conditions for local traffic in the area, and not accessibility to any specific property or activity. Several characteristics may be included describing the changes due to local improvements as well as changes due to improvements on the interurban highway. Surfacing of the streets, traffic routing and signing, parking regulations, street widening and so on are all examples of local improvements. Reduced traffic congestion due to removal of through traffic is an example of an important change due to improvements of the major highway.

Generally there will be little information available about long term changes in local traffic conditions. If traffic volumes on the major facilities and the local street network are known, these, compared to street and interchange capacities, may be used for an index. Another possible characteristic to be used is the variation in traffic accident rates in the area. Generally improvements of the traffic conditions will result in a decrease in the number of traffic accidents. Traffic accidents on the local street network will frequently result in property damages, injuries, and fatalities. The number of accidents may consequently have a direct psychological effect upon the local population, in addition to being an indicator of the local traffic condition. The change in trend over a time period rather than the absolute number each year is expected to possibly affect land uses and land values.

For this particular study the overall local traffic conditions will be assigned to one of three subjectively rated qualitative levels according to changes in the trend in total number of reported traffic accidents on SH-36 and U.S. 90 in Sealy.

Individual Parcel Accessibility

Urban land theories[2] usually attribute variation in land values to variation in location and accessibility. Three different terms for the individual parcel accessibility may be considered to have the most important bearing upon changes in land values. These are accessibility to the central business district (CBD), to public transportation terminals, and to the major interurban highway facility. Generally accessibility is measured in terms of travel time between two points. For this study, however, it is found more appropriate to describe accessibility as a function of distance and adjustment factors. This information can easily be obtained from maps, aerial photographs and inspection of the area. Also, this makes it possible to include more considerations than driving time in the accessibility index.

The indices for accessibility are meant to give the relative difference in accessibility for the individual parcels in the community. Consequently they are not expected to be the best description of the accessibility to one given parcel in absolute terms.

Accessibility to CBD-Area. Traditionally the CBD-area in small rural cities has been a very distinct and limited area. To some degree this has changed over the last decade, but in most cases one area is still the major focal point for local trips. The adjusted distance between the parcel under consideration and the border of a defined CBD-area will be proposed for this index. Shortest distance measured along existing streets will be used. The adjustment factor will have to take care of delays caused by intersections, railroad crossings, and the effect of the type of street surface. There should in principle be different adjustment factors for each individual parcel. However, as this would require detailed information about the street network over the entire study period, a set of three different factors will be used. This set will describe three qualitative levels, the appropriate level being determined by a subjective judgement of the shortest route. The values 0.8, 1.0 and 1.2 are proposed for the corresponding levels good, fair and bad conditions along the measured route. The proposed index for accessibility to CBD will consequently take the form:

$$I_{CBD} = D_{CBD} \cdot A_p$$

where I_{CBD} = accessibility index

D_{CBD} = shortest distance to CBD-area

A_p = adjustment factor for the parcel.

<u>Accessibility to Public Transportation Terminals</u>. Bus and railroad depots are the transfer points between different modes of transportation and also between intercity and local trips. Accessibility to these two terminals may therefore be considered an important link in the public transportation system.

Accessibility to each of these two terminals will be expressed by distance from the parcel under consideration and an adjustment factor as explained above. It is not known which one of the two terminals is the most important. Being located relatively close to each other in Sealy, the average value will be proposed. Thus the index will be:

$$I_{PT} = (D_{BD} + D_{RD}) \cdot A_p / 2$$

where I_{PT} = accessibility index

D_{BD} = distance to bus depot

D_{RD} = distance to railroad depot

A_p = street adjustment factor for the parcel

Accessibility to interurban highway. While the two previous accessibility indices were mainly for local travel, this index has to describe how easy it is to locate and reach the considered parcel for a highway traveler not familiar with the local street network. Consequently accessibility to the interurban highway will not be a question only of a simple adjustment in the distance between the parcel and the highway facility.

It is felt that three characteristics are the most important: distance, interchange type, and parcel location relative to the off ramp. Distance will be measured from the parcel under consideration to the nearest interchange on the existing interurban highway facility at the time of sale. Distance is measured along major streets from the parcel to the interchange. No adjustment factor for the street conditions is used since a considerable part of this trip will be on the local highway. The rationale behind the different ways of measuring distance to CBD and to highway interchange is the possible difference in local versus non-local travelers in the two cases. Traffic to the parcel from the highway is expected to be more non-local than traffic from the CBD-area and will tend to follow major streets.

Interchange type for the nearest highway interchange in each case will to a large extent affect accessibility from the highway route, as well as access to the highway. Referring to Figure 5.3, the interchanges may be divided into three classes, describing the possibility for, and ease of turning movements. As shown interchange types A, B, C, D, and F provide all turning movements at the interchange, but the partial cloverleaf, and grade separated Y, type E, is considered less convenient than the other types because they do not provide all turning movements. The three proposed classifications of interchange types, and corresponding levels of quality, T. are:

All turning movements (at grade, full cloverleaf, diamond)	= 3
All turning movements, partial cloverleaf	= 2
Restricted turning movements	= 1

Location of a parcel relative to the off ramp will be used to describe how easy a parcel is to locate when leaving the interurban highway. This characteristic will partly be a function of visibility from the interurban highway, interchange quadrant, and location relative to the local highway. Good visibility is considered important as is location to the local highway. The highest quality level includes parcels located in the two first right-hand quadrants on grade-separated interchanges and those located on either side near at grade interchanges. Table 5.4 shows proposed quality levels, L:

TABLE 5.4 QUALITY LEVELS OF PARCEL LOCATION RELATIVE TO OFF-RAMPS

Parcel Location		Visibility			
		Good		Bad	
		Quadrant		Quadrant	
		good	fair	good	fair
Location to Local Highway	good	4	3	2	1
	bad	2	2	1	1

Table 5.4 cannot show all possible locations, and hence subjective judgements about the specific locations will have to be used.

The following index for accessibility to the interurban highway facility will be used:

$$I_{HWY} = (T + L) / (D_{HWY} + 1)$$

where I_{HWY} = accessibility index

T = interchange type classification

L = quality of parcel location

D_{HWY} = distance to nearest interchange

Thus this index will fall in the range

$$0 < I_{HWY} \leq 7.0$$

DESCRIPTION OF THE COMMUNITY

To date a simple way of describing the community factors affecting land value has not been developed. Economic and social characteristics are perhaps the most important aspects of a community because they describe the kind and intensity of activities as well as human resources and the possibilities for turning potential for growth and development into reality. However, because of the lack of descriptive techniques for dealing with these two important factors, and also because of the lack of information about economic and social conditions in Sealy at this time, these community characteristics cannot be included in the analysis of land values.

Some community characteristics are common for the entire area, others are related to neighborhoods, and some have to be related to individual parcels. In order to explain the spatial variation of land values in the community each characteristic must be related to its smallest unit and not to any area-wide average. In this particular study most of the characteristics examined have to be related to each individual parcel, and they are therefore listed under "description of the individual parcel."

Population Growth Rate

This characteristic is considered common for the entire study area as there is no available information about how the population in different neighborhoods or subdivisions has varied over the study period. Generally an increase in population growth rate results in a higher demand for housing. This may affect land values in existing residential areas, but also increase the annual amount of agricultural or vacant land developed for housing. In addition to population growth it is important to know the distribution according to sex and age, as this distribution to a high degree affects the demand for housing. Population growth also affects the demand for goods and services, thereby affecting business and social activities and possibly influencing land values for certain land use categories.

Because of available population data for Sealy, only population growth rate will be included in this study. Since market values are functions of the existing supply and demand at a given time, actual growth rate in each specific year will be used in the analysis.

Neighborhood Quality

Usually a community is comprised of distinct neighborhood areas. The boundaries for these neighborhoods may be created by natural or man-made barriers and by the tendency for people of the same social and economic status to cluster together. Because of difference in needs and desires, and purchasing power, land values are expected to vary according to varying neighborhood characteristics. It is a known phenomenon that land values in a neighborhood are sensitive to changes in social and economic status and the general appearance of the properties.

The age of the neighborhood and maintenance of area will generally influence land values. This factor is, however, closely connected to the social conditions. Consequently neighborhood quality may be classified in terms of social status and appearance of the properties. Appearance will have to be based on a subjective judgement of the age of the neighborhood, the homogenity of land use, and the visual impact of the properties. A proposed index for neighborhood quality is shown in Table 5.5.

TABLE 5.5 NEIGHBORHOOD QUALITY INDEX FOR RESIDENTIAL AREAS (Rating 4 is the highest quality)

Social Status	Appearance		
	Good	Fair	Bad
High income	4	3	---
Medium income	3	2	2
Low income	---	1	1

The indicated neighborhood quality index in Table 5.5 applies especially to residential areas. For land uses like commercial and industrial the rating will have to be based mainly on appearance. For agricultural land use social status and appearance are expected to be of little significance. In this case the index should express the property's potential to be turned into a higher land use class.

DESCRIPTION OF INDIVIDUAL PARCELS

Land Value

In this study land value is defined as market value unless otherwise stated. As the data in this study are collected from actual transactions, the market value for the parcel is obtained. This value is the result of negotiations between buyer and seller according to the desires and needs and the actual supply and demand. To get an expression for the market value at any particular time, a parcel of land may be appraised. However, this is a highly theoretical value as long as there is no demand for the parcel in terms of a buyer.

To make the different transactions comparable, the value will be expressed in terms of a unit price, dollars per acre. The most common unit in a CBD-area is dollars per square foot, but it is more appropriate to use the same unit for all transactions. Also, as the purchasing power of the dollar has been subject to change over time, adjustment will be made according to changes in the Consumer Price Index. The index for the Houston area is used, which should reflect the changes in Sealy. The general Consumer Price Index is used, as no specific index for land values is available. The base year chosen is 1950, and the unit prices are stated in 1950 constant dollars. Table A5.1 in the Appendix shows the actual changes in the Consumer Price Index during the study period.

Size

Previous research has shown that the size of the parcel has an influence on the unit price. Size of the parcel is easily measured with one acre used as the unit. It is common practice in most trades that quantity has an influence on the unit price, but in the case of land transactions the sub-division into smaller parcels is expected to be especially important. Consequently it could be desirable to know the degree of sub-division in addition to the actual size. However, since sub-division into smaller lots can mean change to a better land use, it is felt that the information about land use before and after the transaction yields the same information; therefore, size expressed in acres is included in the analysis.

Land Use

Land is in most cases acquired to fulfill a certain need or desire of the buyer. This need or desire is generally reflected in land use. Usually a change in land use of a parcel follows a change in ownership. It might also be a result of an owner's attempt to maximize his net return from the given parcel of land as times and economic conditions change.

To account for changes in land use, land use before and after each transaction will be included in the analysis. Land use before will be the use at the time of transaction, since this tends to reflect the previous owner's judgement of "best use." Land use after the change in ownership will be the last land use before the next transaction or current land use if there is no later change in ownership. Land use immediately after the transaction will not be included because the buyer's long term plans for utilization of the parcel in most cases will determine how much he is willing to pay for the land.

Land use can be classified in a number of ways according to the actual purpose of the study. It is desirable to use standard specifications as far as possible, such as the "Standard Land Use Coding Manual,"[3] but it is felt that a special classification is preferable for this particular study. Previous impact studies seem to indicate that highway related activities should be separated as one land use group and also that the number of groups should be limited. Even though a detailed land use survey showing all land use activities as specified in the coding manual would be desirable, there is no detailed information about the changes in land use over the study period. Consequently the land use categories were made as simple as possible.

According to the general experience from previous impact studies seven classes will be used:

1. Public land. All land owned by the public serving public needs. Another important characteristic of this land use group is that it is not likely that a parcel will be sold to a private party again.
2. Agricultural. All land used for agricultural purposes.
3. Vacant. All land held for future use, and at the time considered not utilized or occupied for any specific purpose. May or may not have structures on it.
4. Industrial. All land used for industrial or manufacturing purposes.
5. Residential. Land occupied for any type of residential development.
6. Non-highway commercial. All types of commercial land use more directed towards the local public than the highway travelers.
7. Highway commercial. Land used for commercial services mainly serving the highway travelers.

The ranking of categories should be chosen to reflect the general level of market value, and the relative weight of the different categories determined for each individual study case. In cases when the activities on a parcel include more than one category, the "highest" land use according to the ranking chosen for this study will be used. Consequently large residential lots where there is some agricultural activity will be classified residential. Studies of the information gathered in Sealy give some indication of what the relative ranking for land use possibly should be. The average land value for each land use category, over the entire study area and the entire study period, is shown in Table 5.6. The wide variation may be caused partly by some systematic variation in other variables, and a less extreme variation in the relative weights for each use category has been chosen. The chosen weights are also shown in Table 5.6. The observations for public land use were too few to draw any conclusions about the relative rank for that category, but the observed values generally were in the same range as for vacant lots.

TABLE 5.6

CHOSEN RELATIVE RANKING WEIGHTS AND OBSERVED DIFFERENCES IN AVERAGE LAND VALUES PER LAND USE CATEGORY

Land Use Category	Chosen Ranking Weight	Land Use Before Transaction	Land Use After Transaction
Public	3	--	4.9
Agricultural	1	1.4	0.9
Vacant	3	6.6	6.5
Industrial	4	19.2	9.4
Residential	5	28.3	18.6
Non-highway commercial	8	71.6	65.3
Highway commercial	7	49.2	36.3

Site Quality

This is a qualitative measurement which to a large extent depends on the actual use and individual judgement of the parcel. Some characteristics, however, might be of general interest. The shape of a parcel is of great importance to the owner. Generally a rectangular shape will give the most economical utilization of a lot as long as it is not too narrow. Irregular shape with narrow angles is usually a disadvantage. The common practice in land appraising is the use of different rates for different parts of bigger lots, the rate declining the more distant from the street or the highway. Thus the unit price will decrease with the decreasing ratio of frontage length/parcel size. As in many cases there is no information available about the actual frontage length, therefore a classification will not be based on actual measured frontage length/parcel size-ratio. The location of a lot in the block is also of significanct importance. Generally the value of the lot increases with increasing front length, the highest value being assessed for a corner lot. Also the slope on the parcel may be crucial for the desirable land use. Other important characteristics may be exposure to flooding, soil conditions, noise level, vegetation and so on.

For this study, it is not possible to collect information about all the above-mentioned factors for each parcel. In order to simplify without completely neglecting site quality, each parcel will be classified according to one out of three levels based on a subjective judgement. The three levels used are: good, fair, and poor, and the corresponding relative values are three, two, and one. The classification will mainly be based on shape, frontage length/parcel size-ratio, and location in the block.

Date of Transaction

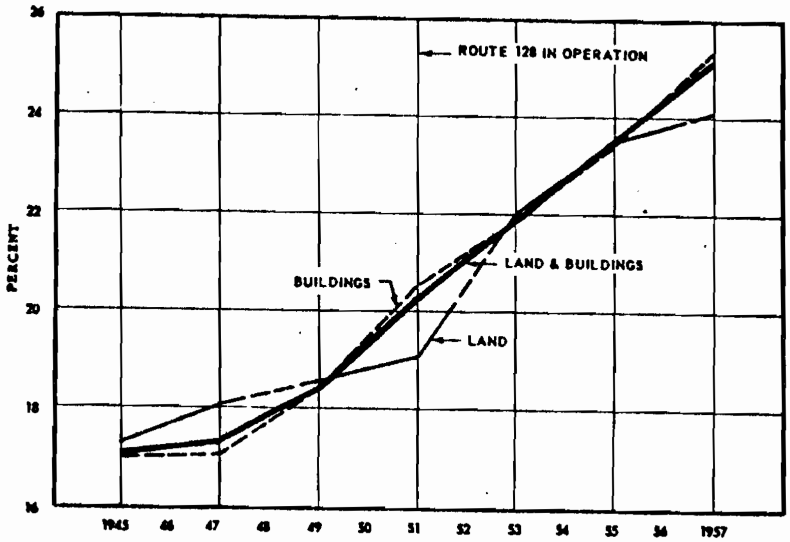
The date for each land transaction included in the study is recorded. The actual time in itself is not the most important factor; what is of interest is the time between changes, in terms of decisions or actions, in the transportation system or community characteristics and the time of the transaction. In this particular study there are four major changes in the transportation system giving rise to questions in which time is an important factor. First, did the announcement of the new bypass route, IH 10, cause any change in the land value pattern? Did the acquiring of land to right-of-way for the new IH 10 cause any changes? Has there been any measurable change since the opening of the new highway facility? Did the sharp decrease in railroad services cause any change in the land value pattern? In order to get an answer to these questions, four variables, expressing time elapsed after each of these changes in the transportation system will be included in the analysis.

Improvements

In addition to use, land may be classified as improved or unimproved depending upon whether or not there is a structure on it. This study deals with land values, but, except for open land, it has not been possible to find the market value for the land alone. Any attempt to separate values for land and structures for improved lots would be based on an unknown degree of accuracy, and this might influence the results from the statistical analysis. The relative proportion between value for land and improvement will vary widely. However, it is assumed that there is an overall relationship between land value and market value, as more money may be used for improvement and structures the more valuable is the land. This assumption is supported by findings from a study on Route 128 around Boston.[4] This study found that, as an overall picture, the value of both land and buildings increased at an approximate equal rate over the study period. The findings from the study are shown in Figure 5.4.

The information gathered in Sealy makes it possible to study the relationship between unit market value ($/acre) for improved and unimproved parcels in the community. By plotting land value for improved and unimproved parcels with common characteristics, it is possible to see a clear general trend. The result is plotted in Figure 5.5. The common characteristics include both spatial distribution, social conditions, parcel characteristics, and time of sale. As can be seen from the figure, unit values for unimproved parcels were generally in the range of 20 percent of the corresponding value for improved parcels. This result is important for the analysis in this study. As both land and improvements have experienced the same changes in value due to changes in other factors, they do not have to be analyzed separately.

It is evident, however, that the accuracy with which the model can describe land value for the individual parcel will suffer from the lack of a qualitative index for improvements. Such an index could have been included for current transactions as the structures could have been visually inspected. For earlier transactions, it would be impossible to include an improvement quality rating with a reasonable degree of accuracy. For this reason the only differentiation made will be between "improved" and "unimproved" parcels.



Assessed values in the adjacent Band Area of Lexington expressed as a percentage of assessed values in the entire town.

FIGURE 5.4

VARIATION IN ASSESSED VALUES FOR LAND AND FOR BUILDINGS IN AN AREA ADJACENT TO A NEW HIGHWAY FACILITY

(SOURCE: BONE, A. J. and Wohl, M.: "MASSACHUSETTS ROUTE 128 IMPACT STUDY," HRB - BULLETIN 227, pp. 21-49, 1959).

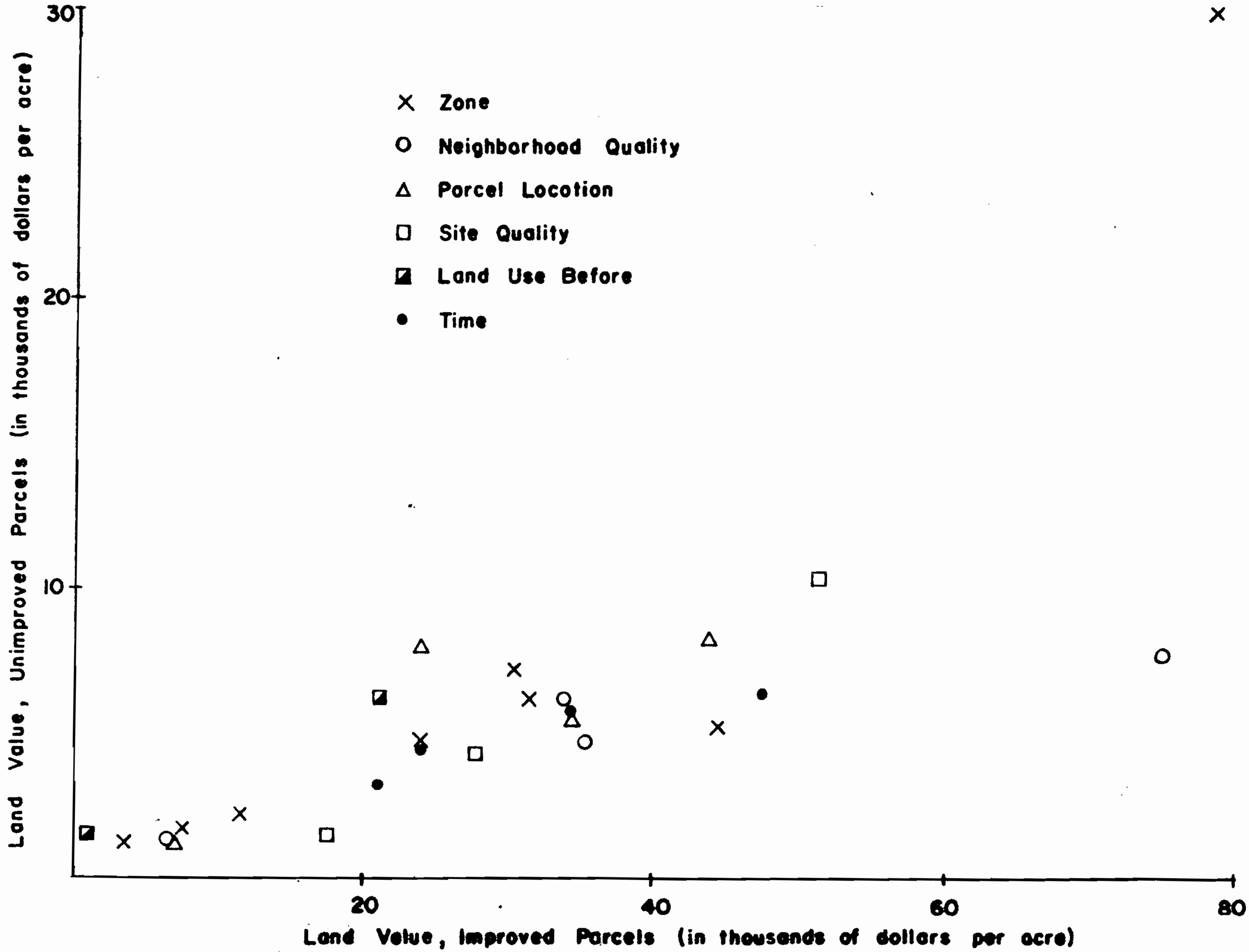


FIGURE 5.5.: COMPARISON OF LAND VALUES FOR IMPROVED AND UN-IMPROVED PARCELS, SEALY

Summary

The indices proposed in this chapter are meant to describe the various aspects of the community, the transportation system, and the individual parcels of land which interact to influence land value. They should not be regarded as an exhaustive set of variables, but rather as tentative groupings of those variables which are thought a priori to be of potential significance. The subsequent analysis should indicate their usefulness as descriptive indices in a particular case, as well as the need for refinement of the forms proposed and the need for the addition of other factors not accounted for in this initial phase of model development. Thus, though they are proposed in a general form, these indices are to be regarded as of hypothetical value for testing in specific cases.

FOOTNOTES

[1] For detailed information about the term "level of service," see pp. 78-87 in "Highway Capacity Manual 1965," Highway Research Board Special Report 87.

[2] As an example, see Johann H. von Thünen, Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie, Hamburg, 1826.

[3] A standard system for identifying and coding land use activities is given in "Standard Land Use Coding Manual," U. S. Department of Transportation.

[4] A. J. Bone and Martin Wohl, "Massachusetts Route 128 Impact Study," Highway Research Board Bulletin 227, pp. 21-49.

CHAPTER VI. AVAILABLE INFORMATION

Studies of small cities frequently suffer from inadequate public records, as the bookkeeping system is often insufficient. This was also the case in the study of Sealy. Some important information consequently had to be gathered from private sources, from studies of aerial photographs, and by visual inspection. Much of the information sought concerned qualitative levels, and these had to be subjectively determined according to the procedures outlined in the previous chapter.

LAND TRANSACTIONS

Sources and Information

The most important factor in this study is land value. Different sources have been used in previous studies of land values, including assessed value for tax purposes, revenue stamps on deeds, and sales prices from deeds. Most studies have concluded that these sources cannot be used reliably to describe market value. In this study the possibilities for using assessed value for tax purposes were examined first. Records from the Austin County Tax Collector, spanning the period 1950 - 1972, were microfilmed, and the changes in value over the study period for a majority of the properties within the city limits were studied. The records, unfortunately, apparently failed to reflect the changes in land values, and because of a lack of specific procedures for reassessment, it was felt that this source could not be used in order to determine market value.

However, the private Bellville Abstract and Title Insurance Company made their files on owners' title policies in Sealy available to the researchers. No information for the time period 1950 - 1955 is available. For this reason the study period in this particular study was changed from 1950 - 1970 to 1955 - 1973. The change in the original study period does not present any problem in the fulfillment of the study requirements presented previously (Chapter IV.). The extension from 1970 to 1973 is in fact desirable in order to examine the long term effects of the construction of IH 10, bypassing Sealy. While information about every individual parcel in the community could be obtained from the County Tax Collector's Records, the abstract company's records yield information about a limited number of properties. The information available, however, may be considered to yield the exact sales price from the transactions included in the records, making it possible to base the analysis on

SAMPLING OF INFORMATION

If information about market value for each individual parcel sold during the entire study period had been available, an appropriate group could have been chosen to assure a statistically valid sample. A sample has to be representative for an entire population of events, in terms of distribution, mean and variance. In order to reveal the cause/effect relationship between land values and other given factors, the sample should include events representing all combinations and levels of factors chosen as independent variables. The great number of variables included in this study would require an extensive sample which could not be gathered with the time and resources available.

In terms of numbers, the maximum limit for the sample is the total number of transactions in the study area over the entire study period. This sample would reveal complete information about changes in market value in the study area. However, there is no requirement for buyer or seller to record the actual price when a transaction takes place. Due to limited resources in this study, the most complete sample is the total set of transactions where the actual sales price is known and where all of the other factors included in the analysis can be determined with reasonable accuracy.

The only readily available source of market land values was the record of title policies from Bellville Abstract and Title Company. The information recorded included the names of the buyer and seller, price, date of transaction, and, in most cases, the size of parcel and the subdivision in which it was located. In this study the names of the grantor and grantee are kept confidential and have only been used to locate supplementary information when needed. Not all of the transactions recorded in the owners' title policies could be used as it was not possible to determine the exact location of all property or the value of some of the other characteristics needed. Consequently the sample is chosen according to the information available, and not according to any sampling technique. This fact will tend to reduce the reliability of the model to be developed, as the social and economic characteristics of seller or buyer may influence who takes out an owner's title insurance policy.

VERIFICATION OF SAMPLE

A total of 611 property transactions is included in the sample. It was not possible to list all transactions that have taken place in the study area over the study period, and therefore, the sample is not known as a percentage of total number of transactions. A study of transfers of ownership in most areas of Sealy was made from the County Tax Assessor's Records. This study indicates that the sample includes about 10 percent of all land transfers[1] in the time period 1955 - 1959, 25 percent in the period 1960 - 1964, and 50 percent in the period 1965 - 1970. Table A.6.1. in the Appendix shows the figures for each subdivision. The most important changes in the transportation system took place after 1960, and the sample size is considered sufficient for this most important part of the study period. Table A.6.2. shows the yearly distribution of the transactions included in the sample.

Table A.6.3. in the Appendix shows the distribution of transactions over time periods and by categories of land use. As can be seen, there is a fairly even distribution for all land use groups, except for public and industrial land uses. Because only one sale of public owned land is included, no conclusion can be drawn about this category. Table A.6.4. shows the distribution of transactions of improved and unimproved parcels over time periods. The total sample is split on 305 unimproved and 306 improved parcels.

In order to find the spatial distribution of the sample over the study area, the transactions are listed according to zones (see Figure 4.1) in Table A.6.5. The table indicates that all zones have a fairly good representation. Table A.6.6. shows the distribution according to neighborhood quality index, which partly expresses social conditions. Here, too, each category has a fairly good representation.

It is not possible to state the validity of the sample in statistical terms. However, as the subgroupings of the sample according to important characteristics show, the sample is fairly representative for the different characteristics of the study area throughout the entire study period. Thus the sample is considered valid for use in an evaluation of the cause/effect relationship between land values and changes in transportation system and community characteristics.

TRANSPORTATION SYSTEM

Interurban Highway Route

Information about the highway route between San Antonio and Houston has been obtained from the Texas Highway Department, partly from the District Engineers in Districts 12, 13, and 15, and partly from the main headquarters in Austin. The information covers both physical and operational characteristics over the entire study period.

Physical Characteristics

U.S. 90 was the major interurban highway route at the beginning of the study period. Except for a 12-mile section between Houston and Addix, U.S. 90 was a two-lane facility primarily constructed with concrete pavement varying in width from 20 to 22 feet. The shoulders were 5 - 7 feet wide, and the alignment had grades up to five percent and horizontal curves up to 3°. Sight distance was restricted on numerous sections, and there were extensive no-passing zones. Railroad underpasses had vertical clearances as low as 14'0", and there was one at grade railroad crossing. The highway passed through ten cities with populations of about 1000 or more; Seguin, Luling, Waelder, Flatonia, Schulenburg, Weimar, Columbus, Sealy, Brookshire and Katy. There was no access control to the highway.

The construction of IH 10 lasted until 1972, when the new facility had replaced U.S. 90 over the entire route. The information gathered includes date for the start and end of construction on each highway section. Thus the degree of completion of the new facility at any given time can easily be found. Degree of completion is here defined as the length of new facility open to traffic in each time period, divided by total highway corridor length. Table A.6.7. and Figure A.6.1. in the Appendix show when construction was finished on the different sections of IH 10, degrees of completion, and number of cities not bypassed.

IH 10 is a four-lane divided highway facility. The traffic lanes are 12 feet wide, and the paved shoulders are ten feet wide on the right side and a minimum of four feet on the left side. Horizontal curvature is restricted to 3°, and the grades are limited to three percent. All grade separations have a minimum clearance of 16'0". All interchanges are grade separated, and there is full access control over the entire route. Frontage roads are provided when required in order to provide access to abutting properties.

While average values are used for characteristics of the highway route as a whole, the characteristics of the section passing through or bypassing Sealy are subject to more detailed analysis. Three different references in time are expected to be of importance for the trend in land development and land values: the dates when the location of the new facility was known, when purchase of right-of-way started, and when construction of the bypass route was completed. The respective years are 1958, 1959, and 1967.

The physical connection between the interurban facility and the community changed extensively when the access-controlled IH 10 replaced the old U.S. 90. Calculations of the "connection to highway" index (see Chapter V) results in the value 9.5 for U.S. 90, and 5.5 for IH 10, expressing that Sealy had a more direct physical connection to U.S. 90 than to the new IH 10. Figure 4.1 shows the highway system in Sealy.

Operational Characteristics

The available information on traffic volumes covers stations along the entire route, each station with traffic counts every third year. The traffic volume varies along the route at a given time. In order to simplify, traffic volume for the highway route is represented by the traffic volume in a given section. Studies of traffic variation along the route showed that the station on the county line between Austin and Colorado counties represents fairly well an average for the route and is used in this study to represent traffic volume on U.S. 90/IH 10 between San Antonio and Houston. Figure A.6.2. in the Appendix shows the variation in traffic volume over time. Speed observations at a location nine miles west of Sealy during the period 1964 - 1973 reveal a steady increase in average speed. As seen on Figure A.6.3. in the Appendix, the opening of IH 10 did not result in an abnormally high increase in the average speed for all vehicles.

Average level of service for the sections of U.S. 90 and IH 10 in operation are calculated according to the traffic volume of the route, average speed, and geometric design averages. These calculations show that the sections of U.S. 90 in use operated under level of service B except for the two years 1970 and 1971. IH 10 has operated under level of service A except for 1972 and 1973 when level of service dropped to B. The index "Quality of Interurban Highway Route" is evaluated in Chapter V. Table A6.8 and Figure A6.4 in the Appendix show the variation in this index over the period 1955 - 1973. The index varies from 0.25 in 1955 to 0.90 in 1973. A drop in the index in 1970 is mainly caused by the drop in level of service from B to C on the remaining sections of the two-lane U.S. 90.

The index "Connection to Nearest SMSA" (see Chapter V) is defined as travel time in minutes between Sealy and the nearest main shopping centers in Houston. For the period 1955 to 1967, the interchange between IH 10 and IH 45 is used as point of destination in Houston; from 1968 to the present, the distance is measured to a point 6 miles west of the interchange to reflect the development of the major shopping centers in the western part of Houston. Speed development is based on the actual speed survey on U.S. 90/IH 10 in the period 1964 - 1973 and speed trends as given for two-lane facilities in AASHO Blue-book for the period 1955 - 1964.[6] The calculated travel time between Sealy and Houston over the entire study period is given in Table A6.8 in the Appendix.

Public Transportation

Today, interurban commercial bus service is the only mode of public transportation serving passenger traffic in Sealy. No information is available about the number of bus passengers. The number of routes serving Sealy and the number of daily stops have, according to local sources, not changed over the study period. The 1973 bus schedule for Sealy is shown in Table A6.9 in the Appendix.

Information about railroad services was obtained from several sources. The information, however, is restricted to those routes having stops in Sealy and the number of daily stops. As yet no information about passenger or freight volumes has been obtained. The last passenger train stopped in Sealy in 1968. Freight services, however, are still available on a daily basis. The rail service index as explained in Chapter V has been calculated from the available information. As shown in Table A6.10 in the Appendix, this index varies from 10 in 1955 to 1 in 1973, clearly indicating the reduction of railroad services available to the community during the last two decades.

Local Traffic Condition

All information about traffic volumes on the local street and highway network in Sealy was obtained from the Texas Highway Department. The city has not made any survey of traffic conditions. Before 1965, the Texas

Highway Department traffic counts did not include any station within the city limits; consequently there is no information available about traffic volumes on any street in the first half of the study period. However, some features are evident. Figure 6.1 shows traffic volumes from 1956, 1965 and 1967 where available. As can be seen from the figure, there has been a steady increase in traffic volumes in the area over the study period, except for the section of U.S. 90 passing through Sealy. Opening of the IH 10 bypass route reduced the 1967 traffic volumes on U.S. 90 to less than half of the 1965 traffic level. Other parts of the local network were also affected by the bypass route.

As discussed in Chapter V, the number of traffic accidents in the area reflects the local traffic conditions. The Texas Highway Department keeps records over all registered traffic accidents on all roads under their jurisdiction, including those within city limits. Thus records for U.S. 90 and SH 36 are available. Because of the way the accidents are located over the study period, records from a 12.6 mile section of SH 36 and a 4.1-mile section of U.S. 90 are included in this study in order to make the figures comparable over time. Accidents on the bypass route of IH 10 are not considered because the amount of local traffic there is relatively small and no pedestrians are involved.

The number of registered fatal and injury traffic accidents on the local parts of U.S. 90 and SH 36 are shown on Figure A6.5 in the Appendix. Up until 1961 the number of accidents is fairly constant, then seems to increase sharply until 1967. The general trend after 1967 seems to be a decreasing number of accidents. These considerations of the accident trend have led to the conclusion that the relative local traffic conditions over the study period may be characterized as fair in the period 1955 - 1961, bad between 1961 and 1967, and good after 1967.

There is not enough available information about street surfacing, maintenance level and parking conditions to include these factors in the analysis.

COMMUNITY CHARACTERISTICS

Area-wide Characteristics

The population in Sealy has been steadily increasing over the study period. Between 1955 and 1970 the annual growth in absolute figures was fairly

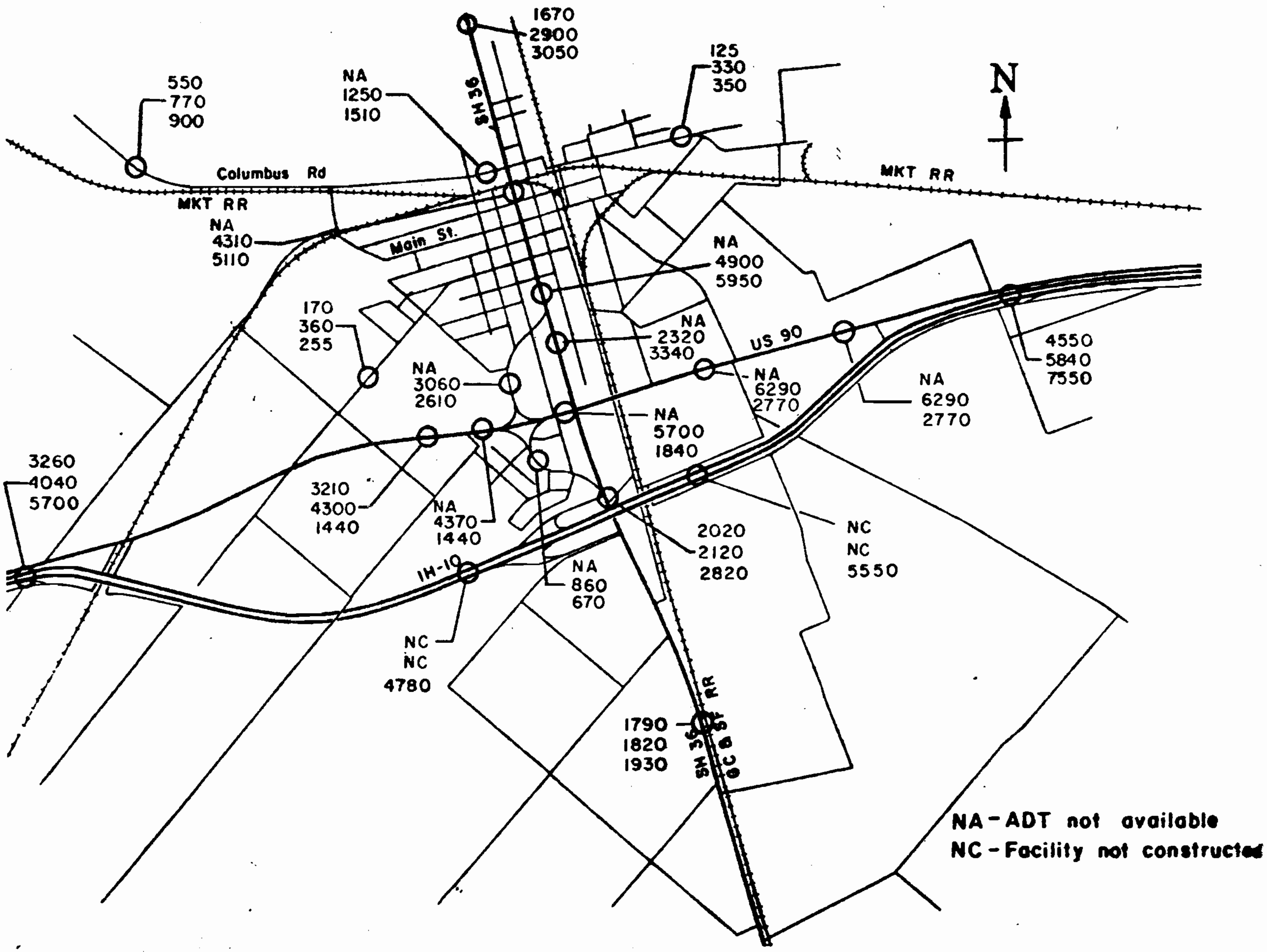


FIGURE 6.1.: TRAFFIC VOLUMES, SEALY
ADT 1956, 1965, 1967

constant, varying slightly around 38 per year. Thus, the growth rate decreased slightly over time. No exact population figures later than 1970 are available. The figures used in this study for 1971, 1972 and 1973 are based on a population forecast made by the Texas Industrial Commission, which is also the source for the population figures for the period 1955 to 1970. Table A6.11 in the Appendix shows the variation in population over the study period in absolute and relative figures.

Rating of the neighborhoods was made by subjective judgement after visual inspection. Studies of aerial photograph from 1960 did not indicate any change in the index for any of the developed areas at that time. For this reason the index for a specific area is kept constant over the entire study period. Figure A6.6 shows the neighborhood indices used in this study. Average land values for all transactions within each neighborhood index group are shown in Table A6.6. There seems to be a general non-linear increase in average land values for index groups 1 to 3, but a drop in values for index group 4. This is probably caused by a higher percentage of unimproved parcels in this group than in the other groups Differences in predominant land use also influence the grand average for each group, but this is not taken into account in Table A6.6.

The index for relative parcel location, which is a part of the composite highway accessibility index, is also based on subjective judgement. This index will usually have different values for a specific parcel in the periods before and after opening of IH 10. The most accessible areas from the inter-urban highway facility are given the score 4, the least accessible the score 1. Maps, aerial photographs and visual inspection have provided the necessary background for the ranking of the areas. The ranking of the different areas before and after the opening of IH 10 is shown on Figure A6.7 in the Appendix. Average land values for each index group are shown in Table A6.12. Except for the highest accessibility group, average values increase with increasing accessibility. Chosen values for the "Street Adjustment Factor," as described in Chapter V, are shown in Figure A6.8 for the different streets and roads in Sealy.

Individual Parcel Characteristics

Most of the community characteristics have to be related directly to each individual parcel. The information gathered includes the absolute location expressed by X and Y coordinates in a defined grid system and the name of the street which the parcel fronts. The coordinates make it possible to plot a picture of the spatial distribution of any information; the identification of front streets makes it possible to analyze those properties which abut certain streets or highways. In order to find the location relative to the CBD-area and transportation facilities, expressed by accessibility indices, absolute street distances have been measured. The base map for the city area and aerial photographs were used to obtain all information about parcel location.

Site quality was mainly determined by means of the base map, showing major sub-divisions and property lines, plats of sub-divisions, and deed descriptions of individual parcels. The average land value for each group ranking by site quality as given in Table A6.13 in the Appendix shows that the value generally increases with an increase in the quality index, as defined in Chapter V.

Information about size and improvement is mainly obtained from deed descriptions, aerial photographs and visual inspection. An improvement is counted as any man-made structure on the parcel which was considered to have had any significant influence on the final sales price. As shown in Table A6.5 there is a very significant difference in average land values for improved and unimproved parcels.

Classification of land use according to the land use definitions in Chapter V is also based on visual inspection and aerial photographs. A majority of the transactions included in this study represent property sold for residential purposes. The most obvious shift in land use is from vacant to residential land use. Average land values for each land-use group are shown in Table A6.14 in the Appendix. As can be seen, agricultural land has the lowest average unit price. The Table gives only average values, and the effect of improvement and other factors is not accounted for.

FOOTNOTES

[1]The figures obtained from the tax assessor's records represent all transfers of ownership, including inheritances, deeds of gift, etc. The figures from the title policies all represent bona fide sales. Thus the percentages are conservative estimates of the actual sample size since the total number of bona fide sales in Sealy is not known.

CHAPTER VII. MODEL SEEKING

Having a data set with a great number of variables, where it is not known whether there exists a linear relationship between the dependent and the independent variables, it is desirable to have a model-seeking technique available. In a case like this, the model may fall in one of two categories:

1) Continuous linear model

2) Binary (discrete) model

Both models have the general form

$$Y = \sum b_i X_i + \epsilon$$

where Y = dependent variable

b_i = coefficient

X_i = independent (predictor) variable, or function of variables

ϵ = error term

The difference between the models lies in the determination of the value of the coefficient. While in the continuous linear model "b_i" is a constant applied over the entire space of the predictor, "b_i" in the binary model is a constant only for the values of the predictor falling in subgroup "i". Consequently the binary models avoid the averaging of the effects represented by a particular coefficient.

Even though there probably is not a continuous linear relationship between the dependent variable and the predictor variables in a "real world" problem like variation in land values, it is desirable to use a linear model because it is so much simpler to apply. However,as a tradeoff between the two models, different linear models may be applied on different subgroups of the data set. Each subgroup should be homogeneous as far as possible with respect to the effect of each predictor variable. Consequently, before any linear regression analysis is performed, the entire data set should be examined to show linearity or homogeneous subspaces.

DESCRIPTION OF "THE AUTOMATIC INTERACTION DETECTION (AID) TECHNIQUE"

The AID technique, as described by Gooch,[1] is a model-seeking technique which will reveal the structure of a given data set. Contrary to regression analysis, no specific structure is presumed. The technique implies stepwise one-way analysis-of-variance procedures to find the variables and the levels of value in the dependent variables.

Different levels of the values of each predictor variable have to be specified in advance, and each observation of the predictor falling within the range for a particular level is considered to fall within the same subgroup. Each subgroup may consist of one or more levels of a particular predictor. To split a group into new subgroups the "between groups sum of squares" for all possible combinations of subgroups within that particular group is calculated, and the subgroups which maximize the ratio between the "between groups sum of squares" and "total sum of squares" are formed. Consequently each group is split according to the predictor and the categories (levels) of that particular predictor variable which can explain the most of the unexplained variation in the dependent variable in the original group.

Through this sucessive splitting of the total data set into homogeneous subgroups, the AID-technique reveals the structure of the data in such a way that conclusions can be drawn about the relationship between the different predictor variables. As a visual display of the results, an "AID-tree" showing the splitting into subgroups can be drawn. Figure 7.1 shows the simplified version of the AID-tree for the data set in this study.

RESULT OF AID-ANALYSIS

In order to perform any analysis by means of the AID 4 UT program, each predictor has to be categorized. There are no specific rules for how to categorize the predictors, but as a general guideline five to seven categories should be the maximum. The segmentation of the predictors used in this analysis is shown in Table A7.1 in the Appendix. Because of the nature of some of the predictor values, the recommended number of categories is exceeded for a third

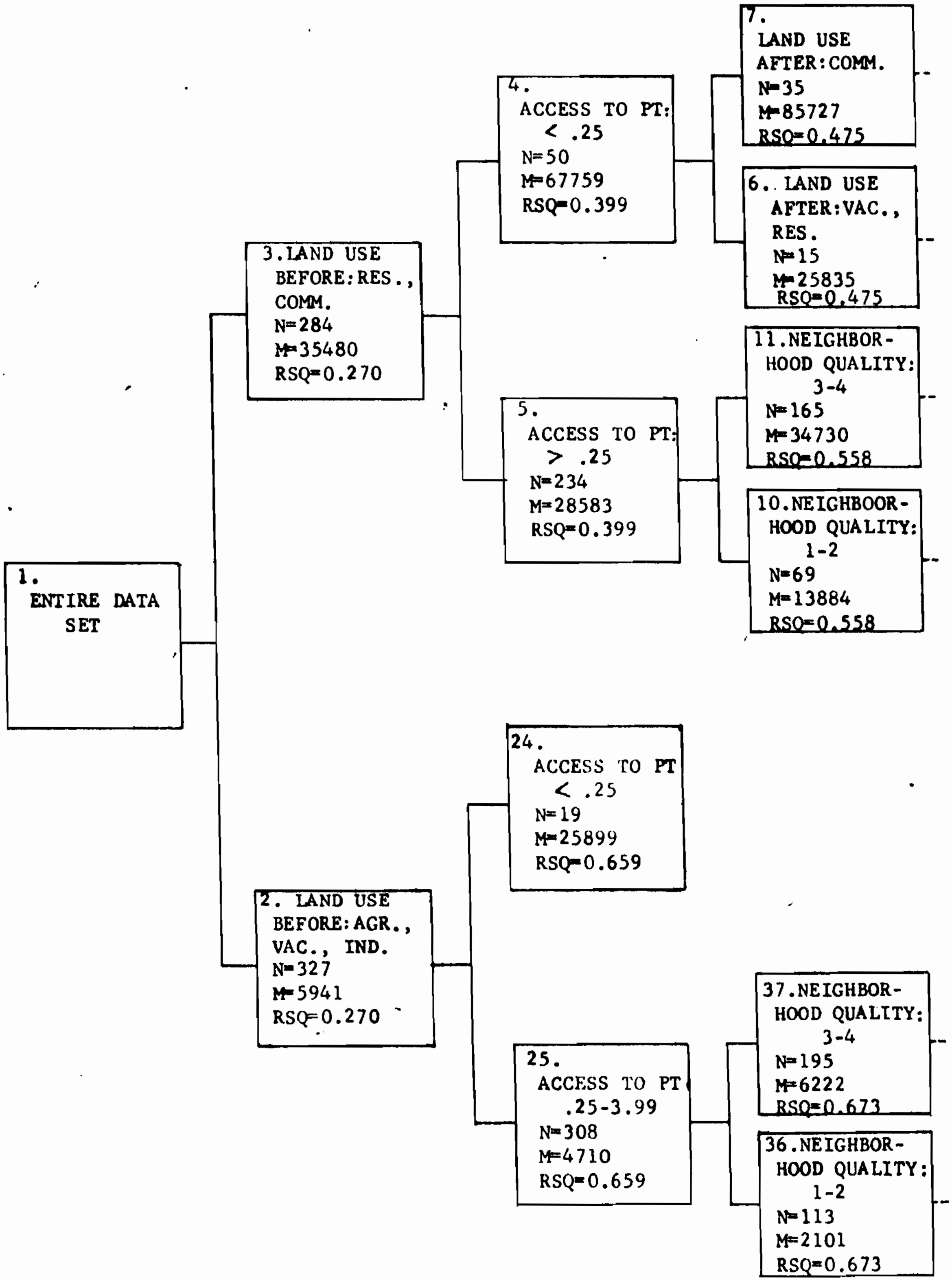


FIGURE 7.1. SIMPLIFIED AID TREE. 611 OBSERVATIONS FOR LAND VALUES IN SEALY

of the predictors. As all of the predictors in the regression analysis will be treated as continuous variables, only monotonic splits of the groups were allowed in the AID-analysis.

As can be seen from Figure 7.1, the data set first splits on the predictor "land use before transaction." From this it can be concluded that land use is the single predictor which can explain most of the variation in land value. The two most significant categories of this variable include 1) public, agricultural, vacant and industrial land use, and 2) residential and commercial land use. While the average land value for the first group is $5,941/acre, the average is $35,480/acre for the second group.

Figure 7.1 also shows a linear interaction between the two predictors "land use before transaction" and "access to public transportation (PT) terminals." As can be seen, both groups of land use split on access to PT, and in both of the splits the smaller values of access to PT constitute the "upper case." Whether the value of access to PT is more or less than 0.25 is the most significant two-group split of this predictor. Consequently the data set indicates a significant drop in land values when distance to PT exceeds 0.2 - 0.3 miles. It should be noted that in this study access to PT in most cases expresses the same relation as access to CBD because of the central location of bus depot and railroad station.

In order to show in detail how each of the two major branches splits further, detailed "trees" are shown in Figures 7.2 and 7.3.

<u>Splits of Group 2; Public, Agricultural, Vacant And Industrial Land Uses</u>
(Figure 7.2)

This branch of the AID-tree shows a linear interaction between the predictors "neighborhood quality" and "access to PT" and also partly between "access to PT" and "time after railroad decrease." No other linear interaction is indicated.

The effect of the predictor "neighborhood quality" as indicated in the split of group 25 is as expected; the higher the ranking, the higher the average land value. This is also the case for "site quality" in the split of group 44. Both groups 36 and 37 split on "access to PT." Even though the categories of the predictor are not exactly the same in the two splits, there is a general

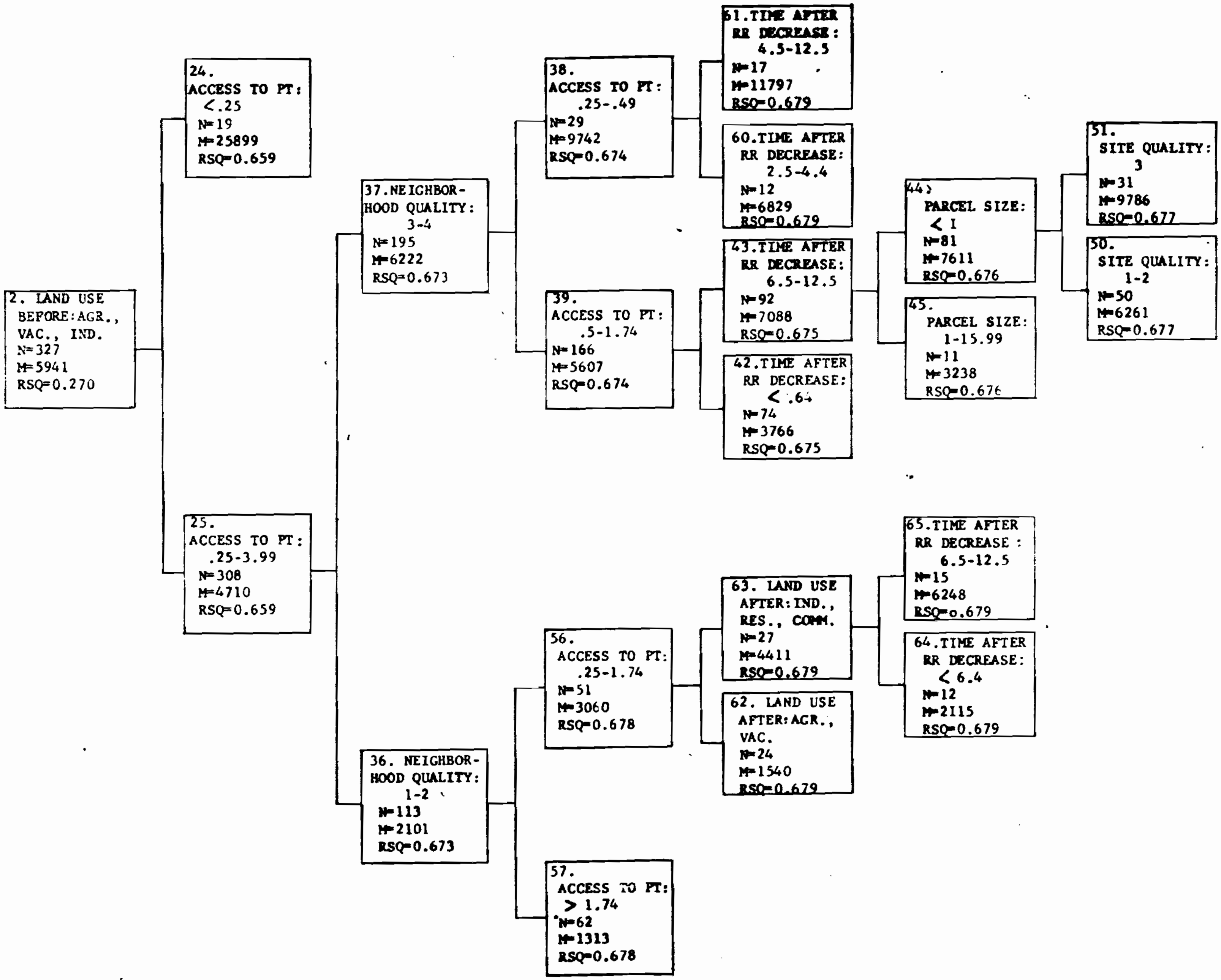


FIGURE 7.2. SPLITTING OF GROUP 2; AGRICULTURAL, VACANT AND INDUSTRIAL LAND USES

decrease in average land value with increasing value for the predictor (i.e., increasing distance to PT). Together with the splits of groups 2 and 3 this indicates a fairly linear effect of the predictor over its entire range.

The splits on "time after railroad decrease" (groups 38,39 and 63) indicate that average land values were higher the longer the elapsed time between the major decrease in railroad services and the date of the transaction. This might indicate that a 4 - 6 year period was needed to recover from a negative effect of the change in quality of railroad services, but the result might also reflect a more general time effect since transactions before 1961 are coded zero instead of being excluded from the group. The split of group 43 on parcel size shows that the critical value of size, in terms of variation in effect from this predictor, is about one acre.

Splits of Group 3: Residential and Commercial Land Use (Figure 7.3)

According to the split from the AID-analysis, there is no continuous linear interaction between the different predictor variables in this part of the tree. Each predictor is split on two different predictors, showing that on different levels of one particular predictor, there is interaction with other predictors. While "land use after transaction" can best explain the difference when "access to PT" is less than 0.25, "neighborhood quality" is at the most significant predictor for further splitting when "access to PT" exceeds 0.25. The split of group 4 shows that land values generally are higher for commercial land use after transaction than for other categories of land use.

Groups 7 and 11 split on "time after highway bypass," and in both groups the upper cases contain an elapsed time period of 4.5 - 6.5 years. It is thus apparent that for the 200 transactions included in groups 7 and 11, there has been a significant increase in land values during the two last years. It is not possible to draw any conclusions about the transactions which took place between 1967, the year the by-pass opened, and 1971 because the lower cases include all transactions between 1955 and 1971 in one group. Two groups, 8 and 16, split on "site quality." As expected, in both cases a site quality ranking of 3 constitutes the upper case, indicating that the better the site quality, the higher the land value.

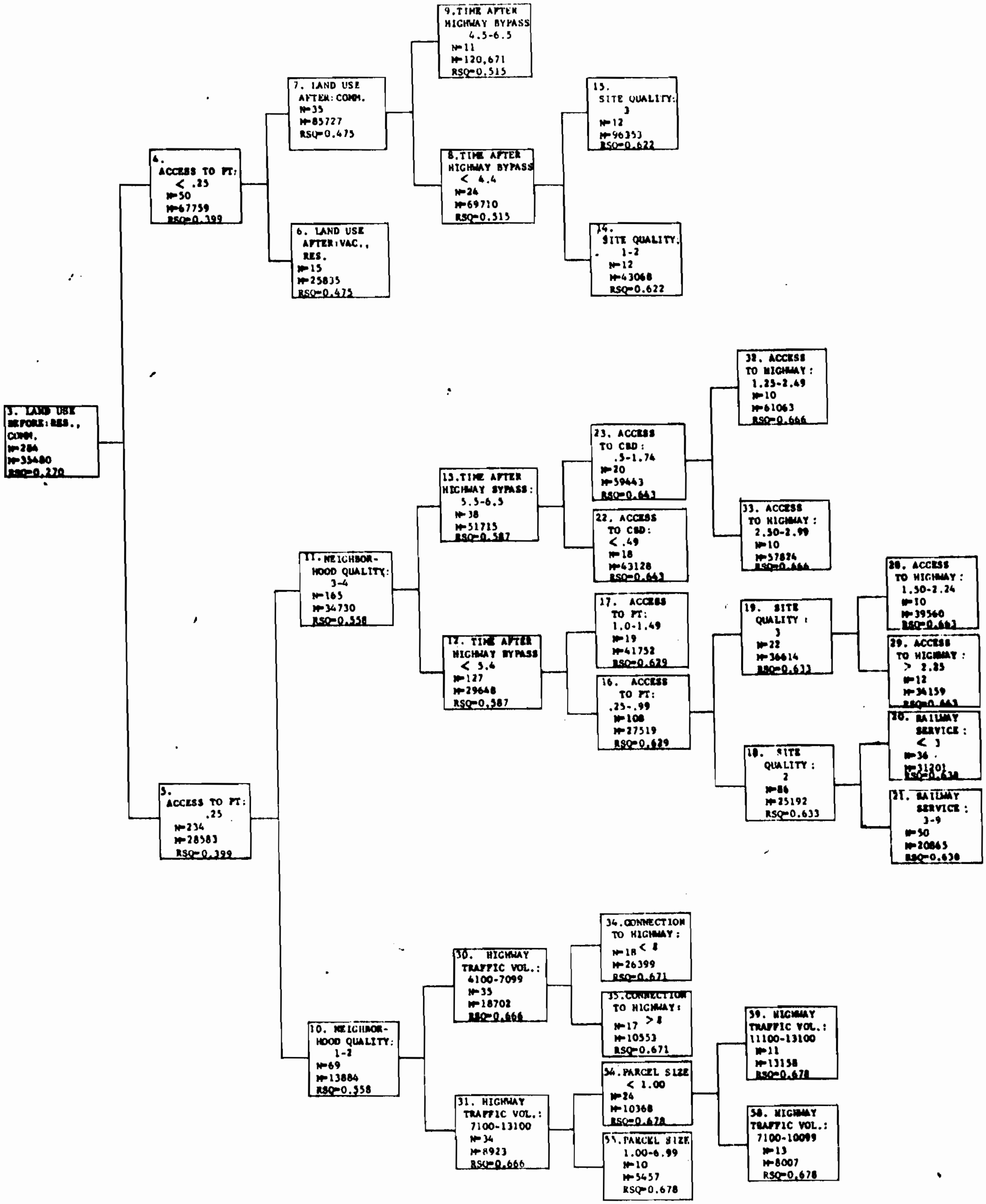


FIGURE 7.3. SPLITTING OF GROUP 3; RESIDENTIAL AND COMMERCIAL LAND USES

Also expected is the effect of neighborhood quality as shown in the split of group 5, where the average land value for ratings 3 and 4 is significantly higher than for ratings 1 and 2.

A very special effect of access to PT is shown on the transactions in group 12. For some not readily explainable reason, average land values are lower when the predictor variable falls between 0.25 and 0.99 than for greater values. The same effect is also reflected in the split of group 13 on "access to CBD." The only plausible reason for this phenomenon is that most of the new development in Sealy during the last two decades has taken place in the central areas and in the outskirts of the city. While the effect of "highway traffic volume" is unclear due to the different splits of groups 10 and 54, the effect of the predictor "access to highway" seems to be quite contrary to what should be expected. The relatively small number of transactions in groups 19 and 23 may be a contributing reason, but it is more reasonable to assume that the index as evaluated in Chapter V may not fully describe accessibility to the highway. Also the split of group 18 on "railraod service index," indicating decreasing land values with increasing quality of the railroad service provided, is very suspicious, but not readily explainable.

CONCLUSION OF AID-ANALYSIS

The structure of the data set, as revealed by the AID-analysis, shows that there is no simple overall relationship between land value expressed as a unit price and the different factors assumed to influence it. As long as the sample of land transactions is considered to be valid, this indicates either that there is a very complex interaction between the predictors or that some important factors are not included in the analysis.

Even though the analysis indicates linear interaction between some predictors, the overall relationship between the predictors is non-linear in character. A linear interaction between land use before the transaction and access to PT is present over the entire data set. In addition, access to PT has a linear interaction with neighborhood quality in two major subgroups (groups 5 and 25), including 92 percent of the observations. This leads to the conclusion that land use before, access to PT and neighborhood quality are the only predictors between which there is a linear interaction. The interaction between all other combinations of predictors is of non-linear character. Consequently it can be assumed that one general linear model cannot describe the variation in land values with a reasonable degree of accuracy. In a case like this, a binary model would be more appropriate.

The AID-tree gives an indication of how the subgroups in a binary model could be defined. However, before subgroups are defined, the eventual effect of the rather arbitrarily chosen categories of the predictors should be examined. A binary model according to the split from the performed AID-analysis would not be able to explain more than about 68 percent of the total variation in land value. The correlation coefficient (R^2) is rather low, indicating that a substantial part of the variation in the sample of land transactions cannot be explained by the predictor variables included in this study.

The low expected value of R^2 for a binary model, and the indication of some linear effect, makes it reasonable to concentrate the modeling effort on linear models in order to simplify the model. As a tradeoff, linear models for different major subgroups may be examined. However, because of lack of homogeneity within the major subgroups, this is not expected to increase R^2 very much, but the absolute value of the residuals will be reduced.

The AID-analysis fails to show clearly the structures of possible linear regression models. It is obvious that configural terms of the variables will have to be included, but the form of these terms is not evident. Consequently the value of the AID-analysis for the further model evaluation in this case is somewhat limited. The major advantage of the AID-analysis is therefore the visual display of the structure of the data set, which reveals the characteristics of the effect of the different levels of the many predictors.

FOOTNOTES

[1]For a detailed description of the "Automatic Interaction Detection Technique," see Lawrence Lee Gooch, "Policy Capturing with Local Models: The Application of the AID Technique in Modeling Judgement," Dissertation, University of Texas at Austin.

CHAPTER VIII. REGRESSION ANALYSIS

DESCRIPTION OF STEP-01

The Step-01 program package is used to test possible regression models. STEP-01 performs stepwise linear regression. For each step one new variable may be added to the regression equation, or one variable already entered dropped from the equation, depending on partial F-test[1] of each individual independent variable. In order to enter, the F-value for a particular variable must exceed a specified level. If the partial F-value for any of the variables already entered on any step decreases below a specified level, this particular variable is removed from the equation. The partial F-test is performed in order to assure that the coefficient for the variable is significantly different from zero. Based on judgement alone, the F-level used for inclusion or removal of the variable was set at a level of 2.0 in this study.

Two major criteria are commonly used when evaluating a regression model; the coefficient of correlation, R^2,[2] and the coefficient of variation, C.V.[3]. Both of these are usually expressed in percent. The coefficient of correlation is calculated from the formula

$$R^2 = \left(\frac{\text{sum of squares due to regression}}{\text{total sum of squares about the mean}} \right).$$

R^2 expresses how much of the total variation in the dependent variable (in this study, land values) is explained by the regression model and is a measure of how successful the regression model is. R^2 will vary between 0% and 100%, and the closer R^2 is to 100% the better the regression equation is. The coefficient of variation is the ratio between a standard deviation and a corresponding mean value. In this study this coefficient expresses the relative accuracy with which the model can describe the land value of each parcel included in the study.

TEST OF POSSIBLE MODELS

According to the results from the AID-analysis, local models should possibly be evaluated for major subgroups of the data set. For this reason five different data groups are analyzed individually:

1. The entire data set, 611 observations (denoted R).
2. Improved parcels, 306 observations (denoted I).
3. Unimproved parcels, 305 observations (denoted U).
4. Residential and commercial land use, 284 observations (denoted RC).
5. Agricultural, public, vacant and industrial land use, 327 observations (denoted AV).

Different models were tested for each data group in order to find the best model to describe variation in land value. The great number of independent variables makes it possible to include an almost infinite number of cross-product terms in the analysis, and the final models are a result of trial and error testing of possible combinations of the individual variables.

Main Effect Models

As a first effort, a model including all variables in the first power was tested. The correlation between dependent and independent variables for each of the data groups is shown in Table A8.1 in the appendix, together with the correlation matrix model R6, Table A8.2. The summary table shows mainly that the correlation coefficients of the individual variables do not vary much for the different data groups. Because of interaction between the different predictor variables, it is difficult to draw any conclusion about the relative importance and the cause/effect relationship of each variable.

A summary of the best regression models for each data group is given in Table 8.1. As can be seen, the variance in land value cannot be satisfactorily described in a first order model. With a R^2 varying from 33 to 45 percent, and a coefficient of variation as high as 108 percent, all of these models are unacceptable for descriptive purposes.

Configural Effect Models

The characteristics of the predictor variables as revealed in the AID-analysis were helpful in determining the form of the cross-product terms to be included in the regression models. These models were evaluated by a stepwise adding and deleting of terms in the regression models. Table A8.3 in the Appendix shows which variables were included in cross-product terms, but the actual form and power of these terms varied in the different models. Generally

TABLE 8.1

SUMMARY OF REGRESSION ANALYSIS

	Model	Sample		Regression Model		
		Mean	Standard Deviation	R^2 Percent	C.V. Percent	No. of Variables
	R 1	19672	28375	45.13	108.1	14
Main	I 1	33058	32515	32.80	81.4	5
Effects	U 1	5614	6596	37.49	94.2	8
Models	R C 1	35707	34874	38.48	77.5	6
	A V 1	5864	7284	39.32	98.2	8
	R 6	19672	28375	70.45	79.5	17
Configural	I 4	33058	32515	63.83	60.2	11
Effect	U 4	5614	6596	74.97	59.6	9
Models	R C 6	35707	34874	62.88	60.8	11
	A V 6	5864	7284	79.32	58.1	17
Configural Effect	R 6 - 3	14530	18947	87.31	47.6	25
Models,	I 5 - 3	28402	24498	79.27	40.3	13
Reduced	U 5 - 3	4676	5229	93.70	28.6	10
Data sets*						

*Reduced data set contains 90% of the original data set.

cross-product terms including land use before transaction, improvement, access to PT, site quality and neighborhood quality proved to be of importance in the regression equation.

Tables A8.4 - A8.8 show the best regression model reached for each data group. A summary of each regression model is given in Table 8.1. Generally, it can be said that the introduction of cross-product terms improved the models considerably. Except for a few single variables, these terms dominate in the resulting regression models. Local models improved the most, as was expected because of the nonlinear interaction between the independent variables.

EVALUATION OF BEST MODEL(S)

The evaluation of the "best" model is mainly based on comparisons of the coefficient of correlation and the coefficient of variation for each model. For practical reasons, however, it is also important to keep the model as simple as possible. Consequently a simpler model might be considered the "best" model even though R^2 and C.V. might not be quite as good as for a very complex model.

Comparisons between Models.

In this case the choice of model(s) includes three possibilities:

1. The R model alone;
2. The I and U models (two local models, one for improved and one for unimproved parcels); and,
3. The RC and AV models (two local models, one for residential and commercial land uses, and one for agricultural, vacant and industrial land uses).

In order to find the best descriptive model(s) for land values the three possibilities must be compared in terms of accuracy and simplicity. The procedure used is a comparison of the two sets of local models, and then a comparison of the best two local models and the single model, R.

Comparing the two sets of local models it is apparent from Table 8.1 that there is not much difference in terms of R^2 and C.V. The AV model has a R^2 of 79.3%, and can explain 4.3% more of the variance in land values than can the U model. The coefficient of variance is also slightly better for the AV model. Comparing the RC and I models, it can be seen that they have practically the same R^2 and C.V. However, the RC and AV models include 17 and 11 terms of variables, while the I and U models on the other hand include 9 and 11 terms of variables. Consequently the I and U models are the simplest of the two sets of local models. Because of the low degree of accuracy (high C.V.) in both sets, the difference in R^2 is of little importance. Thus the I and U models are considered to constitute the best set of local models.

Comparing the R model to the I and U models, the R^2 (70.5%) for the R-model might be considered equivalent to or better than the R^2's for the I and U models. However, while the C.V. for the local models lie around 60%, the C.V. for the R-model is 79.5%. All of these C.V. values are much higher than desirable, and this might reduce the importance of this measure of value. The R model scores high in simplicity in terms of being one model instead of two different models for two categories of parcels, but it is rather complex in its inclusion of 17 term variables.

Consequently the regression analysis reveals both advantages and disadvantages with one single model compared to two local models, and the choice has to be based on a subjective judgement. Since the overall purpose of this project is to evaluate the impact on the community of changes in transportation system, it is desirable that the model(s) indicate whether different factors have different influences on different categories of properties. In this respect a set of two local models may be preferable.

The Best Set of Descriptive Models.

As a conclusion of this evaluation of the regression models, the two local models (I4 and U4) are considered the best models to describe the variation in land values in this study.

The best model for improved parcels has the form:

Unit land value Y [1)] = 15892.29
- 7274.74 · (land use after)
- 5188.39 · (time after bypass completed)
+ 185.28 · (land use before/parcel size)
+ 0.80894 · (land use after · traffic volume)
+ 681.33 · (land use after/access to PT)
+ 0.44335 · (access to highway · traffic volume)
+ 2651.62 · $(\text{neighborhood quality})^2$
+ 19382.36 · $\log_{10}$ (1/ parcel size)
- 13647.91 · $\log_{10}$ $(\text{land use after/access to PT})^2$
+ 81.92 · $(\text{land use before} \cdot \text{site quality})^2$

The best model for unimproved parcels has the form:

$$\text{Unit land value } Y^{1)} = -17168.16$$
$$+ 136.47 \cdot (\text{time when transaction took place})$$
$$+ 3198.27 \cdot (\text{site quality})$$
$$+ 263.03 \cdot (\text{land use after/access to PT})$$
$$- 106.21 \cdot (\text{access to highway})^2$$
$$+ 156.86 \cdot (\text{neighborhood quality})^2$$
$$- 23.359 \cdot (\text{land use before})^3$$
$$+ 666.70 \cdot (1 / \text{parcel size})$$
$$+ 1309.13 \cdot (1 / \text{access to PT})$$
$$+ 12.337 \cdot \frac{(\text{access to highway})^3 \cdot \text{traffic volume}}{(\text{connection to SMSA})^2}$$

---

1) Unit price in constant dollars, base 1950, and "time" as number of years after 1900 with decimal fraction (i.e. 66.5).

EXAMINING THE BEST MODELS

The coefficients of variation are much higher than should be expected from regression models with an R^2 value of 64% - 75%. If a small number of the observations contain values out of the normal range, the model may not be able to describe the land value for these observations with any reasonable degree of accuracy. Thus a few observations may have a significant influence on the coefficient of variation.

A number of extreme observations in the order of 10 percent of the total data set, were removed from the analysis, and the old regression models were tested on the reduced data set. The new models are shown in Table A8.9 - A8.11 in the Appendix. As the summary table in Table 8.1 shows, the removal had a very significant effect upon the R^2 and C.V. Generally R^2 increased 17% and C.V. was reduced 20% - 30%. A further examination shows that the average land value for these observations is higher than the average for the rest of the data set. No reason, however, was found to judge these observations as invalid. It is therefore concluded that the models based on the entire data set should be considered the best models.

Other land value studies also show a very high coefficient of variation. A modeling effort based on a limited number of transactions of parcels abutting a highway shows values of the coefficient of variation in the range of 110% or more.[4] Consequently the reduction to the range of 60% for the C.V. in this study may be considered a further step in evaluating a reliable technique to describe influence on land values of changes in the transportation system.

INTERPRETATION OF RESULTS

The regression analysis show that the variation in land values can be described by functions of factors related to transportation system and community characteristics. The regression models should not, however, be used to draw any conclusion about the cause/effect relationship between the different factors. Because of the non-linear interaction between the factors, cause/effect relationship cannot be revealed in a linear model. Consequently no conclusion should be drawn based on the sign or the size of the coefficient for each term of variables.

The analysis shows that it is possible to describe changes in the trend of land values over time and the spatial distribution of land values by a certain number of factors related to the transportation system and the community itself. The F-to-remove-value in the regression equation gives an indication of the relative importance of the terms included, but because of correlation between the terms this cannot be used to calculate how much of the total R^2 is caused by each individual term. The single factor which alone can explain most of the variance in land value for improved lots is "land use before/parcel size," giving an R^2 of 37.7%. For unimproved parcels the term "land use after/access to PT," when used alone, can explain 49.7% of the variance in land value. This indicates a difference in importance of land use for improved and unimproved parcels. While existing land use seems to be the most important for improved parcels, the potential for future use seems to be the most important when determining land value of unimproved parcels.

According to the best models, only 10 different factors have to be recorded in order to describe variation in land values. These factors to be recorded for each transaction are:

Time when transaction took place,
Land use before transaction,
Land use after transaction,
Parcel size,

Site quality index,

Neighborhood quality index,

Access to public transportation terminals,

Access to interurban highway route,

Traffic volumes on interurban highway, and

Time after completion of bypass route.

It cannot be said that these are the only factors that have to be recorded in other studies of land values, but it seems to be clear that the number of factors to be recorded can be reduced. However, the large coefficient of variance might indicate that one (or more) important factors need be included in the analysis.

Because of the large coefficient of variation in the models, they should not be used to describe any single transaction. The result from this study, however, indicates that as the technique is further refined, descriptive models can possibly be used to describe individual parcels with a desired degree of accuracy.

FOOTNOTES

[1]For a detailed discussion of the F-test, see Norman Draper and Harry Smith, "Applied Regression Analysis," p. 119, John Wiley & Sons, Inc., New York, 1966.

[2]For more details about the coefficient of correlation, R^2, see Norman Draper and Harry Smith, "Applied Regression Analysis" p. 117.

[3]An explanation of the coefficient of variation can be found in Irwin Miller and John E. Freund, "Probability and Statistics for Engineers" p.119, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1965.

[4]See tables 5 to 24 of Edward I. Isibor, "Modeling the Impact of Highway Improvement on the Value of Adjacent Land Parcels," Joint Highway Research Project, Purdue University, 1969.

CHAPTER IX. CONCLUSIONS AND RECOMMENDATIONS

SUMMARY AND CONCLUSIONS

In previous years, major transportation decisions have been based mainly on analysis of user benefits. Recently, however, transportation planners have increasingly recognized the importance of the impact of transportation changes on non-users and on the surrounding environment. It is also realized that changes in interurban transportation systems might have a determining influence on the growth and development pattern of small rural communities located in the vicinity of these facilities. The overall objective of this research project is to provide insight into the influence of transportation development on such rural communities and to provide a rationale for future transportation decision-making. Accomplishment of this objective will assist the residents of rural communities, particularly their decision makers, in evaluating the consequences of changes in the transportation system, and will also be of value to state and regional governments in the planning process.

This report deals with only one of the many facets of transportation impact: the impact of transportation on land values. The aim is to develop and evaluate a model which can be used to describe the variation in land values caused by changes in the transportation system. Realizing that the effect also depends on characteristics of the community itself, the model was structured to include community characteristics as well as transportation system characteristics.

Previous studies have shown that there is an effect of highway improvement on the value of adjacent land parcels. However, relatively few of the previous studies have been aimed at showing a cause/effect relationship between land values and changes in the transportation system. Since most of the studies have been limited to examining land values in the vicinity of the transportation facility, they have not described the effect on the entire community. Another major shortcoming with most of the previous impact studies is that they have been based on the assumption that transportation-related effects can be identified and disassociated from the effect of other factors.

The methodology chosen for this particular study differs from the previous studies in several ways:

1. All transportation modes serving the community are included;
2. The entire community area is surveyed and examined;
3. The study period is long enough to include important changes in both the transportation system and the community; and,
4. No presumption is made that transportation effects can be isolated.

The basic assumption in this study is that the value (expressed in dollars per acre) of an individual parcel may be described as a function of the transportation system characteristics, community characteristics, and time. The evaluation of the model includes four major tasks:

1. Selection of those factors which should be included in the study;
2. Evaluation of ways to measure them;
3. Testing which factors had a significant impact on the variation in land value; and,
4. Determination of the final form of the model.

While the first and second tasks were of general character, a case study of land values obtained from land transactions in Sealy, Texas, was used for statistical testing of a proposed model. A total of 21 variables were included in the analysis. The following variables were included for each transaction:

Time when transaction took place.
Size of the parcel.
Improvements on the parcel.
Land use before the transaction.
Land use after the transaction.
Site quality index.
Accessibility to CBD-area.
Accessibility to public transportation terminals.
Accessibility to interurban highway route.
Neighborhood quality index.
Quality index for highway route.
Traffic volumes on highway route.
Rail service index.
Local traffic conditions.

Connection between Sealy and the highway route.

Connection between Sealy and Houston.

Population growth factor.

Time elapsed after designation of the bypass route.

Time elapsed after purchase of the right-of-way.

Time elapsed after major reduction in rail services.

Time elapsed after completion of bypass route.

Since several of the factors describe qualitative characteristics, indices were developed for classifying or grading these factors into qualitative levels. Generally, this procedure seemed to be useful in explaining certain variations in land values. Procedures for describing quantifiable characteristics were also evaluated, usually in the form of indices. It was not possible to go into depth in the evaluation of these indices, and the techniques probably need to be further refined. Indices such as "connection to interurban highway," "interurban highway quality," "connection to nearest SMSA," "railroad service index," and "local traffic conditions" were not fully evaluated in the case study phase. Techniques for testing the variables and possible models included model-seeking and regression analysis. Program packages under the names of AID 4UT and STEP01 that were available at the University of Texas at Austin Computation Center were used for the statistical analyses.

This study has shown that the basis for establishing land values is very important. Previous studies have also found that the tax assessor's records generally do not provide adequate information about real market values of real estate. Market value should be established from actual sales. One possible way to obtain a sample of sales prices might be through local title insurance companies as was the case in this study.

In this case study, sales price reflected the total property value including both land and buildings. No appropriate technique to separate the value of the improvements from the value of the land was found; consequently, the unit land value analyzed in this study includes both. Analysis of improved versus unimproved parcels, however, showed that a linear relationship between land value for improved and unimproved parcels existed in the case study of Sealy, Texas. However, research to develop a technique for a classification of the worth of improvements seems to be necessary in order to refine the descriptive models for land values. In determining the other factors related to each transaction (e.g., size, location, accessibility, land use) information sources such as deed descriptions, aerial photographs, plats and back issues of the local phone directory have proven valuable.

The study has shown that the variation in land values can probably be described by a limited number of factors. The best descriptive models for land values in Sealy as found from this case study contain 10 of the predictor variables included in the analysis. These factors are:

Time when transaction took place.
Land use before the transaction.
Land use after transaction.
Size of the parcel.
Site quality index.
Neighborhood quality index.
Accessibility to public transportation terminals.
Accessibility to interurban highway route.
Traffic volumes on interurban highway.
Time elapsed after completion of bypass.

The case study indicates that the number of variables can perhaps be reduced in future studies without significant effect on the model. In the general study phase, however, a rather large number should probably be included in order to reveal any deficiencies in this limited study.

Because of the complexity of the relationship between all the factors that influence land values, a model-seeking technique was used to reveal the possible structures included in the data set. The "Automatic Interaction Detection" (AID) technique proved useful in showing the interaction between the variables included in the analysis and in defining homogeneous subspaces of the data. The analysis of land values in Sealy showed that, with a few exceptions, there was a non-linear interaction between the predictor variables. The study indicated that a binary model was preferable to a general linear model. As a trade off, local models for homogeneous subspaces of the data set were used in the case study.

A stepwise regression technique was used to test possible models for describing land values. Two models, one for improved and one for unimproved parcels, were found to be the best procedure for describing land values in an entire community. The models explained 63.8% of the variation in the land value (ie. R^2 63.8%) with a coefficient of variation, C.V., of 60.2% for improved parcels, and corresponding R^2 = 75.0% and C.V. = 59.6% for unimproved parcels.

The difference in R^2 for the two models might be rooted in the fact that the quality of the improvements was not included. No explanation for the high coefficient of variation is offered. The analysis might possibly indicate that significant predictor variables were missing in this study. Because of the lack of appropriate techniques to describe economic, political, and social conditions in the community, such factors were not included at this point. Future phases in the overall research project will evaluate these conditions for use in the analysis.

The models developed from the case study do not adequately explain the complex cause/effect relationship that exists between land values and changes in transportation systems. However, the analysis shows which factors were the most important in describing the variation in a sample of land values in Sealy. The most important factors found in this study were land use before and after the transaction, size of the parcel, access to the central area (CBD and public transportation terminals), site quality index, neighborhood quality index, access to the interurban highway, and traffic volume.

Even though the accuracy with which the value of an individual parcel of land was described is lower than desired, this case study shows that it is possible to model the variation in land values in an entire community and over a substantial period of time which includes major changes in the transportation system. This study might be considered a first step towards the development of a model which can describe land values in a rural community with an acceptable degree of accuracy. Inclusion of other appropriate factors and further refinement of the techniques will possibly lead to the development of a reliable predictive model.

RECOMMENDATIONS FOR FURTHER RESEARCH

A substantial data base was gathered in this study, and it is readily available for further analysis. Further research on this data base will include sensitivity analysis of the predictor variables and more complete analysis of the spatial variation within the community. The stored information may be analyzed to reveal possible differences in the variation in land values between zones, land use categories, location along the interurban highway versus other locations, and land ownership.

In the general study phase, major emphasis of the land value studies should be given to three subjects:

1. Further refinement of the techniques to describe quantitative and qualitative predictor variables already included in the analysis.
2. Development of a technique to separate the value of land and improvements or possibly to classify the quality of the improvement.
3. Development of a technique to include economic, political, social and ownership characteristics in the analysis.

On a state or nation-wide level, an effort should be made to create a data bank where all gathered information can be stored and made available for research teams and governmental agencies. The first step would be to develop general methodologies for data gathering and establish structures for the data bases in order to assure comparability between the different studies. Ideally this will facilitate future research efforts and provide sufficient data to enhance other programs such as land use planning and policy development.

APPENDIX I. TABLES

TABLE A5.1

CONSUMER PRICE INDEX
1950 - 1974

HOUSTON AREA

BASE YEAR 1950

Year	CPI	Year	CPI
1950	100.0	1962	122.0
1950.5	104.0	1962.5	122.6
1951	108.0	1963	123.2
1951.5	108.7	1963.5	124.2
1952	109.3	1964	125.1
1952.5	110.0	1964.5	125.8
1953	110.7	1965	126.6
1953.5	110.7	1965.5	128.4
1954	110.6	1966	130.2
1954.5	110.3	1966.5	131.8
1955	109.9	1967	133.5
1955.5	110.8	1967.5	136.4
1956	111.6	1968	139.3
1956.5	113.4	1968.5	143.8
1957	115.1	1969	148.2
1957.5	116.1	1969.5	152.1
1958	117.1	1970	155.9
1958.5	117.6	1970.5	158.4
1959	118.0	1971	161.0
1959.5	118.6	1971.5	163.9
1960	119.1	1972	166.8
1960.5	119.5	1972.5	171.1
1961	119.8	1973	175.4*)
1961.5	120.9	1973.5	

*) Not enough information to split into half-year periods.

TABLE A6.1

LAND TRANSFERS RECORDED BY COUNTY TAX ASSESSOR

AND

LAND SALES RECORDED BY

BELLVILLE ABSTRACT AND TITLE INSURANCE COMPANY

IN CERTAIN SUBDIVISIONS IN SEALY

Subdivision	Original Owners, 1955	Number of Transfers and Transactions*					
		1955 - 59		1960 - 64		1965 - 70	
		CTA	BAT	CTA	BAT	CTA	BAT
Sealy Town Site (CBD)	86	31	0	12	10	34	16
Sealy Town Site (West)	†	11	1	27	9	45	13
West End Addn.	92	26	4	27	8	47	29
South End Addn.	103	38	5	31	5	56	25
S. E. Subdivision	40	37	5	33	6	55	25
Don Ell Krampitz	1	-	-	19	5	41	17
Carolyn Meadows	1	-	-	13	8	11	10
		143	15	162	51	289	135

*CTA = County Tax Assessor

BAT = Bellville Abstract and Title Insurance Company

†Not determined

TABLE A6.2

YEARLY DISTRIBUTION OF THE TRANSACTIONS INCLUDED IN THE STUDY, AND AVERAGE LAND VALUES

Year	Number of Transactions	Average Land Value for all Transactions ($/acre)*
1955	4	15507
1956	10	6022
1957	9	15623
1958	5	22426
1959	11	7434
1960	15	18227
1961	20	7800
1962	12	15023
1963	26	12433
1964	30	11603
1965	34	13451
1966	49	25031
1967	45	19936
1968	45	18777
1969	38	17082
1970	55	19159
1971	70	16925
1972	67	29264
1973	66	30172

* Constant dollars, base year = 1950.

TABLE A6.3

NUMBER OF TRANSACTIONS AND AVERAGE LAND VALUES PER TIME PERIOD AND LAND USE GROUP

Land Use Before	1955 - 1959		1960 - 1964		1965 - 1969		1970 - 1973	
Group	No.	Average Land Value	No.	Average Land Value	No.	Average Land Value	No.	Average Land Value
Public	0	-	0	-	1	34777	0	-
Agricultural	6	1651	12	552	17	2031	31	1296
Vacant	15	3762	52	5456	95	6325	91	8017
Industrial	0	-	0	-	5	17089	2	24475
Residential	15	19544	26	21230	81	28463	108	31021
Non-Hwy. Commercial	0	-	9	30360	9	83163	23	83210
Hwy. Commercial	3	33756	4	41381	3	88485	3	35934

Land value = Constant dollars, (base 1950) per acre.

TABLE A6.4

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUES AND STANDARD DEVIATION FOR DIFFERENT TIME PERIODS

	All Transactions		Unimproved Parcels			Improved Parcels		
Time Period	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
55-59	39	11814	20	3272	1996	19	20806	UV
60-64	103	12437	62	4668	6802	41	42187	UV
65-70	211	19313	110	5765	6849	101	34069	UV
71-73	258	23995	113	6315	6584	145	37772	UV

UV: Undefined Value," System 2K. "
Land values in constant dollars (base 1950) per acre.

TABLE A6.5

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER ZONE, AND FOR TOTAL AREA

	All Transactions		Unimproved Parcels			Improved Parcels		
Zone	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
1	78	13540	42	4817	5352	36	23716	UV
2	148	18363	77	7327	3321	71	30331	UV
3	50	69711	9	29899	6729	41	78450	UV
4	49	7212	22	2096	2646	27	11200	9703
5	113	20896	48	66258	7779	65	31705	UV
6	76	22969	42	5342	2731	34	44744	UV
7	57	3829	36	1707	3486	21	7468	8481
8	40	1864	29	1201	915	11	3611	3218
Total Area	611	19652	305	5583		306	33676	

UV: Undefined,"System 2K"
Land value in constant dollars (base 1950) per acre.

TABLE A6.6

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER NEIGHBORHOOD RANKING GROUP

Neighborhood Quality Index	All Transactions		Unimproved Parcels			Improved Parcels		
	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
1	33	4221	16	1399	969	17	6876	3695
2	195	20157	96	4600	8339	99	35278	UV
3	331	21543	147	6034	UV	184	33934	UV
4	52	15449	46	7646	1687	6	75268	UV

UV: Undefined Value,"System 2K"

Land value in constant dollars (base 1950) per acre.

TABLE A6.7
COMPLETION OF IH-10
SAN ANTONIO - HOUSTON

Year	Miles Completed	Cummulative Miles Completed	Cummulative Degree of Completion	Cities Not Bypassed
1955	12.1	12.1	0.065	10
1956	-	12.1	0.065	10
1957	-	12.1	0.065	10
1958	-	12.1	0.065	10
1959	4.8	16.9	0.091	10
1960	-	16.9	0.091	10
1961	-	16.9	0.091	10
1962	17.8	34.7	0.187	10
1963	-	34.7	0.187	10
1964	10.5	45.2	0.244	9
1965	-	45.2	0.244	9
1966	30.7	75.9	0.410	9
1967	21.0	96.9	0.523	6
1968	13.9	110.8	0.599	5
1969	16.4	127.2	0.688	3
1970	6.4	133.6	0.723	3
1971	26.3	159.9	0.865	2
1972	24.8	184.7	1.000	0
1973	-	184.7	1.000	0

TABLE A6.8

AREAWIDE VARIABLES

LAND VALUE STUDY, SEALY

Year	Quality Index of Interurban Highway	Highway Use	Rail Service Index	Connection to Highway	Connection to Houston	Population Growth	Local Traffic Conditions
		Variable					
1955	0.253	3320	10	9.5	46	1.86	2
1956	0.253	3220	10	9.5	46	1.83	2
1957	0.253	3170	7	9.5	45	1.80	2
1958	0.253	3140	5	9.5	45	1.76	2
1959	0.264	3100	5	9.5	44	1.73	2
1960	0.264	3130	5	9.5	44	1.66	2
1961	0.264	3170	3	9.5	43	1.59	1
1962	0.318	3210	3	9.5	42	1.40	1
1963	03.18	3370	3	9.5	42	1.38	1
1964	0.355	3540	3	9.5	41	1.40	1
1965	0.355	3710	3	9.5	41	1.43	1
1966	0.453	4550	3	9.5	40	1.44	1
1967	0.556	5450	3	5.5	40	1.42	3
1968	0.622	6250	3	5.5	34	1.44	3
1969	0.713	7050	1	5.5	36	1.46	3
1970	0.703	7890	1	5.5	34	1.44	3
1971	0.845	9780	1	5.5	33	1.69*	3
1972	0.900	11660	1	5.5	32	1.46*	3
1973	0.900	13550	1	5.5	33	1.71*	3

* Population Growth Projected

TABLE A6.9

BUS SERVICES, SEALY (1973)

Kerrville/Greyhound

Route: Houston - Austin

To Austin	To Houston
10:10 AM	9:55 AM
5:15 PM	3:50 PM
8:10 PM	9:35 PM

Continental

Route: Houston - San Antonio

To San Antonio	To Houston
11:35 AM	1:08 PM
8:10 PM	11:23 PM

Central

Route: Galveston - Waco

To Waco	To Galveston
1:35 PM	4:35 PM

Note: No express bus stops in Sealy.

TABLE A6.10

RAILWAY SERVICES, SEALY *)

NUMBER OF DAILY STOPS (EACH DIRECTION), AND SERVICE INDEX

Year	Type of Service: Passenger **)	Type of Service: Freight	Railway Service Index
1955	4	2	10
1956	4	2	10
1957	3	1	7
1958	2	1	5
1959	2	1	5
1960	2	1	5
1961	1	1	3
1962	1	1	3
1963	1	1	3
1964	1	1	3
1965	1	1	3
1966	1	1	3
1967	1	1	3
1968	1	1	3
1969	-	1	1
1970	-	1	1
1971	-	1	1
1972	-	1	1
1973	-	1	1

*) Information mainly from "Official Guide of the Railways", and local newspaper.

**) Sante Fe Routes:
Sealy - Matagorda (passenger and freight) until 1957
Houston - Clovis - California (passenger) until 1969
Houston - Brownwood (passenger) until 1969
Missouri, Kansas, and Texas RR ("KATY") Routes:
Dallas/Ft. Worth - Houston (passenger) until 1958

TABLE A6.11

POPULATION GROWTH IN SEALY

Year	Population*)	Absolute Population Growth**)	Population Growth Rate**)
1950	1942	-	-
1954	2095	-	-
1955	2134	39	1.86
1956	2173	39	1.83
1957	2212	39	1.80
1958	2251	39	1.76
1959	2290	39	1.73
1960	2328	38	1.66
1961	2365	37	1.59
1962	2398	33	1.40
1963	2431	33	1.38
1964	2465	34	1.40
1965	2500	35	1.43
1966	2536	36	1.44
1967	3572	36	1.42
1968	2609	37	1.44
1969	2647	38	1.46
1970	2685	38	1.44
1971	2730	45	1.69
1972	2775	40	1.46
1973	2822	47	1.71

*) Linear interpretation when years missing. Population forecast for 1971-73.

**) Population growth from previous year to year considered.

TABLE A6.12

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER RELATIVE PARCEL LOCATION RANKING GROUP

Relative Parcel Location Index	All Transactions No.	All Transactions Average Land Value	Unimproved Parcels No.	Unimproved Parcels Average Land Value	Unimproved Parcels Standard Deviation	Improved Parcels No.	Improved Parcels Average Land Value	Improved Parcels Standard Deviation
1	37	3392	22	1259	976	15	6519	4623
2	490	20119	241	5539	UV	249	34239	UV
3	61	28085	27	8219	UV	34	43861	UV
4	23	13503	15	8022	12834	8	23777	14295

UV: Undefined Value,"System 2K"
Land values in constant dollars (base 1950) per acre.

TABLE A6.13

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER SITE QUALITY RANKING GROUP

Site Quality Index	All Transactions No.	All Transactions Average Land Value	Unimproved Parcels No.	Unimproved Parcels Average Land Value	Unimproved Parcels Standard Deviation	Improved Parcels No.	Improved Parcels Average Land Value	Improved Parcels Standard Deviation
1	7	13187	2	1488	1986	5	17867	27153
2	457	15892	233	4283	4842	224	27969	UV
3	147	31649	70	10026	UV	77	51306	UV

UV: Undefined Value,"System 2K."
Land value in constant dollars (base 1950) per acre.

TABLE A6.14

NUMBER OF TRANSACTIONS AND AVERAGE LAND VALUE PER LAND USE GROUP

Land Use		Before Transaction		After Transaction	
Group	Relative Weight	No.	Average Land Value	No.	Average Land Value
Public	3	1	34777	4	4931
Agricultural	1	66	1382	34	852
Vacant	3	253	6603	97	6496
Industrial	4	7	19199	13	9424
Residential	5	230	28265	393	18566
Non-highway Commercial	8	41	71599	47	65428
Hwy. Commercial	7	13	49235	23	36295

Land value in constant dollars (base 1950) per acre.

TABLE A7.1

SEGMENTATION OF PREDICTORS FOR AID-ANALYSIS

Predictor		No. of Categories	Interval Length
No. of Variable	Name		
2	Time	9	2 Years
3	Parcel size	40	1 Acre
4	Improvement	2	
5	Land Use Before	6	1
6	Land Use After	6	1
7	Site Quality	3	1
8	Access to CBD	16	0.25
9	Access to PT	16	0.25
10	Access to Highway	25	0.25
11	Neighborhood Quality	4	1
12	Highway Quality	4	0.300
13	Highway Traffic Volume	9	1000 ADT
14	Railway Service	5	3
15	Local Traffic Conditions	3	1
16	Connection to Highway	2	
17	Connection to SMSA	5	3 Minutes
18	Population Growth Rate	4	0.20%
19	Time After Bypass Known	7	2 Years
20	Time After Purchase ROW	7	2 Years
21	Time After Rail Decrease	6	2 Years
22	Time After Highway Bypass	6	1 Year

TABLE A8.1

SUMMARY, CORRELATION BETWEEN DEPENDENT
AND
INDEPENDENT VARIABLES (IN THOUSANDS)

	R 1	I 1	U 1	R C 1	A V 1
TIME	168	163	132	184	139
SIZE	-163	-199	-215	-272	-225
IMP	495	-	-	- 3	217
LUB	614	451	374	433	352
LUA	474	427	337	425	287
SITEQ	233	287	370	295	369
ACC - CBD	-319	-278	-418	-232	-433
ACC - PT	-324	-281	-419	-237	-435
ACC- HWY	- 28	- 4	58	- 28	5
NEIGH Q	56	181	208	125	146
HWY Q	166	143	127	167	125
TRAF V	179	168	122	191	129
RAIL Q	-116	-123	- 84	-137	- 85
LOCAL	105	63	56	76	49
C - HWY	-120	- 91	- 81	-105	- 75
C - SMSA	-148	-133	-111	-157	-123
POPLN	14	- 28	- 7	- 31	- 43
T KNOW	158	163	131	185	183
T ROW	172	163	130	185	137
T RAIL	174	161	127	185	134
T BYPS	166	142	101	167	111

CORRELATION MATRIX

VARIABLE NUMBER	1 LVALUE	2 TIME	3 SIZE	4 IMPR	5 LUB	6 LUA	7 SITEQ	8 ACCCBD	9 ACCPT	10 ACCHWY	11 NEIGHQ
1	1.000	.168	-.163	.495	.614	.474	.233	-.319	-.324	-.028	.056
2		1.000	.062	.103	.048	-.008	.037	.049	.048	-.551	.025
3			1.000	-.146	-.371	-.472	-.118	.482	.478	-.054	-.221
4				1.000	.753	.413	.014	-.268	-.273	-.057	-.103
5					1.000	.754	.104	-.510	-.514	.001	.017
6						1.000	.143	-.480	-.481	.052	.092
7							1.000	-.197	-.195	.061	.160
8								1.000	.999	.096	-.261
9									1.000	.096	-.247
10										1.000	.077
11											1.000

VARIABLE NUMBER	12 HWYQ	13 TRAFV	14 RAILQ	15 LOCAL	16 C-HWY	17 C-SMSA	18 POPLN	19 T-KNOW	20 T-ROW	21 T-RAIL	22 T-IH-10
1	.166	.179	-.116	.105	-.120	-.148	.014	.158	.172	.174	.166
2	.952	.890	-.888	.707	-.834	-.949	-.020	.959	.994	.982	.855
3	.059	.056	-.071	.045	-.054	-.061	-.013	.064	.062	.061	.062
4	.118	.114	-.059	.114	-.106	-.099	.070	.097	.110	.118	.117
5	.043	.051	-.042	.006	-.012	-.041	.016	.047	.048	.050	.057
6	-.018	-.008	.002	-.055	.050	.010	-.013	-.007	-.007	-.009	.002
7	.040	.040	.010	.039	-.042	-.042	.014	.042	.040	.042	.025
8	.064	.058	-.025	.064	-.060	-.060	.033	.036	.055	.060	.063
9	.064	.059	-.024	.066	-.061	-.060	.035	.035	.055	.060	.064
10	-.531	-.467	.496	-.443	.513	.552	.061	-.527	-.551	-.542	-.456
11	.037	.048	-.033	.035	-.024	-.031	.060	.023	.026	.031	.046
12	1.000	.955	-.781	.825	-.887	-.959	.192	.929	.969	.982	.933
13		1.000	-.699	.736	-.776	-.885	.345	.872	.913	.935	.983
14			1.000	-.491	.661	.815	.193	-.832	-.847	-.810	-.695
15				1.000	-.962	-.779	.238	.701	.739	.774	.714
16					1.000	.867	-.080	-.814	-.850	-.861	-.742
17						1.000	-.056	-.914	-.955	-.956	-.873
18							1.000	.014	.034	.103	.384
19								1.000	.961	.954	.840
20									1.000	.995	.881
21										1.000	.906
22											1.000

TABLE A8.2

CORRELATION MATRIX, MODEL R1

TABLE A8.3

VARIABLES INCLUDED IN CROSS-PRODUCT TERMS AND TRANSGENERATION

(Form of Transgeneration or Power of

Cross-Products Not Shown)

	VARIABLE	TIME	SIZE	IMPR	LUB	LUA	SITEQ	ACC - CBD	ACC - PT	ACC - HWY	NEIGH Q	HWY Q	TRAFV	RAIL Q	LOCAL	C - HWY	C - SMSA	POPLN	T - KNOW	T - ROW	T - RAIL	T - IH -10	OTHER
2	TIME																						X
3	SIZE		X	X	X		X																
4	IMPR				X		X		X	X			X		X		X		X				
5	LUB				X	X	X		X	X	X		X	X	X	X	X			X	X	X	
6	LUA				X								X										
7	SITEQ								X	X	X		X		X	X							X
8	ACC - CBD																						
9	ACC - PT											X		X			X						X
10	ACC - HWY									X		X	X				X		X			X	
11	NEIGH Q										X	X					X	X				X	X
12	HWY Q												X		X								
13	TRAFV														X	X							X
14	RAIL Q													X									X
15	LOCAL																						
16	C - HWY																						
17	C - SMSA																						X
18	POPLN																						
19	T - KNOW																		X				
20	T - ROW																						
21	T - RAIL																				X		
22	T - IH - 10																					X	

1) Includes adding constants, $\lg_{10}$ - transgeneration and inverse-transgeneration.

STEP NUMBER 29
VARIABLE REMOVED 30

MULTIPLE R .8394
R SQUARED .7045
STD. ERROR FOR RESIDUALS 15643.4674

C.V. = 79.5%

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	17	[illegible]602[illegible]142696.3105	2[illegible]5448[illegible]1923.3124	83.1752
RESIDUAL	593	[illegible]5117817245.3457	24471[illegible]072.9264	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		116814.93039		
IMPR	4	-22908.27393	10401.13485	4.8509
LUB	5	-20667.29380	3002.85704	47.3694
SITEW	7	-13762.80842	3700.97580	13.8287
ACCCBD	8	-6610.93640	2779.93031	5.6553
POPLN	18	-29795.45206	5658.40617	27.7276
IMPLUB	24	6280.35313	1455.41979	18.6205
ICSMSA	28	-1186623.34727	89475.90147	9.2825
LUBSIZ	31	257.27692	38.75766	44.0643
LUBAHW	32	368.08090	171.86097	4.5870
LUBSIQ	33	5966.23229	1099.91960	29.4224
RWACPT	39	915.78532	177.15071	26.7240
HWACPT	40	6718.13118	981.57258	46.8438
IMPNW	47	13479.90887	1545.84775	76.0397
SWIMP	48	-9149.47785	4167.92647	4.8190
TRFLUB	49	.58589	.09362	39.1667
LGSIZE	51	-5383.82689	1764.94841	9.3050
LGACPT	52	38325.32445	8959.98836	18.2960

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.01869	.0912	.2069
SIZE	3	.04736	.4263	1.3304
LUA	6	.00331	.3517	.0045
ACCPT	9	-.00166	.0016	.0014
ACCHWY	10	-.03107	.1604	.5722
NEIGHW	11	.01162	.4181	.0799
HWYW	12	-.02805	.0515	.4661
TRAFV	13	-.02794	.0680	.4624
RAILW	14	-.01694	.2376	.2124
LOCAL	15	-.01941	.3255	.2231
C-HWY	16	.01625	.2415	.1563
C-SMSA	17	-.03198	.0031	.6060
T-KNOW	19	-.01612	.1584	.1539
T-ROW	20	.00503	.0624	.0159
T-RAIL	21	.00514	.0758	.0157
T-IMIU	22	-.03674	.0738	.8003
SIZLUB	23	.05051	.3539	1.5145
LUBSQ	25	.01210	.0245	.0866
ISIZE	26	-.03271	.0430	.6339
IACCPT	27	.02329	.0190	.3213
CTIME	29	.01869	.0912	.2069
IMPSIZ	30	.04548	.0573	1.2272
LUBRLQ	34	-.02775	.1612	.4563
LUBRL	35	.05449	.0343	1.7633
LUBNHW	36	-.00543	.0794	.0174
LUATRV	37	-.00926	.1182	.0508
SWACHW	38	.00919	.1406	.0500

TABLE A8.4

REGRESSION MODEL R6

STEP NUMBER 16
VARIABLE ENTERED 36

MULTIPLE R .7990
R SQUARED .6383 C.V. = 60.2%
STD. ERROR FOR RESIDUALS 19887.4940

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	10*3136718467.273	.2031367184	6.7292	51.3604
RESIDUAL	291*5094113021.9287		395512415.8829	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		15892.28762		
LUA	5	-7274.73644	1949.79721	13.9205
TBYPS	21	-5188.39391	1585.25137	10.7120
LUBSIZ	22	185.28198	61.83826	8.9774
LUATRF	32	.80894	.19616	17.0025
LUAAPT	33	601.82779	110.70768	34.1311
ACHTRF	36	.44335	.24665	3.2311
NONQ	40	2652.61927	453.29442	34.2444
LGISIZ	50	19382.35727	3841.67861	25.4549
LGLAPT	53	-13647.90693	3025.52627	20.3484
LUBSQ2	56	81.91945	13.43405	37.1844

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.07177	.2390	1.5017
SIZE	3	.04923	.3321	.7046
LUB	4	-.01051	.1332	.0320
SITEQ	6	-.01477	.3268	.0633
ACBD	7	-.01421	.1329	.0585
APT	8	-.00454	.1223	.0060
AHWY	9	-.00457	.2080	.0060
NEIGHQ	10	-.05707	.0218	.9475
HWYQ	11	.03426	.1094	.3409
TRAFV	12	.04069	.0200	.4810
RAILQ	13	-.04550	.4873	.6016
LOCAL	14	-.00415	.4599	.0050
CHWY	15	-.01481	.4227	.0637
CSMSA	16	-.03852	.2277	.4310
POPLN	17	-.08941	.8145	2.3369
TKNOW	18	.07040	.2095	1.4446
TROW	19	.07285	.1910	1.5472
TRAIL	20	.07907	.1434	1.8243
LUBLUB	23	-.01633	.1331	.0774

TABLE A8.5

REGRESSION MODEL I4

STEP NUMBER 13
VARIABLE ENTERED 35

MULTIPLE R	.8658	
R SQUARED	.7497	C.V. = 59.6%
STD. ERROR FOR RESIDUALS	3350.7363	

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	9	9784678845.1965	1087186538.3552	96.8330
RESIDUAL	291	3267183257.6344	11227433.8750	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =	-17168.16452		
TIME 2	135.47683	59.68781	5.1518
SITEW 6	3198.27199	475.27117	45.2843
LUAAPT 33	263.02789	52.86808	24.7524
AHW2 35	-106.21512	40.55947	6.8579
NQNQ 40	156.86569	53.38092	8.6354
LUB3 43	-23.35955	8.59695	7.3831
ISIZE 46	666.69561	116.78811	32.5880
IAPT 49	1309.13675	259.73526	25.4044
AHTRF3 55	12.33707	1.69303	53.1000

VARIABLES NOT IN EQUATION

VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
SIZE 3	.01694	.8041	.0833
LUB 4	-.00163	.3842	.0008
LUA 5	-.00131	.5601	.0005
ACBD 7	.04865	.4919	.6879
APT 8	.05730	.4919	.9554
AHWY 9	.08074	.0473	1.9031
NEIGHQ 10	.03191	.0287	.2956
HWYQ 11	.03864	.0938	.4335
TRAFV 12	.02392	.2040	.1660
RAILQ 13	.02311	.2354	.1550
LOCAL 14	-.00129	.4798	.0005
CHWY 15	.00098	.2942	.0003
CSMSA 16	.01839	.0958	.0981
POPLN 17	.01855	.9724	.0998
TKNOW 18	.00513	.0050	.0076
TROW 19	.00191	.0114	.0011
TRAIL 20	.00929	.0349	.0250
TBYPS 21	.02626	.2711	.2000
LUBSIZ 22	.02784	.0124	.2249
LUBLUB 23	-.00163	.1125	.0008
LUBLUA 24	-.03118	.3047	.2822
LUBSQ 25	.02152	.2733	.1344
LUBAPT 26	.03700	.0093	.3974
LUBAHW 27	.03798	.2787	.4188
LUBNQ 28	.02503	.1182	.1818
LUBCSM 29	.00345	.3245	.0035
LUBTKN 30	.01583	.1637	.0727
LUALUA 31	.02528	.4390	.1856
LUATRF 32	-.01249	.3680	.0453

TABLE A8.6

REGRESSION MODEL U4

STEP NUMBER 17
VARIABLE REMOVED 36

MULTIPLE R .7930
R SQUARED .6288
STD. ERROR FOR RESIDUALS 21678.9952

C.V. = 60.8%

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	11	*3382692136.9629	19398426557.9056	41.2751
RESIDUAL	268	*595*326634.8589	469978830.7271	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		-35960.19446		
ACCCBD	8	-12671.15115	6868.58246	3.4033
HWYQ	12	-82300.37454	22606.42257	13.2538
SIZLUB	23	1650.52380	644.27037	6.5631
LUBSQ	33	2187.00411	454.87988	23.1156
LUATRV	37	28.62549	15.12324	3.5827
RQACPT	39	1184.16841	289.01207	16.7878
HQACPT	40	11429.76682	1673.95525	46.6216
IMPKNO	46	4012.82188	982.61471	16.6776
HWYQSQ	50	2863.40237	484.37627	34.9461
LGSIZE	51	-45952.48381	7733.21094	35.3100
LGACPT	52	84388.71214	17490.91388	23.2779

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	-.02175	.0256	.1264
SIZE	3	.02240	.0084	.1340
IMPR	4	.05992	.5901	.9620
LUB	5	-.03022	.2139	.2441
LUA	6	-.03733	.2296	.3726
SITEQ	7	-.01588	.2263	.0674
ACCPT	9	.01912	.0022	.0976
ACCHWY	10	.06637	.4870	1.1815
NEIGHQ	11	-.01865	.0247	.0929
TRAFV	13	-.00165	.0445	.0007
RAILQ	14	-.00556	.1753	.0082
LOCAL	15	.02090	.2640	.1167
C-HWY	16	-.01031	.1904	.0284
C-SMSA	17	.02279	.0644	.1387
POPLN	18	-.06606	.5358	1.1704
T-KNOW	19	-.05992	.0189	.9620
T-ROW	20	-.06110	.0166	1.0005
T-RAIL	21	-.04138	.0133	.4581
T-IH10	22	-.05065	.0736	.6867
IMPLUB	24	.01081	.2789	.0312
LUBSQ	25	-.03491	.2127	.3258
ISIZE	26	.04896	.2491	.6416
IACCPT	27	.00287	.0226	.0022
ICSMSA	28	-.01883	.0686	.0947
CTIME	29	-.02175	.0256	.1264
IMPSIZ	30	.05975	.2676	.9567
LUBSIZ	31	.05549	.2924	.8245
LUBAHW	32	.05741	.4593	.8828

TABLE A8.7

REGRESSION MODEL RC6

STEP NUMBER 23
VARIABLE ENTERED 30

MULTIPLE R	.8906	
R SQUARED	.7932	C.V. = 58.1%
STD. ERROR FOR RESIDUALS	3403.7374	

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	17	13507918020.3226	794583412.9602	68.5847
RESIDUAL	304	3521970218.7004	11585428.3510	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		-29271.66752		
IMPR	4	6209.51542	3210.82509	3.7401
LUA	6	315.19194	149.85551	4.4239
ACCCBD	8	-16695.67734	5488.80434	9.2524
ACCPT	9	20159.95075	5795.27098	12.1013
ACCHWY	10	-7833.77294	1967.75171	15.8490
C-SMSA	17	461.58605	157.35756	8.6046
IMPLUB	24	2880.25969	628.86841	20.9770
IACCPT	27	1520.98688	397.91083	14.6110
IMPSIZ	30	366.59129	225.42577	2.6446
SQACHW	38	769.14866	155.82436	24.3641
AHCSM	43	344612.01130	95779.21494	12.9455
AHTRFV	44	12.10667	5.95731	4.1300
SQSIZ	45	320.51992	51.36641	38.9360
SQIMP	48	-4422.55866	1547.09685	8.1717
HWYQSQ	50	171.27266	61.33734	7.7970
LGACPT	52	-12057.59186	3879.89702	9.6579
LGTRFV	53	-15270.57170	4934.82216	9.5756

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.02485	.0807	.1873
SIZE	3	.02132	.5917	.1378
LUB	5	-.04708	.3929	.6730
SITEQ	7	-.03979	.1622	.4806
NEIGHQ	11	-.05677	.0177	.9796
HWYQ	12	.03084	.0272	.2886
TRAFV	13	.02602	.0288	.2053
RAILQ	14	-.01858	.3248	.1047
LOCAL	15	-.04961	.3228	.7476
C-HWY	16	.04775	.2111	.6925
POPLN	18	-.03344	.4990	.3393
T-KNOW	19	.02726	.0686	.2253
T-ROW	20	.02577	.0633	.2014
T-RAIL	21	.02486	.0500	.1874
T-IH10	22	.02898	.0651	.2546
SIZLUB	23	.02653	.5956	.2134
LUBSQ	25	-.03355	.3685	.3414
ISIZE	26	.02624	.0468	.2088
ICSMSA	28	.02581	.0039	.2020
CTIME	29	.02485	.0807	.1873
LUBSIZ	31	.02036	.0527	.1257
LUBAHW	32	-.05699	.2382	.9873
LUBSQ	33	-.06351	.3189	1.2272
LUBRLQ	34	-.06634	.3953	1.3395
LUBTRL	35	.01660	.1841	.0835
LUBNHQ	36	-.03647	.1165	.4035
LUATRV	37	-.03395	.0855	.3497

TABLE A8.8

REGRESSION MODEL AV6

STEP NUMBER 37
VARIABLE ENTERED 6

MULTIPLE R .9344
R SQUARED .8731
STD. ERROR FOR RESIDUALS 6910.2637

C.V. = 47.6%

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	25	171138849750.2734	6845553990.0109	143.3571
RESIDUAL	521	24878659089.9861	47751744.8944	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		59094.15934		
IMPR	4	-17971.91794	5057.00260	12.6300
LUB	5	-15187.39022	1627.15217	87.1184
LUA	6	493.72198	324.06452	2.3211
SITEQ	7	-15349.20615	2312.77511	44.0459
NEIGHO	11	4100.82669	820.56206	24.9758
POPLN	18	-13042.99714	2770.76940	22.1592
T-KNOW	19	-968.30063	176.51223	30.0934
IMPLUB	24	5014.06472	777.59752	41.5786
ISIZE	26	-4150.04221	818.10677	25.7327
LUBSIZ	31	825.65632	79.75534	107.1714
LUBAHW	32	909.75729	181.45404	25.1373
LUBSQ	33	4026.71739	604.02495	44.4419
LUBTRL	35	398.57255	57.53794	47.9851
SQACHW	38	1438.23409	488.81656	8.6570
HQACPT	40	2377.17707	600.70379	15.6604
NQACPT	41	-2339.89106	415.17866	31.7630
CSMAPT	42	174.30267	20.86407	69.7927
AHCSM	43	-289334.86777	55972.28330	26.7212
AHTRFV	44	46.52793	11.67030	15.8951
SQSIZ	45	1142.88793	293.02055	15.2129
IMPNQ	47	9090.47662	1022.22833	79.0820
SQIMP	48	-5288.82254	2038.86252	6.7289
LGSIZE	51	-1964.70496	1234.04093	2.5348
LGACPT	52	5032.64541	2362.64307	4.5373
LUB3	54	-46.77612	9.55625	23.9593

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	-.01548	.0450	.1246
SIZE	3	.01599	.3188	.1330
ACCCRD	8	-.03771	.0521	.7406
ACCPT	9	-.04410	.0470	1.0133
ACCHWY	10	-.01498	.0068	.1168
HWYQ	12	-.00425	.0557	.0094
TRAFV	13	-.02688	.0574	.3760
RAILQ	14	.01044	.2485	.0567
LOCAL	15	.01453	.3621	.1098
C-HWY	16	-.01523	.2613	.1206
C-SMSA	17	.00367	.1046	.0070
T-ROW	20	-.01291	.0376	.0867
T-RAIL	21	-.00892	.0390	.0414
T-IH10	22	-.05337	.0934	1.4852
SIZLUB	23	.04118	.2374	.8834
LUBSQ	25	-.01490	.0003	.1154
IACCPT	27	.02250	.0006	.2635
ICSMSA	28	-.01153	.1166	.0691
CTIME	29	-.01548	.0450	.1246
IMPSIZ	30	.03579	.0970	.6669
LUBRLQ	34	.02701	.1761	.3797
LUBNHQ	36	-.00856	.0075	.0381
LUATRV	37	-.06020	.0577	1.8913
RQACPT	39	.00253	.0774	.0033
IMPKNO	46	.01260	.0839	.0826
TRFLUB	49	-.02079	.0291	.2248
HWYQSQ	50	.02554	.0222	.3395
LGTRFV	53	.00032	.0448	.0001
LGRLQ	55	.01749	.1969	.1592

F-LEVEL OR TOLERANCE INSUFFICIENT FOR FURTHER COMPUTATION

TABLE A8.9

REGRESSION MODEL R6-3

STEP NUMBER 17
VARIABLE REMOVED 22

MULTIPLE R .8903
R SQUARED .7927 C.V. = 40.3%
STD. ERROR FOR RESIDUALS 11427.6231

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	13	130822736243.4375	10063287403.3413	77.0598
RESIDUAL	262	34214729331.4725	130590569.9675	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		-25091.13749		
SIZE	3	521.20422	215.07393	5.8727
CSMSA	16	1128.77974	360.27712	9.8162
POPLN	17	-15416.95842	6554.83587	5.5319
LUBSW	25	-1707.88806	925.40560	3.4061
ACHTRF	36	52.08708	15.53147	11.2469
NQAPT	42	-2235.37148	357.05584	39.1947
NQTRFV	43	149.89748	14.39017	108.5068
SQAPT	44	1368.16596	342.35867	15.9704
ISIZE	46	791.77851	330.61090	5.7355
LAAPT2	48	3.77550	.53032	50.6841
LGISIZ	50	19586.74839	3200.40918	37.4630
SQTBP	51	-1261.85213	349.54931	13.0317
LUBSW2	56	114.62631	32.21521	12.6604

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	-.04996	.0714	.6530
LUB	4	-.00963	.1447	.0242
LUA	5	-.01089	.2481	.0310
SITEQ	6	.02047	.2676	.1094
ACBD	7	.07384	.3478	1.4309
APT	8	.07103	.3389	1.3236
AHWY	9	-.06409	.1898	1.0765
NEIGHQ	10	.03718	.2261	.3612
HWYQ	11	.00209	.0430	.0011
TRAFV	12	-.02307	.0518	.1390
RAILQ	13	.01746	.2272	.0796
LOCAL	14	.07154	.3692	1.3428
CHWY	15	-.06470	.2550	1.0972
TKNOW	18	-.05176	.0643	.7010
THOW	19	-.04259	.0615	.4743
TRAIL	20	-.02150	.0546	.1207
TBYPS	21	-.03477	.0383	.3159
LUBSIZ	22	-.08601	.0257	1.9454
LUBLUB	23	-.02643	.1853	.1824
LUBLUA	24	-.02367	.1879	.1463
LUBAPT	26	-.01215	.0316	.0385

TABLE A8.10

REGRESSION MODEL U5-3

STEP NUMBER 14
VARIABLE REMOVED 52

MULTIPLE R .9680
R SQUARED .9370 C.V. = 28.6%
STD. ERROR FOR RESIDUALS 1337.6052

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	10	6916047514.6716	691604751.4672	386.5468
RESIDUAL	260	465188771.9966	1789187.5846	

VARIABLES IN EQUATION

INTERCEPT = -7151.88631

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
POPLN 17	1895.07108	676.41612	7.8492
LUBSIZ 22	-131.11956	40.95969	10.2476
LBAPT2 29	-1.58974	.37411	18.0579
LUBTKN 30	46.76546	7.62812	37.5851
SQISIZ 38	536.53570	52.38137	104.9165
NQNQ 40	216.39129	25.09481	74.3552
ACHTRF 45	.01387	.00396	12.1553
IAPT 49	2721.99600	183.85046	219.2025
LGIAPT 51	-4410.53246	641.09582	47.3300
LAAPT2 54	2.14695	.30044	51.0651

VARIABLES NOT IN EQUATION

VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME 2	.04435	.2580	.5104
SIZE 3	.03954	.7504	.4056
LUB 4	-.06449	.3586	1.0817
LUA 5	-.03293	.6689	.2812
SITEQ 6	.02748	.3743	.1958
ACBD 7	-.05531	.0465	.7948
APT 8	-.02192	.0401	.1245
AHWY 9	-.05260	.4554	.7187
NEIGHQ 10	-.06610	.0249	1.1365
HWYQ 11	.06131	.2936	.9772
TRAFV 12	.04392	.2629	.5005
RAILQ 13	-.03460	.4381	.3140
LOCAL 14	.04442	.5529	.5120
CHWY 15	-.05706	.4780	.8460
CSMSA 16	-.03202	.3276	.2659
TKNOW 18	.04452	.2499	.5143
TROW 19	.04440	.2485	.5115
TRAIL 20	.04212	.2510	.4604
TRYPS 21	.03073	.2912	.2448
NQAPT 23	-.01528	.0318	.0605
LUBLUA 24	-.04355	.3769	.4921
LUBSQ 25	-.02172	.3876	.1223
LUBAPT 26	-.03503	.0042	.3182
LUBAHW 27	-.04789	.6272	.5954
LUBNQ 28	-.05105	.1226	.6767
LUALUA 31	-.03011	.6221	.2351
LUATRF 32	.00935	.2865	.0226
LUAAPT 33	.01329	.0268	.0457
ACBD2 34	-.02867	.1633	.2130
AHW2 35	-.06199	.5333	.9990

TABLE A8.11

REGRESSION MODEL U5-3

APPENDIX II. FIGURES

Segment	Length Miles	Year Opened
Loop 13 – FM 1516	4.8	59
FM 1516 – Bexasr 1 Guadalupe C.L.	8.7	62
Bexasr 1 Guadalupe C.L. – W. Seguin	9.1	62
W. Seguin – E. Seguin	8.9	68
E. Seguin – Guadalupe Caldwell C.L.	17.6	71
Guadalupe Caldwell C.L. – Caldwell Gonzales C.L.	6.0	72
Caldwell Gonzales C.L. – US 90	18.7	72
US 90 – N. Flatonia	8.7	71
N. Flatonia – FM 2238	6.4	70
FM 2238 – US 77	6.1	69
US 77 – Fayette/Colorado C.L.	5.0	68
Fayette/Colorado C.L. – Glidden	10.3	69
Glidden – FM 102	10.5	64
FM 102 – SH 36	20.3	66
SH 36 – Fort Bend/Harris C.L.	21.0	67
Fort Bend/Harris C.L. – Addix	10.3	66
Addix – IH 45	12.1	55

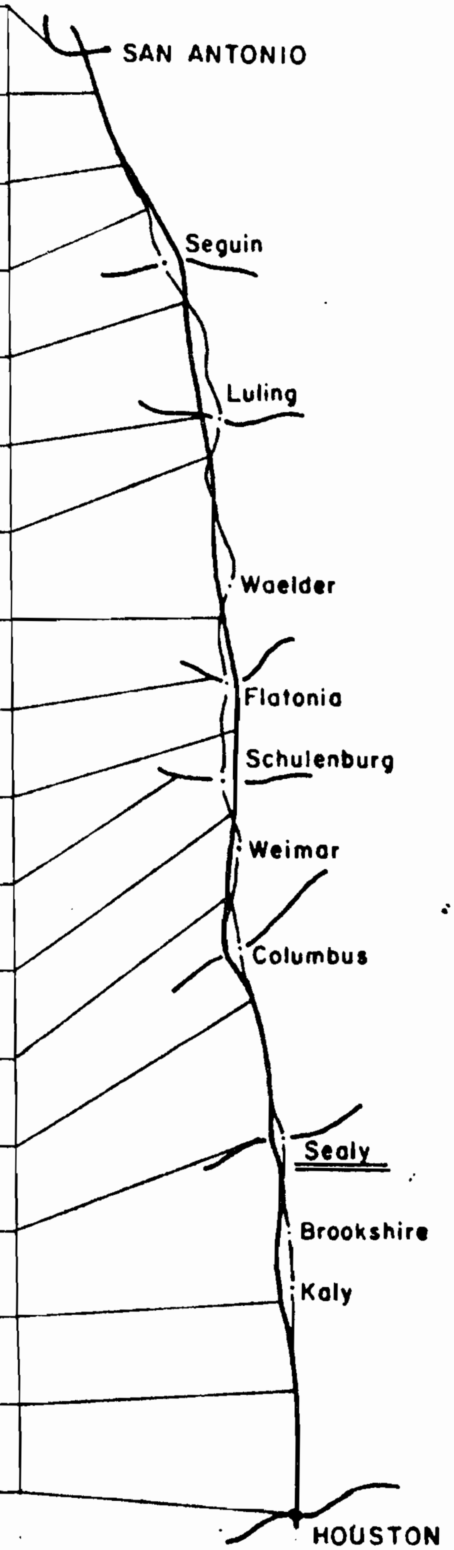


FIGURE A6.1. COMPLETION OF IH 10

SAN ANTONIO - HOUSTON

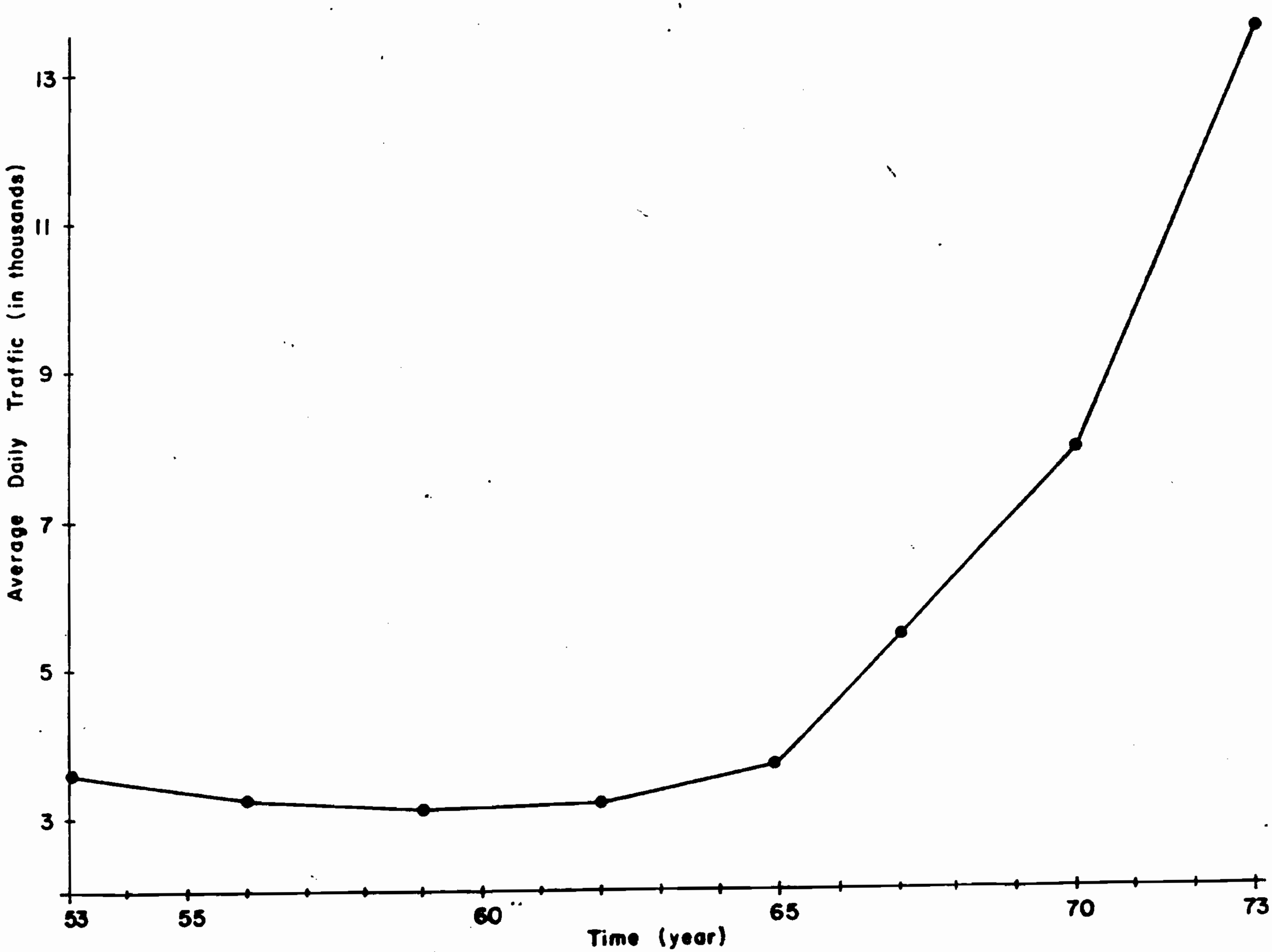


FIGURE A6.2: TRAFFIC VOLUMES, US 90/IH 10 SAN ANTONIO - HOUSTON
AUSTIN COUNTY LINE, WEST

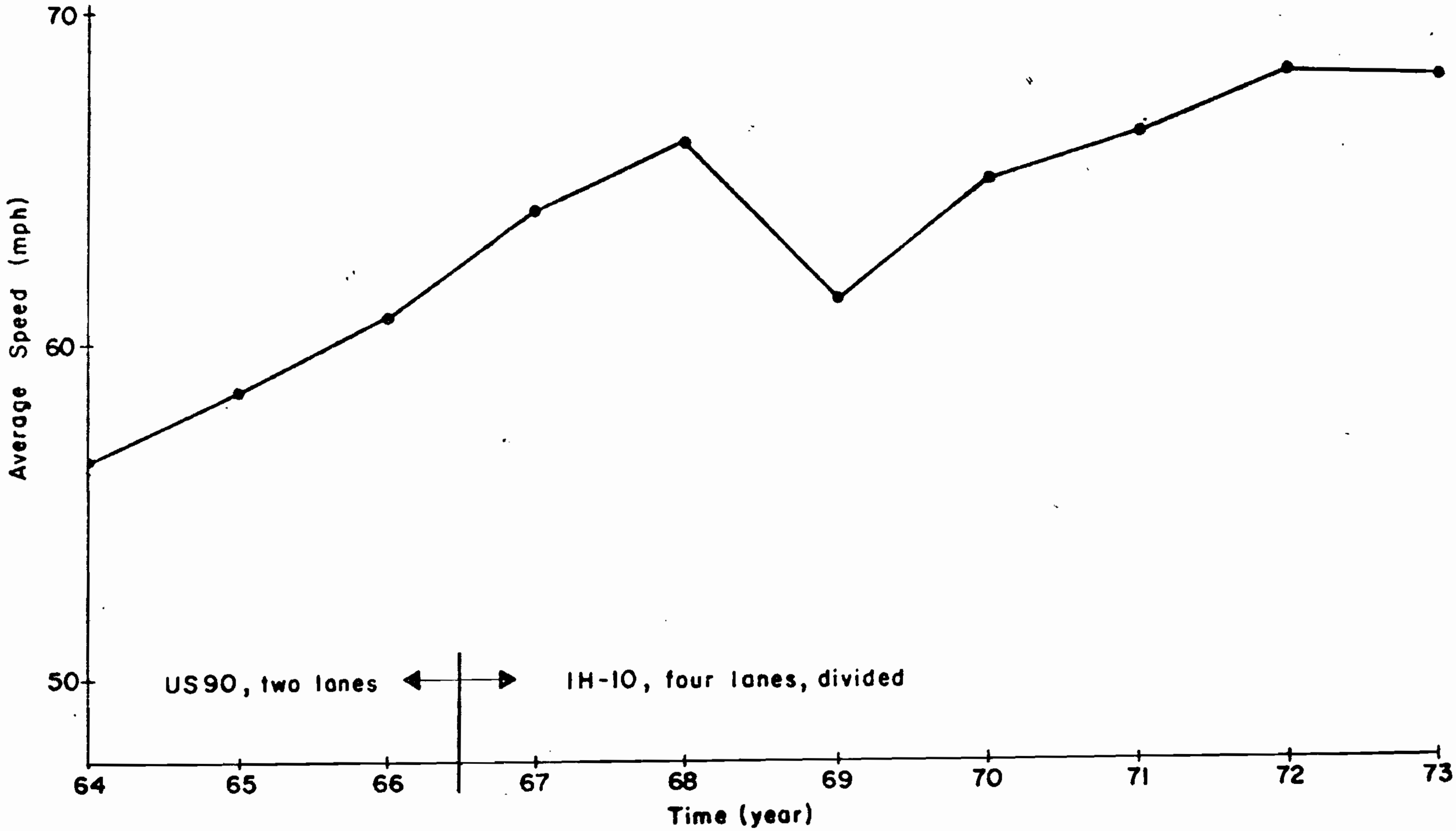


FIGURE A6.3.: SPEED VARIATION ON US 90/IH 10,
9 MILES WEST OF SEALY
1964 - 1973

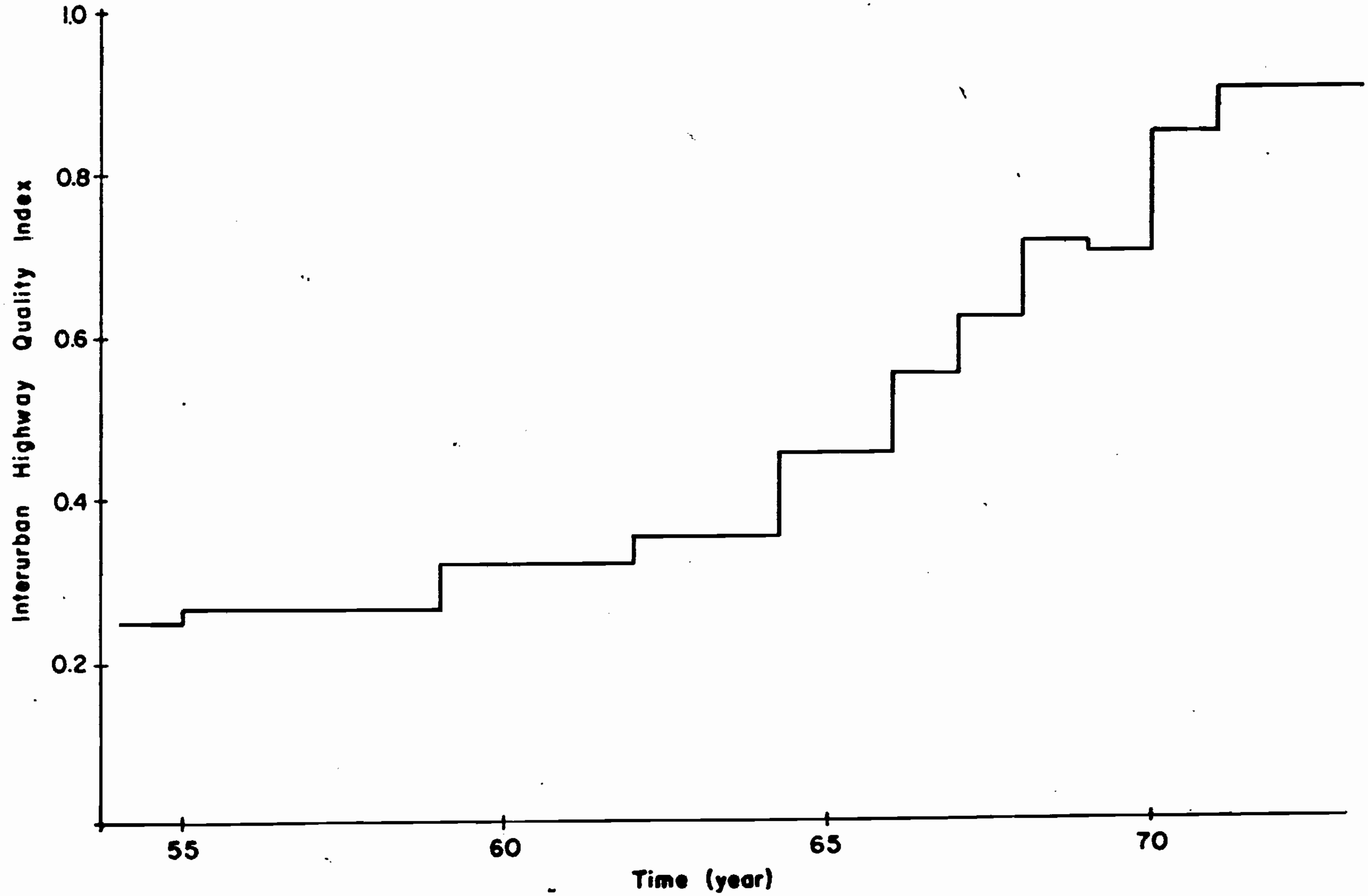


FIGURE A6.4: INTERURBAN HIGHWAY ROUTE QUALITY INDEX,

US 90/IH 10 SAN ANTONIO - HOUSTON

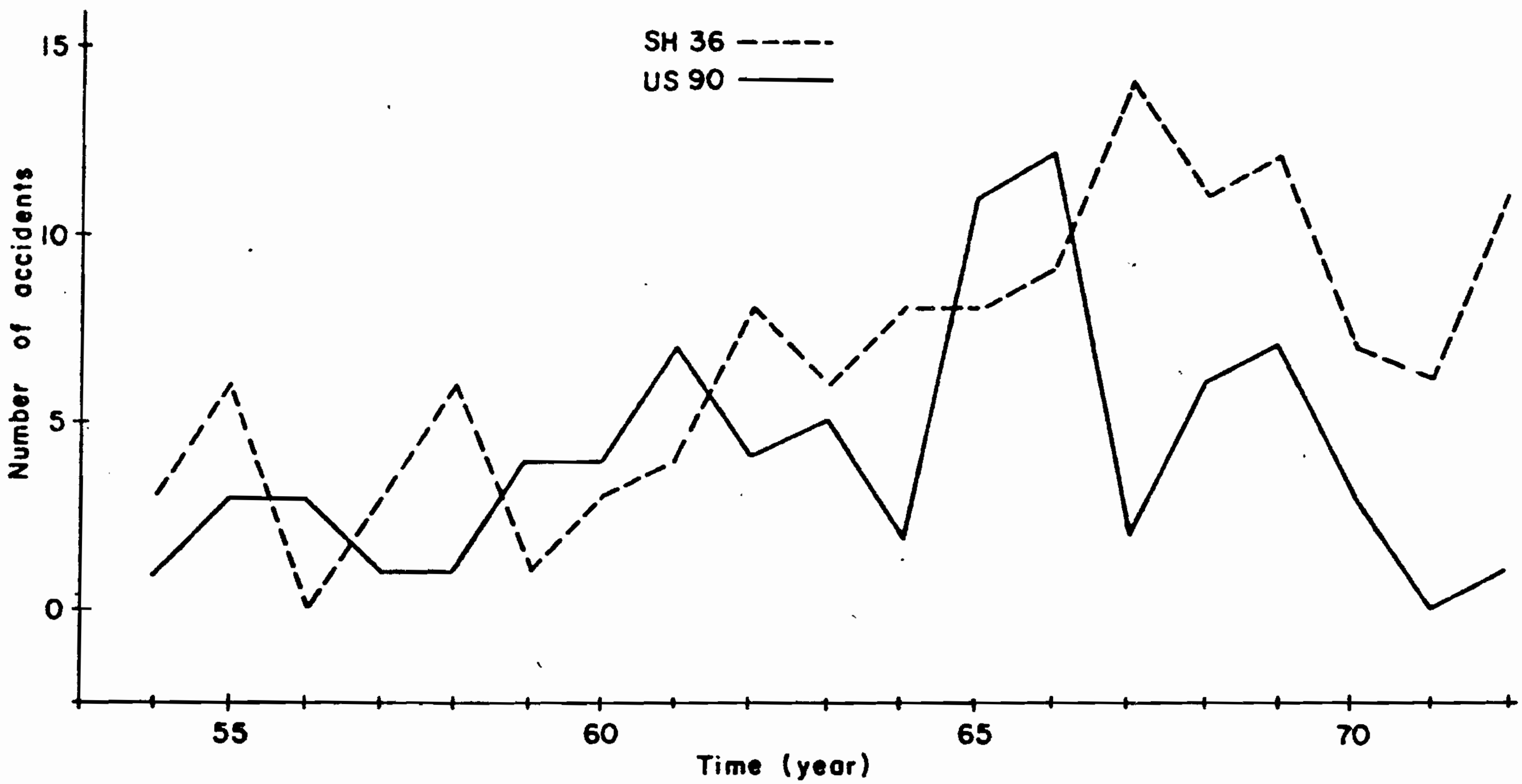


FIGURE A6.5.: NUMBER OF REGISTERED FATAL AND INJUROUS TRAFFIC ACCIDENTS INCLUDES 12.6 MILES ON SH36 AND 3.1 MILES ON US 90 IN SEALY

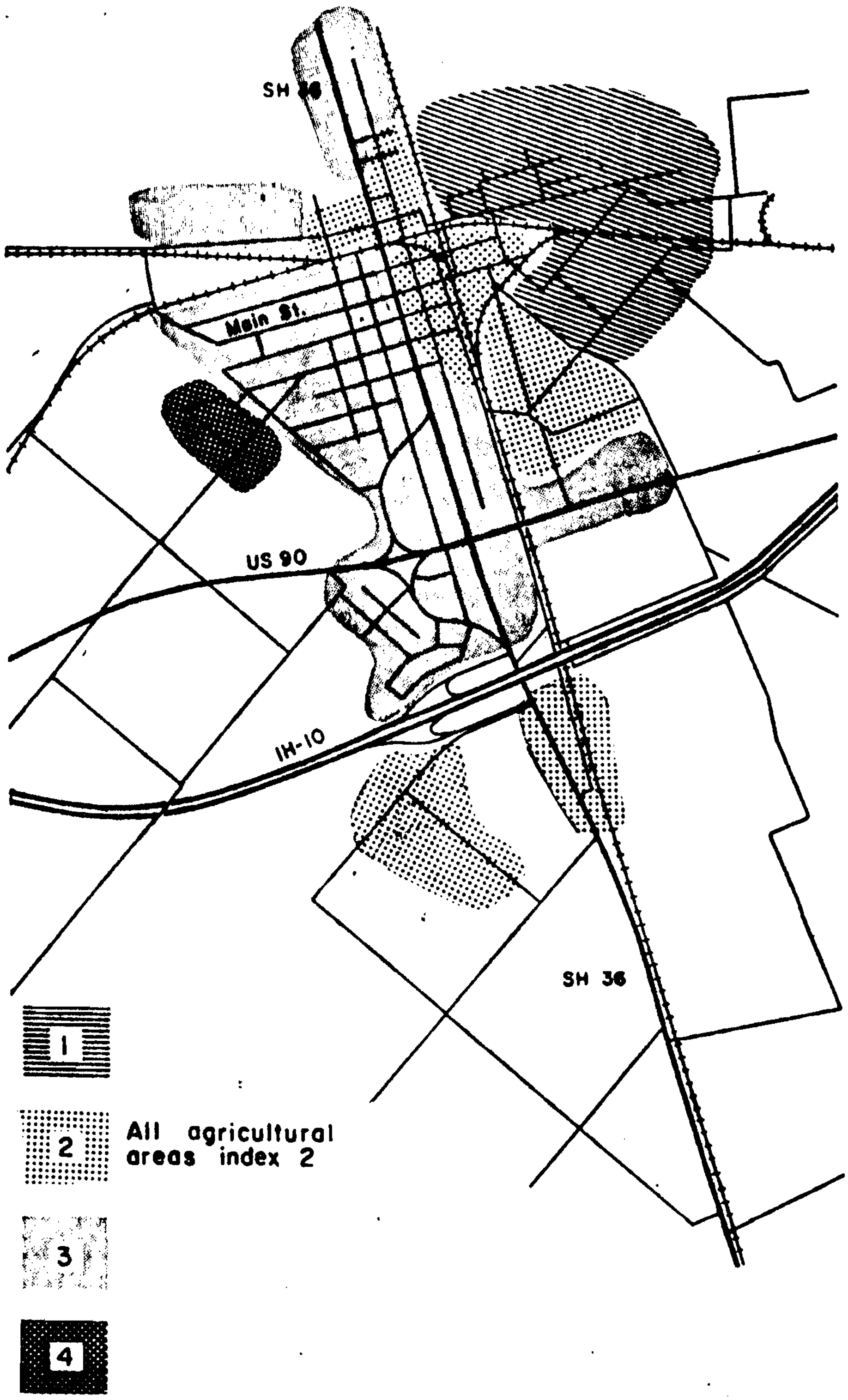


FIGURE A6.6.: NEIGHBORHOOD QUALITY INDICES, SEALY

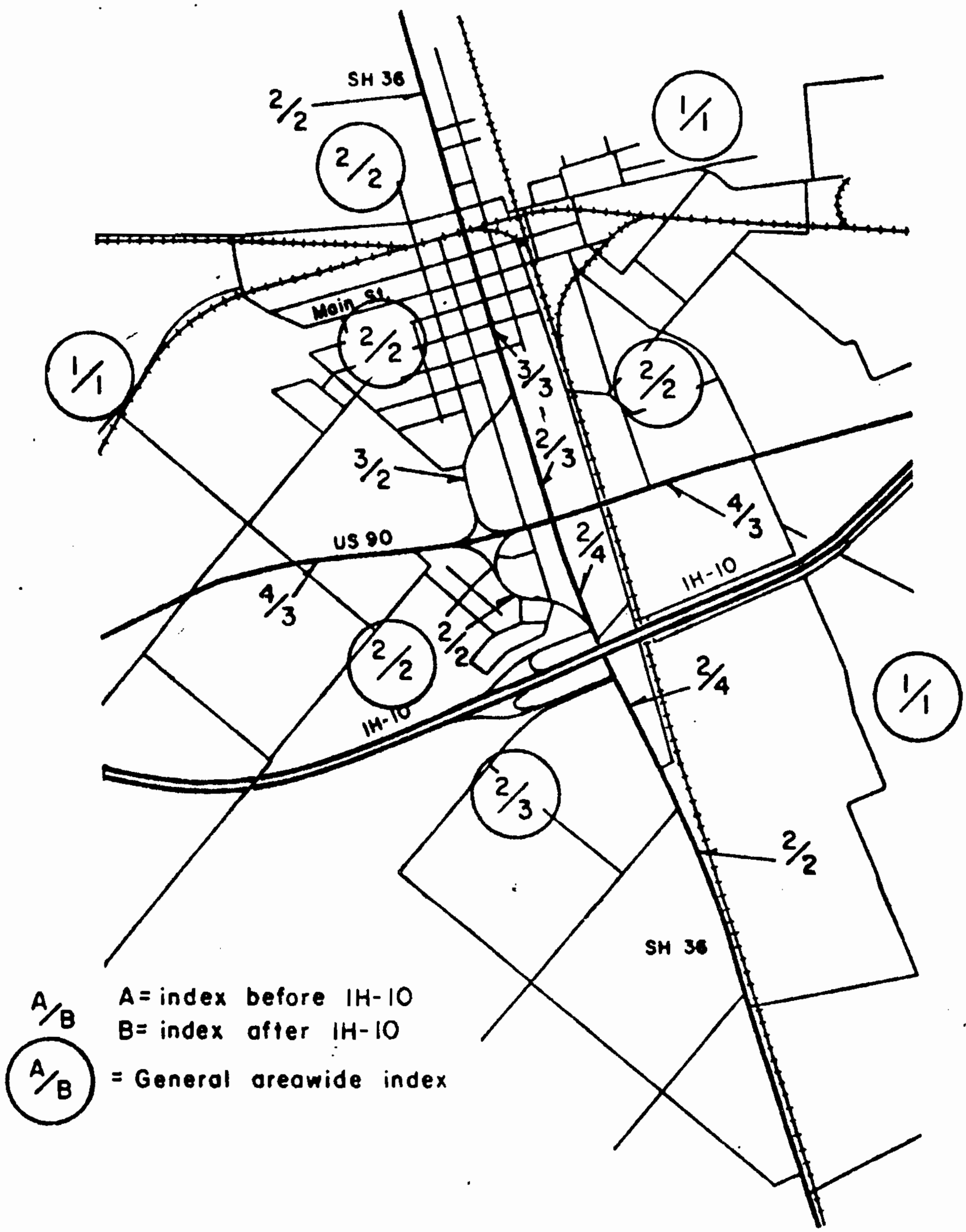


FIGURE A6.7.: RELATIVE PARCEL LOCATION RATINGS, SEALY

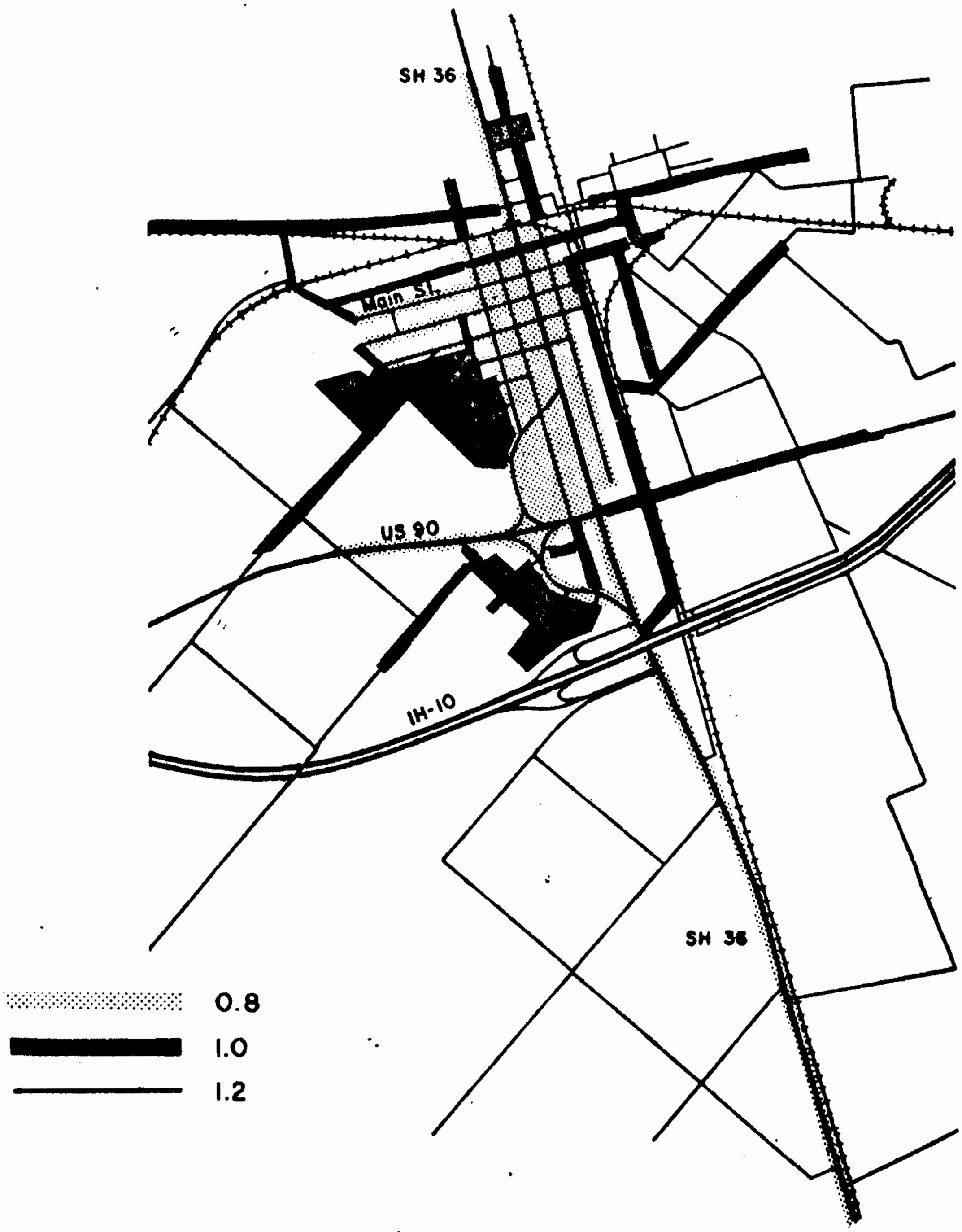


FIGURE A6.8.: STREET ADJUSTMENT FACTORS, SEALY

ANNOTATED LIST OF RESEARCH REPORTS

Ashley, R. H., and W. F. Berard. "Interchange Development Along 180 Miles of I-94." Highway Research Record No. 96, Highway Research Board (1967), pp 46-58.

A study of land use related to interchange type (full, partial and closed interchanges) and interchange location (major city, secondary city, small town, rural) (Michigan). Also examines land value and gallonage for service stations.

Babcock, W. F., and S. Khasnabis. "Land Use Changes and Traffic Generation On Controlled Access Highways in North Carolina." North Carolina State University at Raleigh, 1971, pp 1-20.

A study of 221 interchanges along a total of 550 miles of controlled access freeway in North Carolina. Investigation of land development and land use in the interchanges for urban, suburban and rural areas.

Bardwell, G. E., and P. R. Merry. "Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value." Bulletin 268, Highway Research Board (1960), pp 37-73.

Study of the influence of U.S. 85 and U.S. 87 on business activity and land values in certain bypassed Colorado communities. Business activity expressed by sales tax collections, land values by sales price per acre. Land values seems to decline with increasing distance from an urban community.

Beimborn, E. A., B. P. Nedwek, and C. R. Ryan. "An Evaluation of the Feasibility of Social Diagnostic Techniques in the Transportation Planning Process." Highway Research Record 410, Highway Research Board (1972).

Survey (questionnaire) which shows demographic characteristics, attitudes towards transportation services, attitudes towards non-transportation services, and analysis of freeway support and opposition to a freeway project in Milwaukee.

Bone, A. J., and M. Wohl. "Massachusetts Route 128 Impact Study." Bulletin 227, Highway Research Board (1959).

The principal impact of route 128 (circumferencing Boston about 60 miles from CBD) has been the channeling of industrial development into the towns through which it passes. Residential development has also been stimulated in areas along the highway.

Bouchard, R. J., E. L. Lehr, M. J. Redding, and G. R. Thomas. "Techniques for Considering Social, Economic, and Environmental Factors in Planning Transportation Systems." Highway Research Record No. 410 (1972), pp 1-7.

Use of an "urban planning matrix" as a tool in the comprehensive transportation planning process. Nothing is explained about how to find the value of the different factors which are the elements in the matrix.

Bowersox, Donald J. "Influence of Highways on Selection of Six Industrial Locations." Bulletin 268, Highway Research Board (1960), pp 13-28.

A group of industrial firms were interviewed about the importance of location adjacent to freeway access. The influence of highway facilities on the selection of these plants was considered as important, but not critical (Michigan).

Buffington, J. L., and H. G. Meuth. "Economic Impact Restudy, Temple, Texas." Texas Transportation Institute, Bulletin 27 (1964).

Restudy of the economic impact of the new bypass route of IH35, Temple. This study includes a second "after construction period" - otherwise it is the same as a previous study, TTI Bulletin No. 14 (1960).

Buffington, J. L. "Economic Impact Study, Rural Area East of Houston, Texas." Texas Transportation Institute, Bulletin 37 (1967).

The economic impact of IH10 on a rural area, about 15 miles east of Houston, Texas. Changes in land values, land use, and business activity.

________________. "Economic Impact Study, Chambers County, Texas." Texas Transportation Institute, Bulletin 39 (1967).

A study of the economic impact in a study area in Chambers County, Texas, along a 14 mile-long section of IH10. There was no other route before the construction of IH10, and land use was agricultural. The study includes changes in land values, land use and business activity.

________________. "Economic Impact Study, Huntsville, Texas." Texas Transportation Institute, Bulletin 38 (1967).

A study of the impact of IH45 on Huntsville, Texas. Influence on land values, land use, business activity, travel patterns and general community development.

________________. "Economic Impact Study, Conroe, Texas." Texas Transportation Institute, Bulletin 40 (1967).

A study of economic impact of IH45 on Conroe, Texas. Includes land values, land use, business activity, travel patterns, and general community development.

________________. "Economic Impact Study, Waxahachie, Texas." Texas Transportation Institute, Bulletin 35 (1966).

An economic impact study of IH35E on Waxahachie, south of Dallas. Includes changes in land values, land use, business activity and other economic considerations.

________________. "Economic Impact Study, Merkel, Texas." Texas Transportation Institute, Bulletin 36 (1966).

Brinton, Jr. J. H., and J. N. Bloom. "Effect of Highway Landscape Development on Nearby Property." National Cooperative Highway Research Program, Report No. 75 (1969).

Physical disturbance (noise, vibration) on 800 properties adjacent to highway is analyzed to find the correlation to differences in property values. Concludes that sound from trucks is the most objectionable highway disturbance to residential areas.

Burke, D. E., J. L. Buffington, H. G. Meuth, W. G. Adkins, and D. Schafer. "Attitudes, Opinions, and Expectations of Businessmen in a Planned Freeway Corridor." Texas Transportation Institute, Study 2-1-71-148, Research Report 148-2.

Discussion of how businessmen obtain information about a freeway project, their attitudes (pro vs. con), preferences with regard to freeway location and design, and expectations about how the freeway will affect their business decision-making.

Charles River Associates, Inc. "Measurement of the Effects of Transportation Changes." National Technical Information Service Report PB-213 491 (September, 1972).

The report discusses methodologies used in previous studies, analyzes the problem of measuring urban transportation impacts. Also discussion of the theory of transportation impact, relevant variables, and guidance to existing sources of information (data).

Cribbins, P. D., W. T. Hill, and H. O. Seagraves. "Economic Impact of Selected Sections of Interstate Routes on Land Value and Use." Highway Research Record No. 75, Highway Research Board (1965), pp 1-31.

An effort to find the influence on land value and use by use of multiple regression techniques. Great variations for different sites. Land value = f (size of parcel, year of sale, vacant -non-vacant land use, rural-urban land use, subdivision, roadside, alternate roadway, distance to right-of-way, distance to CBD, distance to access.

Dansereau, H. Kirk. "Five Years of Highway Research: A Sociological Perspective." Highway Research Record No. 75, Highway Research Board (1965), pp 76-81.

Discusses various highway-community relationships, namely, population, changes in levels of linving as measured by a social class rating, community values as evidenced to an extent by attitudes expressed, and degree of community organization as ascertained through use of an Index of Community Complexity. Sites studied in Pennsylvania - Monroeville (Pittsburgh), Blairsville (Indiana County) and four interchanges near York.

Dansereau, H. K., R. A. Rehberg, and J. R. Maiolo. "Specified Social Determinants of Attitudes Toward Community Planning and Zoning." Pennsylvania State University (1966).

Study of attitudes toward planning and zoning in interchange communities, and identification of some factors related to differences in those attitudes.

Ellis, Raymond H. "Toward Measurement of the Community Consequences of Urban Freeways." Highway Research Record No. 229, Highway Research Board (1968), pp 38-52.

This article proposes a strategy for quantitative estimation of community consequences of urban freeways. Discussion about how to consider community consequences and transportation impact on the existing community linkages.

Ellis. R. H., and R. D. Worral. "Towards Measurement of Community Impact: The Utilization of Longitudinal Travel Data to Define Residential Linkages." Highway Research Record No. 277, Highway Research Board (1969), pp 25-39.

An effort to present a methodology for using residential linkages as a strategy for measuring community impact of transportation projects.

Eyerly, Raymond W. "Land Use and Land Value in Four Interchange Communities: An Interim Report on the York Study." The Pennsylvania State University, 1968.

The study included all properties within two miles of the interchanges. It investigates the rate of formation of new properties, types of land uses, and changing land values.

Fabbroni, Lawrence P. "Land Use Development at Interstate Interchanges in Indiana." Joint Highway Research Project, Purdue University, Project C-36-70D, May, 1973, pp 1-85 and appendices.

Brief review of past research in this area: collects data from 102 interchanges along 8 interstate sections and makes an effort to set up a model to determine the extent of land use development along crossroads (1 mile to each side). More detailed studies of 10 intersections and discussion of available planning tools which might have been used in one of the "case areas."

Fleishman, Edward R. "The Impact After Seven Years of a Highway Improvement in a Small City." Joint Highway Research Project C-36-64D, Purdue University, May, 1968.

Study from Lafayette, Indiana (population 62,000 in 1967), considering changes in traffic patterns, accidents, travel times, and to some degree land use, values, due to construction of a new bridge over Wabash River.

Franklin, William D. "The Effect of Access on Right of Way Costs and the Determination of Special Benefits. Texas Transportation Institute, Research Report No. 82-1F (1968).

The effects of granted access contrasted with non-access on amount paid for damages connected with property acquisition.

Frey, J. C., H. K. Dansereau, R. D. Pashek, and A. Twark. "Land Use Planning and the Interchange Community." Bulletin 327, Highway Research Board (1962).

Discussion of land-use adjustment at interchange locations and importance of land-use regulations and control in preserving highway efficiency. No methodology to predict development which will take place at the interchange.

Garrison, William L. "Land Uses in the Vicinity of Freeway Interchanges." University of Washington, December 1961.

Discussion of simulation models of interchange - urban growth and development, a deterministic land development model, and the problems of estimation of supply and demand in the vicinity of freeway interchanges.

Goldberg, Michael A. "Economics of Transportation Corridors: Further Empirical Analysis." Highway Research Record 410, Highway Research Board (1972), pp 37-51.

Study of 325 properties within 0.2 mile of the Trans-Canada Highway (Vancouver). Showed that even the properties closest to the freeway only increased at a compound annual rate of 2.85 percent net inflation (properties in Richmond as a whole 5.23 percent net inflation).

Greenbie, B. B. "Interchange Planning in Rural Area." Traffic Quarterly, April, 1970, pp 265-278.

Example of interchnge area planning (1-90 and 1-74) in Monroe County, Wisconsin.

Grossman, D. A., and M. R. Levin. "Area Development and Highway Transportation." Highway Research Record 16, Highway Research Board (1963).

Discussion of "distressed" areas in the light of Area Redevelopment Act of 1961.

Holshouser, E. C. "An Investigation of Some Economic Effects of Two Kentucky Bypasses: The Methodology." Bulletin 268, Highway Research Board (1960), pp 74-79.

One bypass provided free access, the other limited access. The belt-line had positive influence mainly within 1/4 mile of the facility, the effect of the limit access expressway reached 2-3 miles. Discussion of methodologies: survey-control area comparison, case study method, multiple regression analysis, projected land use-value relationship approach.

Horwood, Edgar M. "Freeway Impact on Municipal Land Planning Effort." Bulletin 268, Highway Research Board (1960), pp 1-12.

A discussion of some factors which impose limitations on the city planning and highway development processes.

Isibor, Edward I. "Modeling the Impact of Highway Improvements on the Value of Adjacent Land Parcels." Joint Highway Research Project C-36-64G, Purdue University, (December, 1969).

Use of regression analysis to find a model for change in land value as a function of size, time after construction, type of highway, type of land use, type of area, and type of access control. Only adjacent parcels (from two right-of-way studies, Florida and Indiana) included in the study.

Jordan, Jack D. "Final Report on Studies of Right of Way Remainders." Texas Highway Department, 1970.

Analysis of 300 remainder properties from Right of Way taking. Relationship of dollar amount of appraised damages to actual damages or enhancements.

Kahn, H. M., and A. Kriken. "Social Characteristics of Neighborhoods as Indicators of the Effects of Highway Improvements." Marshall Kaplan, Gans, and Kahn, San Francisco, California.

Study of the social impact of highways on neighborhoods (4 cases), where a predictive "Social Feasibility Model" was developed. The model is based on secondary data. No quantitative measurement of the degree of impact.

Kemp, Barbara H. "Social Impact of a Highway on an Urban Community." Highway Research Record No. 75, Highway Research Board (1965), pp 92-102.

Discusses the effects of a loop through D. C. on those who would have to move and those who would remain in the area and to formulate programs to reduce possible harmful effects on the people concerned.

Kiley, Edward V. "Highways as a Factor in Industrial Location." Highway Research Record No. 75, Highway Research Board (1965), pp 48-52.

Survey of 4,150 industrial establishments, by American Trucking Association. Included all states. Proximity to highways was found to be one of the most frequently mentioned location factors.

Klein, G. E., et al. "Methods of Evaluation of the Effects of Transportation Systems on Community Values." Stanford Research Institute, April, 1971.

An effort to develop methods of identifying, measuring and valuating selected community attributes that are affected by transportation system changes. Looks into the effects of accessibility to services, property development, relocation, disruption, and noise and air pollution.

Lang, A. S., and M. Wohl. "Evaluation of Highway Impact", Bulletin 268, Highway Research Board (1960), pp 105-119.

The authors state that "there is no logical basis for assuming highway improvements can produce any net economic benefits over and above user (vehicular) benefits." Secondary benefits such as increase in land values, etc., however, are of importance in the over-all picture of land-use development. Followed by a discussion of the arguments by Sidney Goldstein, Bureau of Public Roads.

Levin, David R. "Informal Notes on Sociological Effects of Highways." Highway Research Record No. 75, Highway Research Board (1965), pp 82-84.

Raises questions on the degree transportation and sociology are related. Also, some considerations a transportation planner should look at. Concerned mainly with urban transportation.

Levin, D. R. "The Highway Interchange Land-Use Problem." Bulletin 288, Highway Research Board (1961), pp 1-24.

Rather general discussion of development at freeway interchanges, land use problem at the interchange, types of land associated with interchanges, land use and access control.

Long, Gale A, Gary D. Long, and Raymond W. Hooker. "A Corridor Land Use Study: The Impact of an Interstate Highway on Land Values, Private Investment and Land Use in Southwestern Wyoming." Division of Business and Economic Research, University of Wyoming, October, 1970.

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Longley, J. W., and B. T. Goley. "A Statistical Evaluation of the Influence of Highways on Rural Land Values in the United States." Bulletin 327, Highway Research Board (1962), pp 21-55.

Analysis of 5,000 rural land sales, to determine existing differences in land values by type of road as to price per acre and distance from nearest trading center. Distance to nearest trading center seems to be most significant.

McKain, W. C. "Community Response to Highway Improvement." Highway Research Record No. 96, Highway Research Board (1965), pp 19-23.

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Miller, Stanley F., Jr. "Effects of Proposed Highway Improvements on Property Values." National Cooperative Highway Research Program, Report 114 (1971).

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Meuth, H. G. "Right of Way Effects of Controlled Access Type Highway on a Ranching Area in Madison County, Texas." Texas Transportation Institute, Research Report 58-4 (1968).

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Meuth, H. G. "Right of Way Effects of Controlled Access Type Highway on a Farming Area in Colorado and Fayette Counties, Texas. Texas Transportation Institute, Research Report 58-6 (1970).

How operators in a diversified farming area were affected by, and how they adjusted to right of way acquisitions for IH70, in Colorado and Fayette Counties. (Land value, land use, travel patterns, and income, etc.)

National Center for Highway Research. "A Review of Transportation Aspects of Land-Use Control." National Cooperative Highway Research Program, Report No. 31 (1966).

Mainly a literature review on the subject of the relationships between land-use control, traffic generation and transportation systems in urban areas. Chapters: Urban Structure, Land-use Control, Land-use Stability, The Highway System, Highway Functional Classification, Access Controls, Highway Design Control, Traffic Generation, Freeway Interchanges.

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Pendleton, W. C. "Relation of Highway Accessibility to Urban Real Estate Values." Highway Research Record No. 16, Highway Research Board (1963).

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Pillsbury, Warren A. "Economics of Highway Location: A Critique of Collateral Effect Analysis." Highway Research Record No. 75, Highway Research Board (1965), pp 53-61.

Discussion of different methods for economic analysis of possible highway locations. Highway economic impact may be one factor in the analysis, but nothing is said about how to calculate economic effect in a highway corridor.

Raup, P. M. "The Land Use Map Versus the Land Value Map - A Dichotomy." Bulletin 227, Highway Research Board (1959), pp 83-88.

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Sauerlender, O. H., R. B. Donaldson, and R. D. Twark. "Factors That Influence Economic Development at Non-urban Interchange Locations." The Pennsylvania State University, 1967.

The development in 36 typical interchanges in Pennsylvania was analyzed on the background of the characteristics of each interchange and the surrounding region. Indicates factors that should be useful as predictors of development.

Skorpa, L., Dodge, R., Walton, C. M. and Huddleston, J. "Transportation Impact Research: A Review of Previous Studies and a Recommended Methodology for the Study of Rural Communities." The University of Texas at Austin, 1974.

Spears, John D., and Charles G. Smith. "Final Report on a Study of the Land Development and Utilization in Interchange Areas Adjacent to Interstate 40 in Tennessee." University of Tennessee, July, 1970.

Study of adjacent properties to 74 interchanges on I-40 between Memphis and Knoxville, with listing of tracts, property sales and land uses. Summary of interchange development in different groups of interchanges.

Stein, Martin M. "Highway Interchange Area Development - Some Recent Findings." Public Roads Vol. 35, No. 11 (December, 1969), pp 241-250.

The study of 332 interchanges in 16 states shows that interchange land development is affected both by type of intersecting road and by the relative accessibility of the interchange quadrants.

Stover, V. G., W. G. Adkins, and J. C. Goodknight. "Guidelines for Medical and Marginal Access Control on Major Roadways." National Cooperative Highway Research Program, Report 93 (1970).

One of the chapters, "Highways and Economic Development," summarizes previous research about economic impact on land values in interchanges, bypass effect, etc.

Stroup, R. H., and L. A. Vargha. "Economic Impact of Secondary Road Improvements." Highway Research Record No. 16, Highway Research Board (1963), pp 1-13.

The study may show that there is a relationship between changes in retail business and road improvement. The geographic dispersion of business may be expressed as a function of population density, per capita income and proportions of farms on all-weather roads. Rural area (six counties) in Kentucky.

Stroup, R. H., L. A. Vargha, and R. K. Main. "Predicting the Economic Impact of Alternate Interstate Route Locations." Bulletin 327, Highway Research Board (1962), pp 67-72.

Report of a study method used in an examination of the comparative economic impact of three alternative routes for 1-65, Kentucky.
Use of the concept of an economically "neutral" road, against which the three alternative routes are compared (on the basis of access, visibility of establishment, development potential, etc.)

Texas Aeronautics Commission. "Importance of a Modern Airport, Austin, Texas, 1965."

Attitude survey among towns and small communities in Texas about how important they consider an airport to be.

Texas Transportation Institute. "Economic Effects of Bypasses and Freeways." Bibliography.

Listing and short description of 38 papers and studies about economic effect of highways.

Thiel, Floyd I. "Social Effects of Modern Highway Transportation." Bulletin 327, Highway Research Board (1962), pp 1-20.

Discussion of some ways in which highways affect the way of living. Effect on population mobility, residences, relocation, employment conditions, public services, education, rural employment and improvement (reference to a study, Montana), recreation, etc.

____________. "Seminar on Sociological Effects of Highway Transportation, Introductory Remarks." Highway Research Record No. 75, Highway Research Board (1965), p 75.

Five different articles, dealing with sociological effects and (one article) trip generation.

____________. "Highway Interchange Area Development." Public Roads Vol. 33, No. 8 (June, 1965), pp 153-166.

About controlling the development in interchange areas. Includes discussion of development problems, available means of controls, application of control, space needs at interchanges, and techniques to implement interchange planning.

U. S. Congress. "Final Report of the Highway Cost Allocation Study." House Document No. 72, 87th Congress, 1st Session, January 1961.

Mainly summary of changes in land values from previous highway impact studies.

U. S. Department of Transportation. "Benefits of Interstate Highways." Federal Highway Administration, U. S. Department of Transportation, June 1970.

Summary of user and non-user benefits from interstate highways. General economic and community benefits: land use and value, industrial and commercial effect, non-work opportunities, opportunities for community change, etc.

U. S. Department of Transportation. "Economic and Social Effect of Highways." Federal Highway Administration, U. S. Department of Transportation, 1972.

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U. S. Department of Transportation. "Guide for Highway Impact Studies." Federal Highway Administration, 1973.

States the need for impact studies and indicates types of studies that may be especially appropriate in identifying social and economic effects. Lists and describes socioeconomic studies proposed, studies in progress, and studies recently completed.

Vargha, Louis A. "Highway Bypasses, Natural Barriers, and Community Growth in Michigan." Bulletin 268, Highway Research Board (1960), pp 29-36.

The freeway as a physical barrier.

Vaughan, C. M. "Development Aspects of Kentucky's Toll Roads." American Society of Mechanical Engineering Publication 73-ICT-19 (1973).

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Warner, A. E. "The Impact of Highways on Land Uses and Property Values." Michigan State University, March, 1958.

A Review of current studies with bibliography.

Wheat, Leonhard F. "The Effect of Modern Highways on Urban Manufacturing Growth." Highway Research Record No. 277, Highway Research Board (1969), pp 9-24.

Nationwide study of manufacturing growth in 212 cities (population 10,000-50,000), 106 "freeway-cities" (< 7 miles from freeway) and 106 "non-freeway-cities" (> 16 miles from freeway). The study findings indicate that modern highways do significantly affect manufacturing growth, but not in all situations. Freeway-cities grew faster only in regions where traffic flow along regular highways is seriously impeeded. The study also considers effect of air service, rail, waterways, and distance to freeway.

Wootan, C. V. and H. G. Meuth. "Economic Impact Study, Temple Texas." Texas Transportation Institute, Bulletin 14 (1960).

Study of the economic impact of the new by-pass route for IH 35, Temple, Texas. The study area is located along a section (3 miles) of the new IH 35. Changes in land values compared to a control area; changes in land use along the new route; and changes in business activity along the new and old route.

Wynn, F. Houston. "Who Makes the Trips? Notes on an Exploratory Investigation of One-Worker Households in Chattonooga." Highway Research Record No. 75, Highway Research Board (1965), pp 84-91.

Studies question: given shorter working days and/or shorter working weeks - how will this affect future urban travel demands?

Zinkefoose, Paul W. "Economic Survey of Anthony. New Mexico - Texas." New Mexico State University, Bulletin No. 41 (May, 1970).

Study of the impact of highway relocation in a small town having practically no economic data. More or less a general description of the effect.

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TRANSPORTATION-RELATED CONSTRUCTS OF ACTIVITY SPACES OF SMALL TOWN RESIDENTS

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NOTICE

EXECUTIVE SUMMARY

INTRODUCTION

This report is concerned with one phase of a research project entitled, "The Influence on The Rural Environment of Interurban Transportation Systems." It represents an initial step in the attempt to develop a model for predicting how different groups in small urban areas will respond to proposed or actual changes in the interurban transportation system. At the same time, the research is part of a larger effort aimed toward developing improved models of behavior within urban activity spaces in general.

PROBLEM STUDIED

The nature of the activity spaces which people use for recurrent activities (shopping, work, recreation, etc.) has received considerable attention in recent studies. However, most work on an individual's activity spaces is founded on a classical geometric definition of place. In this report, an alternative concept of space is proposed based on a cognitive definition of place. Given a transportation system permitting movement within space, places which are used for recurrent activities are described by learned bundles of meaning (constructs).

Of special interest in this case are the cognitive definitions of place used by smalltown residents. While some work has been conducted with residents of larger urban areas, it is hypothesized that those from smaller communities will use different constructs in place definition.

RESULTS ACHIEVED

Using G. A. Kelly's personal construct theory[1] and elicitation procedures modified by P. Slater,[2] an experiment was designed to determine significant constructs used by small town residents to define their recurrent activity spaces. A sample of 31 Univeristy of Texas freshmen from towns ranging in population from under two thousand to twenty thousand was randomly chosen to participate in the experiment. There were two reasons for the choice of participants other than the size of their hometowns. First, the elicitation procedures used in the experiment are time-consuming, and thus a relatively small sample was selected. Second, since it has been found that construct elicitation requires an articulate group of respondents, university students were deemed an appropriate group from which to select subjects, although it was necessary that they were not long removed from a small town environment.

The actual procedure of obtaining the constructs was divided into five steps. First, each student was asked to list places within his/her hometown which he/she regularly visited. Each was asked to begin with "home" as the first place and then list the others in order of recall. In the second step, each participant listed twenty four places outside his/her hometown.

In the third step, each subject was presented with combinations of three places from each list. These combinations, or triads, were determined by randomizing procedures so that, for example, places numbered 1, 5, 16 might be presented as one combination to all students, even though these would represent different places for each person. The subject was then asked to put two members of the triad together on the basis of some characteristic which made them alike and opposite from the third.

The fourth step required the participant to label the two characteristics which he/she used to identify the two groups of the triad. Thus, for each triad two constructs were elicited. The subject was then asked to state which construct he/she preferred, and the total of these were set aside as "preferred constructs" for the next step in the experiment.

The final phase involved the use of a repertory grid. The preferred constructs were arranged in order of most to least preferred. These were then listed in the vertical margin of the grid. The numbers of each place listed by the student constituted the horizontal margin of the grid. Each subject was then asked to rate on a scale of 1 - 7 the amount of the quality that each place possessed.

The in-town and out-of-town repertory grids for a person summarize the individual's cognitive definitions of every component in his/her activity space. Consequently, the repertory grids of the 31 respondents, taken all together, summarize considerable information about transportation-related meanings of places in the activity spaces of smalltown residents in general.

A comparison of the preferred poles of the 31 subjects indicates marked differences in the names, number, and preferential order of the constructs on both in-town and out-of-town grids. Likewise, for each individual the names, number, and preferential order tend to differ depending on whether he/she is considering places within the hometown or outside of it.

As can be expected, the magnitude of variation in the total sample produces an unwieldly number of individually-defined constructs. However, taken together, a considerable quantity of information is provided concerning the preferred, transportation-related features of activity spaces.

In order to extract communality from the lists of many preferred poles, a modified principal components analysis (INGRID) is used to identify and give order to the attributes which give meaning to places for smalltown residents.

Through the principal components procedure, the multitude of verbal constructs elicited from the subjects is reduced to a manageable number of components (attributes). These attributes are named, following standard practice, by looking at the construct loadings on components.

As with the constructs, differences exist between individuals in their components for within-town grids, out-of-town grids, and the grids for each individual depending on whether he/she was considering within-town places or out-of-town places. Over the entire sample of subjects, however, many components were found to be common to several individuals, but at varying levels of salience. It seems clear that some communality and order in transportation-related definitions of activity spaces is revealed in these data through the use of INGRID.

Thus, the present procedures for searching for cognitive meanings of places will produce a considerable quantity of information which can be given a parsimonious form. However, there will be some arbitrariness in the final selection of components (attributes) to be used in further field research or for incorporation in models.

Nonetheless, some such degree of arbitrariness is required in these circumstances in any case. Moreover, a pilot study like the present one has the advantage that the subject's, rather than the researcher's, meanings of place can be used in later research.

In spite of the difficulties of the procedure so far recognized, its benefits seem clear. From a very large number of differentially-ordered and defined transportation-related constructs of urban activity spaces, a reduced number of operationally feasible attributes may be derived. These attributes, elicited from a small pre-sample, help define places within urban activity spaces in terms of their preferred meanings to individuals.

UTILIZATION OF RESULTS

The results of this research should be of value to federal, state, and local planning agencies and to research groups interested in the perceived impact of transportation investments as well as to those interested in the general problem of defining activity spaces. This experiment represents a first step toward identifying the attributes of places which smalltown residents perceive as being important.

CONCLUSION

It remains to illustrate in conclusion how the results of a small-sample study like the present one can be utilized to explain at least one kind of spatial behavior--in this case, the evaluation of the impacts on activity spaces of different transportation systems. At least one computerized model is available, INDSCAL, which will measure environmental utility for both individuals and groups under alternative transportation services.[3]

One essential requirement of this model is a list of semantic differential scales, with poles opposite in meaning, to define the important attributes of activity spaces under a transportation system. These scales are then used by an individual to score his/her activity space across as wide a range as possible of attributes which people regard as significant. The scores for an individual's activity space under different transportation alternatives are later manipulated to generate the required measures of environmental utility. The necessary semantic scales can obviously be generated by a judicious selection of the components describing activity spaces elicited from a small scale sample like the one above.

The second essential requirement of the INDSCAL model is that both the attributes and the saliences of the attributes of activity spaces must vary between individuals. The findings of inter-individual heterogeneity in the study above are consistent with this. Accordingly, the cognitive definition of place, and the procedures used to define it, seem applicable in at least one modelling area: the use of INDSCAL to define the impacts of transportation changes on the environments of population groups.

On the basis of the experiment with the students from small towns, a list of attributes was derived and incorporated into a survey for field testing in one community (Sealy, Texas). These attributes provide the necessary basis for semantic differential scaling, permitting an individual to rate the perceived effect on the smalltown environment of different transportation systems, both actual and potential.

The survey was administered to a sample of 104 residents of Sealy; the analysis of the respondents' scaling of possible effects that different transportation alternatives have had or might have on the community is presently underway. The results will be utilized to generate a model to predict how different groups will respond to changes in transportation systems.

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1. Kelly, G. A., The Psychology of Personal Constructs (New York: W. W. Norton, 1955).
2. Slater, P., "Theory and Techniques of the Repertory Grid," British Journal of Psychiatry, Vol. 115 (1969), pp. 1287-1296.
3. Shepard, R. N., A. K. Romney, and S. B. Nerlove (Eds.), Multidimensional Scaling: Volume 1: Theory (New York: Seminar Press, 1972).

PREFACE

This is the eighteenth in a series of research reports describing activities and findings as part of the work conducted under the research project entitled "Transportation to Fulfill Human Needs in the Rural/Urban Environment." The project is divided into five topics; this report describes a portion of the research under Topic II, "The Influence on the Rural Environment of Interurban Transportation Systems."

This report is concerned with one phase of the research which deals with the small town resident's perception of transportation-related aspects of his/her environment. It represents an initial step in an attempt to develop a model to predict how different groups in small towns will respond to proposed or actual changes in the interurban transportation system.

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John Huddleston and Gordon Derr, of the Division of Research in Transportation, also helped with organizing the study interviews, and their assistance was greatly appreciated.

ABSTRACT

This paper first discusses the nature of the space which people in small urban areas use for recurrent activities. It is postulated that most work on the individual's activity space is founded on a classical geometric conception of place. An alternative cognitive definition is proposed. Places which are used for such purposes as shopping or recreation are described by learned bundles of meanings (constructs), given a transportation system permitting movement within space. Recent modifications of Kelly's Personal Construct Theory and elicitation procedures are used to demonstrate the richness of the cognitive definition of place, with data from a small sample of 31 University students. In conclusion, it is suggested how elicited transportation-related constructs of places can be utilized to develop improved models of behavior within urban activity spaces.

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TRANSPORTATION-RELATED CONSTRUCTS OF ACTIVITY SPACES OF SMALL TOWN RESIDENTS

INTRODUCTION

Since the seminal work of Horton and Reynolds[1] on action spaces and by Brown and Moore[2] on activity spaces, considerable interest has been shown in the delimitation, description and use of those places which the urban individual visits in the course of recurrent activities (shopping, recreation, working, visiting friends, etc.). This interest is now particularly reflected in space-time budget studies and activity analyses, following Hagerstrand and Chapin.[3] It is also manifest in studies of the cognition and learning of the locations used in the course of recurrent travel.[4] In much of this work, a classical geometric definition appears to be given to the destinations and routes comprising the time-space within which a decisionmaker journeys: destinations are objects that are

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[1] F. E. Horton and D. R. Reynolds, "An Investigation of Individual Action Spaces: A Progress Report," Proceedings of the Association of American Geographers, Vol. 1 (1969), pp. 70-74.

[2] L. Brown and E. G. Moore, "The Intra-Urban Migration Process: A Perspective," Geografiska Annaler, Vol. 52, Series B (1970), pp. 1-13.

[3] Reviewed by J. Koefed, "Person Movement Research: A Discussion of Concepts," Regional Science Association, Papers, Vol. 15 (1970), pp. 141-155; J. Anderson, "Space-Time Budgets and Activity Studies in Urban Geography and Planning," Environment and Planning, Vol. 3 (1971), pp. 353-368; and G. A. Gutenschwager, "The Time-Budget Activity Systems Perspective in Urban Research and Planning," Journal of the American Institute of Planners, Vol. 39 (1973), pp. 378-387.

[4] For example, see R. Downs, "The Cognitive Structure of an Urban Shopping Center," Environment and Behavior, Vol. 2 (1970), pp. 13-39; and S. E. Hanson, Information Levels and the Intra-Urban Travel Patterns of Swedish Households, (Household Travel Behavior Study, Report No. 5, Transportation Center, Northwestern University, 1973).

most readily conceptualized as points or areas, and linkages between them are most readily conceived of as lines.[5]

This report outlines a preliminary attempt to provide and test for an alternative cognitive definition of place, which yields much more information about properties defining places which are significant to individuals. It also briefly outlines how a cognitive definition of place might be used for the explanation of some other behaviors besides recurrent travel in small town activity spaces.

ARGUMENT

Recent work on the impact of changes in transportation networks suggests that places are defined by individuals, not geometrically, but in terms of subjective meanings ascribed to them. Alterations in a network cause disruptions in that bundle of learned meanings which define places as components of activity spaces. In turn, these alternatives cause changes in place preference and utility which may ultimately be manifested not only in shifts in travel behavior, but also in residential migration, or in political activities directed towards the conservation or alteration of the cognitive definitions of places.[6]

Justification for this definition of place as an alterable bundle of learned meanings, some of which are transportation-related, is provided by three sources:

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[5]See S. E. Hanson, Information Levels . . ., op. cit., pp. 7-9, especially 9, and R. Palm and A. Pred, "A Time-Geographic Perspective on Problems of Inequality for Women," ed. K. P. Burnett, New Perspectives on the Roles of Women in Society (Chicago: Maaroufa Press, forthcoming).

[6]For example, see University of Pennsylvania, Department of Regional Science, Research in Conflict on Location Decisions (Discussion Series, Nos. 1-19, September, 1970 to May, 1972.

(1) the use of theory and tests in clinical psychiatry concerning the individual's definition of objects (e.g., places) by meanings ascribed to them (personal constructs);[7]

(2) the adjectives used by protagonists to describe the desirable/undesirable connotations of places within activity spaces prior to or after transportation changes;[8]

(3) the few recent applications of extensions of Kelly's work to define "what is place?" in the study of urban images;[9] in environmental perception and evaluation;[10] and in housing and neighborhood description.[11]

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[7]Following G. A. Kelly, The Psychology of Personal Constructs (New York: W. W. Norton, 1955).

[8]For example, see those listed in J. Hinman, Controversial Facility-Complex Programs: Coalitions, Side-Payments and Social Decisions (Research on Conflict in Locational Decisions, Discussion Paper 8, Regional Science Department, University of Pennsylvania, 1970), and S. Amir, "Highway Location and Public Opposition," Environment and Behavior, Vol. 4 (1972), pp. 413-436.

[9]For example, see D. Demko, "The Structure of Common Urban Constructs," International Geography, Vol. 2 (1972), pp. 854-856; and J. D. Harrison and W. A. Howard, "The Role of Meaning in the Urban Image," Environment and Behavior, Vol. 4 (1972), pp. 387-411.

[10]For example, see B. Honikman, "An Investigation of the Relationship Between Construing of the Environment and Its Physical Form," Proceedings EDRA 3, Vol. 1 (1972), pp. 6.5.1.-6.5.11; V. J. Silzer, Personal Construct Elicitation in Space Preference Research (Discussion Paper Series, No.1, Department of Geography, York University. Toronto, 1972); R. Hudson, "Measurement of Environmental Images and Their Relationship to Behavior: An Example of the Use of the Repertory Grid Methodology," a paper read to a meeting of the Quantitative Methods Group, Institute of British Geographers, Coventry, 1972; H. S. Leff and P. S. Deutsch, "Construing the Physical Environment: Differences Between Environmental Professionals and Lay Persons," Proceedings of EDRA 4, Vol. 1 (1973), pp. 284-297; and B. Goodchild, "Class Differences in Environmental Perception: An Explanatory Study," Urban Studies, Vol. 2 (1974), pp. 157-169.

[11]For example, see E. J. Harman and J. F. Betak, "Some Preliminary Findings on the Cognitive Meaning of External Privacy in Housing," Proceedings of EDRA 5, (forthcoming), and C. J. Tuite, Personal Construct Theory and Neighborhood Cognition (M.A. thesis, Department of Geography, McMaster University, Hamilton, Ontario, 1974).

Bannister, Mair, Hinkle, Bonnarius, Slater, and Epting, et al., are among those who have modified or extended Kelly's work in psychology on Personal Construct Theory.[12] For the purposes of this report, however, it does not seem necessary to elaborate on these theoretical and methodological alterations. It seems appropriate only, first, to critically examine how Personal Construct Theory and elicitation procedures can be applied to define transportation-related meanings of places in urban activity spaces; second, to illustrate and evaluate the results for selected members of a sample of individuals; and third, to point out how such results can be input into a general model of the evaluation of environmental aspects of activity spaces under alternative transportation conditions.

GENERAL METHODOLOGY

Conceptually, following Kelly and the application of his theory and method to environmental studies by Harrison and Sarre,[13] each person should be viewed as having an individual activity space containing a unique set of

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[12] D. Bannister, "Personal Construct Theory: A Summary and Experimental Paradigm," ACTA Psychologica, Vol. 20 (1962), pp. 104-120; D. Bannister and J. M. M. Mair, The Evaluation of Personal Constructs (London: Academic Press, 1963); D. N. Hinkle, The Change of Personal Constructs from the Viewpoint of a Theory of Construct Implications (Ph.D. dissertation, Columbus, Ohio, The Ohio State University, Department of Psychology, 1965); J. C. J. Bonnarius, "Research in the Personal Construct Theory of George A. Kelly: Role Construct Repertory Test and Basic Theory," ed. B. A. Mahr, Progress in Experimental Personality Research (New York: Academic Press, 1965); P. Slater, The Principal Components of a Repertory Grid (London: Vincent Andrews, 1964); P. Slater, "Theory and Techniques of the Repertory Grid," British Jounal of Psychiatry, Vol. 115 (1969), pp. 1287-1296; P. Slater, Notes on INGRID 72 (London: Institute of Psychiatry, 1972); and F. R. Epting, D. I. Suchman, and C. J. Nickerson, "An Evaluation of Elicitation Procedures for Personal Constructs," British Journal of Psychology, Vol. 62 (1971), pp. 513-517.

[13] J. Harrison and P. Sarre, "Personal Construct Theory in the Measurement of Environmental Images: Problems and Methods," Environment and Behavior, Vol. 3 (1971), pp. 351-374.

n elements, where each element, i, is defined by some number of constructs, m_i ($i = 1, \ldots, n$). The n elements will be places visited on recurrent activities by the individual, and the m_i constructs will be the meanings which he/she uses to define the places. (It will be noted that, in this case, the specification of each person's element and construct sets will be dependent upon the existence of transportation services: without these, no elements can be defined because no recurrent activities can be conducted.) Constructs are considered as subjectively perceived characteristics (e.g., perceived distance to a place); however, they are also conceived as bipolar scales, where the poles provide oppposite descriptions of the characteristic for the individual (e.g., "near," "far"). Clearly, every person's activity space under this theory can contain different elements (places), and each element can be measured (defined) in different ways using different constructs by different persons.

Although construct and element systems are personal, it seems plausible to argue that similarities will exist in the systems of different individuals from similar backgrounds and with similar experiences. However, for a large sample of heterogeneous individuals, it is conceptually possible to obtain an extremely large number of elements and constructs. Hence, construct theory and elicitation procedures should ideally be used, as they are here, for pilot studies with small homogeneous samples, prior to model-building or large scale sample survey questionnaire designs.

Practical reasons also appear to favor the application of Personal Construct Theory and elicitation procedures for small-sample, pilot research. Previous work [14] indicates that the elicitation of meanings (constructs) of places requires a relatively articulate group of respondents; constructs can therefore be readily elicited only from a well-educated sample and not from the whole population. Furthermore, the procedure is one which is time-consuming, so only a small sample of respondents will be willing to assist.

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[14] See. C. J. Tuite, Personal Construct Theory . . ., op. cit., and E. J. Harman and J. F. Betak, "Some Preliminary Findings . . .," op. cit.

At the same time, most of the work to date has concentrated on individuals whose activity spaces are within large urban areas. There exists a clear need for studying the activity spaces of small town residents and the meanings they assign to these spaces. Hence, this study was limited to a sample of 31 cooperative first year university students from towns within the range of 2,000 to 20,000. The emphasis on activity spaces of residents of smaller, rather than larger, urban areas is meant to lay a foundation for discriminating between the possible differences in the perceptions of the small town resident and those of his/her metropolitan counterpart.

At the same time, in keeping with the avowedly experimental purposes of this paper, the use of a sample from small towns allows control over the possible number of elements and constructs elicited. It is clearly a plausible assumption that respondents from larger urban areas will provide more elements and more diverse definitions of places within their activity spaces.

EXPERIMENTAL DESIGN

The experiment was divided into two parts. (See Figure 1, p. 7 for an outline of the experimental procedure and examples of the subjects' responses.) First, each student listed against numbers from 1 to 24 all those places inside his or her home town (including routes, sidewalks, and streetcorners) which were used for recurrent activities. "Home" was always recorded against the number 1, but remaining places were listed against successive numbers in order of recall. Second, the students listed against number 1 to 24 all those places outside their home towns which were used for recurrent activities, including non-rural places. The majority of small-town respondents, as might be expected, had difficulty in listing 24 elements; the number of places available to them to use on recurrent activities is small.

The application of this procedure meant that, over the whole smaple of students, different numbers stood for different elements in activity spaces encompassing both in-hom town and out-of-home town areas. Despite the fact that the respondent sample was confined to students, it is plausible to

FIGURE 1: STEPS IN THE EXPERIMENTAL DESIGN

PART I

STEP 1 List of Intown Places (Sample)

1. HOME
2. DAIRY QUEEN
3. CHURCH

etc.

STEP 2 List of Outtown Places (Sample)

1. HOUSTON ZOO
2. LAKE AUSTIN
3. SIX FLAGS

etc.

PART II

STEP 3 Triad Elements (Sample)

1. (Home)

3. (Church)

13. (Grocery Store)

STEP 4 Labelling (Sample)

"Secure"
(Preferred Pole)

"Insecure"

STEP 5 Repertory Grid (Sample)

Place	Constructs			
	Secure	Warm	Relaxation	Etc. ....
1. Home	1	2	4	
2. Dairy Queen	5	3	6	
3. Church	2	4	7	

argue that the few places used for shopping, recreation, visiting friends or family activities are shared by a majority of the "home" town populations. Hence, there is no reason to believe that the elements elicited by the procedure over all students did not comprise a representative sample of the elements of the activity spaces of small town residents in general.

The next task was to define the cognitive bundles of meanings of places inside and outside town (Figure 1, Step 3). The personal constructs for within-town and out-of-town elements, respectively, were elicited from each student separately through the triadic method.[15] Two sets of triads were used. The first set comprised a random drawing of all possible pairs of numbers 2 - 24 combined with 1 (Home). The second set of triads comprised a random drawing from numbers 1 - 24 paired with that number corresponding to the person's most important place after home. Thus, all students were presented in turn with the same sets of triads of numbers, first where the sets represented the places for recurrent travel on their in-town list, and second, where the sets represented places for the recurrent activities on their out-of-town list.

The two numbers within a triad representing the most similar places were set together by the student and defined one pole of the construct; the third was left aside and defined as the contrasting pole. All students were asked to label each pole - what makes these two places similar? this one opposite? (Figure 1, Step 4). They were then asked to state their preferred pole. Triads were presented until no new constructs were elicited. This method of opposites has been found most efficient in test-retest situations, like the present one, requiring the elicitation of bundles of meanings of numerous elements -- in this instance, places.[16] Thus, cognitive meanings which defined places in the activity spaces of each indivdiual were isolated.

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[15] J. Harrison and P. Sarre, "Personal Construct Theory . . . Problems and Methods," op. cit., 368-369.

[16] F. R. Epting, D. I. Suchman, and C. J. Nickerson, "An Evaluation of Elicitation Procedures . . .," op. cit.

Next, each preferred pole of elicited constructs was rank ordered by each respondent. This gave each person's ordering of preferred features defining places for recurrent activities under a transportation system. Consequently, when the results thus far taken all together for all 31 respondents:

(1) considerable cognitive information about many places in different activity spaces had been provided, since the same triads of numbers represented different places for different people;

(2) the amount of information yielded about definitions of places in activity spaces was clearly greater tham that yielded by alternative techniques;[17] and

(3) a range of preferred features defining elements of the transportation-related activity spaces of small town residents had been defined.

In the fifth and final step of the experiment, a "repertory grid" was constructed to estimate the importance of each transportation-related construct for the definition of all places in the activity space of each individual. To construct a grid, each respondent was asked to rate every element (place) on his/her in- and out-of-town list, respectively, according to the quantity of the preferred pole of each construct which the place possessed (1 = very much, and therefore top-rating; 7 = very little, and therefore bottom-rating). The in-town and out-of-town repertory grids for a person summarize the individual's cognitive definitions of every component in his/her activity space. The definitions are comprised of the preferred meanings of places in the activity spaces of small-town residents in general.

The value of the procedure, and of the resultant cognitive definitions of place, can now be illustrated through case studies of the results and their interpretation for selected respondents.

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[17] For example, the technique of multidimensional scaling in Pat Burnett, "The Dimensions of Alternatives in Spatial Choice Processes," Geographical Analysis, Vol. 3 (1973), pp. 181-204.

RESULTS FOR CASE STUDY SUBJECTS

The preferred poles of the constructs of subjects 9, 17, and 29 are arranged in order of their stated desirability in Table 1.

TABLE 1: PREFERRED POLES OF THE CONSTRUCTS OF THREE SUBJECTS

Subject	Category	Top Three Preferred Poles	Total No. Poles
9	Intown	Human relationships, privacy, quiet	13
9	Outtown	Simplicity, scenic, intellectual pleasure	7
17	Intown	Music, beautiful buildings, exciting	14
17	Outtown	Pleasant scenery, being off beaten track, privacy	15
29	Intown	Personal freedom, homey environment, family union	11
29	Outtown	Private, keeps property personal, active environment	11

A comparison of within-town poles between the subjects identifies marked differences in the names, number, and preferential order of the constructs. Similar differences exist between the individuals' constructs defining out-of-town places. Likewise, for each individual the names, number, and preferential order of poles tend to differ depending on whether he/she is considering a within-town place or an out-of-town place. As can be expected, similar magnitudes of variation among the remaining 28 subjects in the sample produce an unwieldy number of individually-defined constructs. However, taken together, a considerable quantity of information is provided concerning the preferred, transportation-related features of activity spaces.

(See Table A.1 in the Appendix, which shows the preferred poles of fifteen of the sample subjects.)

If the essential definitive substance can be extracted from the lists of many individuals' preferred poles, considerable order and parsimony will be achieved in identifying the attributes which give meaning to places for individuals. INGRID[18] performs a modified principal components analysis of each individual's repertory grid to achieve this. The algorithm follows a procedure analogous to Saunder's[19] direct factor method, and uses Bartlett's test, despite its shortcomings,[20] to determine significant principal factors. The results of the principal components analysis for both the within-town and out-of-town grids for three of the case study subjects are presented in Table 2. Through the principal components procedure, the thirty-eight verbal constructs elicited from the three subjects for only within-town places have been reduced to eight components (attributes). These attributes are named, following standard practice, by looking at the construct loadings on components. An illustration of this naming procedure is given in Table 3.

As can be seen in the table, component 1 shows high negative loadings on the subject's preferred poles. The negative loading on this component clearly represents high negative correlation with an evaluative dimension which we have labelled "Approval-Disapproval." Subsequent components (e.g., components 1 and 2) receive their labels from bipolar loadings. The labels are assigned by choosing bipolar terms which seem to express the character of the negative and positive loadings on the poles. For example, component 2 is assigned the bipolar label "Stimulating-Tranquil" on the basis of the negative loadings

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[18] P. Slater, The Principal Components . . ., op. cit. and P. Slater, Notes on INGRID 72, op. cit.

[19] D. R. Saunders, Practical Methods in the Direct Factor Analysis of Psychological Score Matrices (Ph.D. dissertation, Department of Psychology, University of Illinois, Urbana, 1950).

[20] D. N. Lawley and A. E. Maxwell, Factor Analysis as a Statistical Method (London: Butterworth, 1963).

TABLE 2: EXAMPLES OF THE USE OF INGRID: TRANSPORTATION-RELATED COMPONENTS

Subject	Comp. 1	Comp. 2	Comp. 3	% Var. Explained	Total Sig. Comp
9-Intown	Work-Relaxation	Outdoor-Indoor Pasttimes	Access to Services-Access to Entertaining Activities	76.75	11
9-Outtown	Change of Scene-Familiar Environment	Outdoors Sporting-Indoors Intellectual Enjoyment	Less Effort to go Places-More Effort to go Places	97.00	4
17-Intown	Family ties-Friendships	Exciting Socialising-Private Enjoyment	More Effort to go Places-Less Effort to go Places	69.09	6
17-Outtown	Close Relationships-Private Feelings	Approval-Disapproval	Adventure-Security	85.09	6
29-Intown	Informality-Formality in Relationships	Uninterpreted[a]	Lack of Restriction-Restriction	68.47	11
29-Outtown	Social Activity-Private Activity	Outdoor Sports-Indoor Country-Western	Lack of Mobility to Distant Places-Nearby Activities	73.50	6

[a]This subject was chosen to illustrate one of the difficulties of the use of principal components procedures: the naming of attributes.

TABLE 3: EXAMPLE OF COMPONENT NAMING FROM CONSTRUCT LOADING SUBJECT 30 - INTOWN

Preferred Poles In Order of Preference	Comp. 1 Approval-Disapproval	Comp. 2 Stimulating-Tranquil	Comp. 3 Interesting-Uninteresting
Interesting	-.8071	.4040	.2235
Tasteful	-.8647	.3964	.0205
Warm (Emotional)	-.9452	.1505	.1147
Relaxed	-.5899	-.1630	.7080
Comfortable	-.7546	.1480	-.3069
Private	-.6144	-.7031	.1560
Quiet	-.8595	-.3040	-.2498
Neat	-.7250	-.2011	-.4042
Permanent	-.6496	.0192	-.1243
% Var. Explained	58.60	11.32	10.27
% Var. Explained by First Three Components	80.19		

on such terms as "relaxed" and "private" and the positive loadings on such terms as "interesting" and "emotionally warm." (See Table A.2 in the Appendix for examples of component naming for other subjects.)

As with the constructs, differences exist between individuals in their components for within-town grids, out-of-town grids, and the grids for each individual depending on whether he/she was considering within-town places or out-of-town places. Over the entire sample of subjects, however, many components were found to be common to several individuals, but at varying levels of salience. For example, subjects 3, 7, 10, 11, 14, 15, 17, 18, 24, and 26 all had close, secure, or family-like relationships among their first three components defining places they used within-town. Although the components ranged from first to third in importance between individuals, it seems clear that some communality and order in transportation-related definitions of activity spaces is revealed in these data through the use of INGRID.

The benefits of order and parsimony in the principal components approach, however, are accompanied by difficulties inherent in the model. For most grids the technique yields a great many statistically significant components.[21] For example, for subjects 9, 17, and 29, INGRID derived eleven, six and eleven significant components, respectively, from the within-town repertory grids and four, six, and six components, respectively, from the out-of-town repertory grids (Table 2).

This illustrates that the present procedures for searching for cognitive meanings of places will produce a considerable quantity of information in parsimonious form. However, it also demonstrates that there will be some arbitrariness in the final selection of components for further field research or for incorporation into models. Nonetheless, some such degree of arbitrariness is required in these circumstances in any case. Moreover, a pilot study like the present one has the advantage that the subject's, rather than the researcher's, meanings of place can be used in later research.

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[21] P. Slater, The Principal Components..., op.cit., pp. 35-36.

CONCLUSION: THE USE OF COGNITIVE DEFINITIONS OF PLACE

In spite of the difficulties of the procedure so far recognized, its benefits seem clear. From a very large number of differentially-ordered and defined transportation-related constructs of urban activity spaces, a reduced number of operationally feasible attributes may be derived. These attributes, elicited from a small pre-sample, help define places within urban activity spaces in terms of their preferred meanings to individuals.

It remains to illustrate in conclusion how the results of a small-sample study like the present one can be utilized to explain at least one kind of spatial behavior -- in this case, the evaluation of the impacts on activity spaces of different transportation systems.

At least one computerized model is available, INDSCAL,[22] which will measure environmental utility for both individuals and groups under alternative transportation services. One essential requirement of this model is a list of semantic differential scales, with poles opposite in meaning, to define the important attributes of activity spaces under a given transportation system. These scales are then used by individuals to score activity spaces across as wide a range as possible of attributes which they regard as significant. The scores for an individual's activity space under different transportation alternatives are later manipulated to generate the required measures of environmental utility. The necessary semantic scales can obviously be generated by a judicious selection of the components describing activity spaces elicited from a small scale sample like the one above. Additional components can also be supplied, if required, from the literature.[23]

The second essential requirement of the INDSCAL model is that both the attributes and the saliences of the attributes of activity spaces must vary between individuals. The findings of inter-individual heterogeneity in the

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[22] R. N. Shepard, A. K. Romney, and S. B. Nerlove (Eds.), Multidimensional Scaling: Volume 1: Theory (New York; Seminar Press, 1972).

[23] J. Harrison and P. Sarre, "Personal Construct Theory...", op. cit., p. 370.

study above are consistent with this. Accordingly, the cognitive definition of place and the procedures used to define it seem applicable in at least one modeling area: the use of INDSCAL to define the impacts of transportation changes on the environments of population groups.

In keeping with this argument, a survey instrument was designed for use in Sealy, Texas (A.3 in Appendix). Part of the instrument (see pp. 34-36) comprises semantic differential scales derived from the constructs elicited in the study reported on above. In addition, other components were supplied from a historical case study of Sealy.[24] The survey instrument has been administered to a 5% spatially random sample of Sealy households to obtain their evaluation of the likely effects and desirablility of alternative transportation systems on Sealy. This study will be reported in a later document.

There certainly remain methodological and conceptual problems too numerous to go into here (e.g., especially problems of aggregation and ecological fallacy). However, a tentative conclusion can perhaps be reached. The quantity of information provided through the individual's cognitive definition of place may in due course permit better explanation of different kinds of behavior of important concern: for example, not only transportation impacts but also residential choice and recurrent travel behavior.

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[24] Graham Hunter, "Rural Communities and Interurban Transportation Systems: A Study of the Stages of Interaction," unpublished Master's Thesis, The University of Texas at Austin, 1974. (Publication forthcoming.)

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A.1: PREFERRED POLES OF THE CONSTRUCTS OF FIFTEEN SUBJECTS

TABLE A.1: PREFERRED POLES OF THE CONSTRUCTS OF FIFTEEN SUBJECTS

Subject	Category	Preferred Poles	Total No. of Poles
1	Intown	Intimacy, Secure, Controlled Environment, Comfortable Surroundings, Freedom of Choice, Comfort, Convenient, Discipline, Less Pressure, Obligated, Outdoor, Duty, Inhibited, Unstructured	14
1	Outtown	Quiet, Personal, Intimate, Unpopulated, At Ease, Exciting, Relaxing, Free, Outdoor, Homely, Economical, Open, Tranquil, Accessible, Smaller	15
3	Intown	Happiness, Fun, Relaxation, Gathering of Friends, Peer Relationships, Talking, Freedom, Background Similarity, Old Building, Driving, Away From Home	11
3	Outtown	Accessible, Change of Atmosphere, Cultural-Educational Experiences, Freedom to Experience New Things, Buying, Security, Fun, Freedom, Familiar Surroundings, Family-or Friend-related Activity, Sight seeing	11
6	Intown	Peaceful, Natural, Quiet, Free, Informal Pleasant, Fun, Pretty, Relaxing, Routine Required Activities	11
6	Outtown	Natural, Pretty, Simple, Friendly, Scenic, Freedom, Unrestricted, Uninhibited, Convenient, More Accessible, Social Activity	11
7	Intown	Social Interacting, Love, Outdoor, Unrestricted, Socialized, Relaxing, Pleasure, Peaceful, Friendly, Affectionate, Recreational, Fun, Guidance, Familiar, Historical	15
7	Outtown	Personal, Peaceful, Calm, Private, Outdoor, Luxury, Pleasure, Sentimental, Familiar Atmosphere, Non-commercial, Convenient	11

TABLE A.1 (Continued)

Subject	Category	Preferred Poles	Total No. of Poles
9	Intown	Humanizing Relationships, Privacy, Quiet, Relaxation, Freely Chosen Routine Activities, Physical Refreshment, Stimulating Entertainment, Intellectual Stimulation, Pleasant Outdoor Scenery, Convenient Routine Activities, Things Accessible but Together, Little Effort by Car, Luxuries	13
9	Outtown	Simple, Scenic, Intellectual Pleasure, Pleasant/Enjoyable Sensations, Changed Scenery, Accessible with Less Effort	7
10	Intown	Secure, Individual, Familial, Stability, Calm, Close and Personal, On One's Own, Present and Future Orientation, Relaxed, Uninhibited, Pleasure Oriented, Youth	12
10	Outtown	Familiar, Special, Familial, Close (Friendship), Recreational, Open Possibility for Activity, Casual, Informal, Unorganized, Uncrowded, Conservative	11
11	Intown	Friendly, Personal, Secure, Leadership, Friendship, Guidance, Enjoyable, Social Activities-Relaxed, Relaxing, Routine, Unrestricted, Large, Different, Unpopulated, Noisy	15
11	Outtown	Individual, Personal, Obedience, Familiar Homely, Growing, Antique (Traditional), Social Activities, Enjoyable, Entertaining, Natural, Routine, Accessible, Convenient, Exciting	15
14	Intown	Affectionate, Activity, Natural, Pleasure, Close-Familiar, Friends, Respect, At Ease, Socially Open, Relaxing, Public, Structurally Varied, Boisterous, Financial Options	14
14	Outtown	Enjoyable, Friendly, Natural, Recreational Outdoors, Involved, At Ease, Fun, Public, Familiar, Educational, Near Family Activities, Quiet, Unstructured, Free Options	15

TABLE A.1 (Continued)

Subject	Category	Preferred Poles	Total No. of Poles
15	Intown	Intimate Friendship, Route Learning, Personal Freedom, Privacy, Father's Interests, Intellectual Involvement, Peer Friendships, Shared Enjoyment of Outdoors, Relaxation, Public Activities	10
15	Outtown	Activities with Others, Recreation, Pleasure with Peer Group, Enjoyable Family Activities, Beauty of Land-scape,	6
17	Intown	Music, Beautiful Buildings, Exciting, Enjoyable, Degree of Involvement, Family Association, Intimate Contact with People, Role Playing, Socializing with Peers, Social Grouping, More Distant Peer Relationships, Domestic Activities or Chores, Freedom, Functional, Makes Place Accessible	15
17	Outtown	Pleasant Rural Environment, Off the Beaten Track, Privacy, Challenging, Access to Friend's House, Freedom from Personal Corruption, Victimization, Enjoyable Sensations, Belief in Places, Geographical Separation, Family Compan-ionship, Family Kind of Relationship, Family Activities, Direction, Access to School	15
20	Intown	Scientific and Technical Background, Peaceful, Sexual Interest, Close and Friendly Relationships, Close Friend Relationship, Socializing Atmosphere, Special Friends, Science Related Con-servation, Enjoyable, Academic Atmos-phere, Entertaining and Recreational Activities, Less Accessible Relation-ships, Brother's Interests, Family Sporting, Social Entertainment	15

TABLE A.1 (Continued)

Subject	Category	Preferred Poles	Total No. of Poles
20	Outtown	Social Activities, Normal Everyday Activities, Drinking and Social Entertainment, Interrelated Activities, Combined Activities, Combined Recreational Activities, Academic Activities Outdoor Activity Groups, Family and Social Activities, Everyday Family Activities, Family Socializing, Same Activities, Combined Family Activities, Accessible Family Related Activities, Inaccessible Trip	15
22	Intown	Security and Love, Solitude, Freedom, Getting Out, Accomplishment, Scenery, Fulfilling, Relaxing, Same Activities, Parties and Sports, Enjoying Getting Together with Friends, Fun, Conversation, Location, Location Related Activities, Laziness	15
22	Outtown	Grew Up in the Place, Achievement, Memories, Friendly Atmosphere, Nature, Freshness, Variety, Easy Going, Relaxing, Fun, Gathering of Friends, Outdoor Activity, Recreation, Dating, Distance	15
25	Intown	Informal, Supportive, Happier, Friendly, Stable, Comfortable, Quiet	7
25	Outtown	Familial, Belonging, Togetherness, Enjoyable Frequent, Exciting, Peaceful, Casual	8
29	Intown	Free, Homey Environment, Family Union, Historical, New People, Personal Interaction, Groups of People, Social, Recreational, Role Playing, Unrestricted Play	11
29	Outtown	Private, Personal Property, Personal Activity Social, Watersports, Rural, Animals, Natural, Outdoors, Active, Stationary	12
30	Intown	Interesting, Tasteful, Warm (Emotional), Relaxed, Comfortable, Private, Quiet, Neat, Permanent	9
30	Outtown	Varied, Beautiful, Unexplored, Quaint, Open, Undisturbed, Tranquil, Mobile, Active	9

A.2: EXAMPLES OF THE USE OF INGRID: TRANSPORTATION-RELATED COMPONENTS

TABLE A.2: EXAMPLES OF THE USE OF INGRID: TRANSPORTATION-RELATED COMPONENTS

Subject-Category	Component 1	Component 2	Component 3	% Variation Explained	Total Significant Components
1-Intown	Freedom-Restriction	Convenient-Outdoors Environment-Secure Comfortable Environment	Secure-Insecure	77.80	12
1-Outtown	Intimate and Quiet Impersonal and Exciting	Homely-Sophisticated	Relaxing Rural Environment-Stimulating Urban Environment	81.69	3
3-Intown	Lots of Fun with Friends-Little Fun with friends	Warm Relationships-Loneliness	Close Personal Relationships-Distant Personal Relationships	83.26	3
3-Outtown	New Experiences-Familiar Experiences	Routine Travel-Travel for Adventure	Shared Pleasure with Relatives-No Shared Pleasure with Relatives	85.30	7
6-Intown	Peaceful Environment-Irritating Environment	Fixed Routine-Freedom	Not Significant	62.28*	2
6-Outtown	Approval-Disapproval	Accessibility to Places-Accessibility to People	Socialization in Town-Freedom in an Attractive Countryside	87.51	5
7-Intown	Guided Interactions-Unrestricted Pleasure	Pleasurable Private Outdoor Activities-Loving Relationships	Traditional Family Ties-Fun with Peer Groups Activities	71.05	6

TABLE A.2 (Continued)

Subject-Category	Component 1	Component 2	Component 3	% Variation Explained	Total Significant Components
7-Outtown	Guided Interaction-Unrestricted Pleasure	Pleasurable Private Outdoor Activities-Loving Relationships	Traditional Family Ties-Fun with Peer Group Activities	71.05	6
9-Intown	Work-Relaxation	Regular Outdoor Pastimes-Indoor Pastimes	Access to Serious Activities-Access to Entertainment	76.75	11
9-Outtown	Change of Scene-Family Environment	Enjoying Outdoor Sports-Indoor Intellectual Enjoyment	Less Effort to Go Places-More Effort to Go Places	97.02	4
10-Indoors	Family Stability-Individual Freedom	Peace and Security-Personal Pleasure-Seeking	Not Significant	46.22*	2
10-Outdoors	Progressive-Conservative	Family Relations-Special Friendships Outside Family	Traditional Family Pastimes-Recreation with Friends	78.48	6
11-Intown	Environment with Secure Personal Relations-Environment with Insecure Personal Relations	Large, Diverse Social Gatherings-Isolation	Freedom-Restraints	65.03	3
11-Outtown	Exciting Social Activities-Isolation	Parental Control-Adventure With Friends	Natural Self-Playing Roles	70.86	5
14-Intown	Public Dealings-Private Dealings	Close Relationships-Distant Relationships	Financially Rewarding Environment-Emotionally Rewarding Environment	67.81	4

TABLE A.2 (Continued)

Subject-Category	Component 1	Component 2	Component 3	% Variation Explained	Total Significant Components
14-Outtown	Public Dealings-Private Dealings	Family Involvement-Free Activities	Outdoor Activities-Indoor Activities	77.36	9
15-Intown	Public Activities-Private Activities	Outdoor Recreation-Indoor Intellectual Involvement	Close Personal Relations-Interest and Activities of Others	84.54	6
15-Outtown	Approval-Disapproval	Family Activities-Activities with People Outside the Family	Social Contacts-Private Rural Recreation	89.63	4
17-Intown	Family Relationships-Friendships	Exciting Activities with Others-Private Enjoyments	More Effort-Less Effort	69.09	6
17-Outtown	Close Relationships with Others-Private Feelings	Approval-Disapproval	Adventure-Security	85.29	6
20-Intown	Good Working Environment-Relaxation	Access to Scientific Knowledge-Friendships	Sporting Activities-Friendships	75.77	5
20-Outtown	Enjoyable Social Activities with Friends-Activities with Family	Routine Activities with Peers-Routine Family Activities	Outdoor Activities-Indoor Family Activities	65.78	6
22-Intown	Approval-Disapproval	Solitary Rural Activities-Urban Social Activities	Relaxing Privacy-Enjoyable Relations with Others	75.33	5

TABLE A.2 (Continued)

Subject-Category	Component 1	Component 2	Component 3	% Variation Explained	Total Significant Components
22-Outtown	Approval-Disapproval	Familiarity with People and Places-Freshness and Variety of Outdoor Scenery	Not Significant	47.58*	2
25-Intown	Approval-Disapproval	Not Interpretable	Enjoyable-Dull	88.73	4
25-Outtown	Exciting-Familiar	Rooted-Rootless	Stimulating Companionship-Peaceful Family-Relations	85.72	7
29-Intown	Informal Group Recreation-Formal Group Recreation	Not Interpretable	Unrestricted Activities Away from Home-Role Playing at Home	68.45	3
29-Outtown	Outdoor Social Activity-Private Activity	Outdoor Sports-Indoor Country and Western Activities	Lack of Mobility to Distant Places-Outdoor Activities Nearby	73.50	6
30-Intown	Approval-Disapproval	Stimulating-Tranquil	Interesting-Uninteresting	80.19	3
30-Outtown	Tranquil-Active	Challenging-Unchallenging	Peacefulness-Adventure	76.34	3

A.3: SEALY, TEXAS SURVEY

The first part of this questionnaire is to help us collect some information on your household and its travel habits. This is because different transportation proposals affect different kinds of household in different ways. You may, of course, refuse to answer any question.

PART A	Margin for Computer Coding of Answers
1. Length of Residence	
a. In what year did you move to live in Sealy?__________	__________
b. How many years have you lived in Sealy altogether?_____years.	__________
2. Household Characteristics	
a. How many persons are there in this household?________	__________
b. Note your present occupation, or occupations, below.	
1.______________________________	__________
2.______________________________	__________
3.______________________________	__________
c. How many years of schooling have you completed?______years.	__________
d. How many cars does you household own?_________	__________
e. In what country were you born?____________________	__________
f. How many rooms are there in this dwelling?___________	__________
g. In which of the following age groups do you belong? Check One	
Under 18______ 35 and under 45_______	
18 and under 25______ 45 and under 55______	__________
25 and under 35______ 55 and under 65_______	
65 and over______	
h. Estimate the value of <u>your own</u> earnings and other assets for 1973-74, before taxation deductions $______________	__________

2. Continued

i. Fill in the following table for each other person in your household.

Relationship to you	Occupation	Age	Hours worked per week for last 6 months
1.			
2.			
3.			
4.			
5.			
6.			

Continue on blank page at end if necessary

j. How many hours per week have you worked on average for the last six months?_______hours/week.

k. What is your religion?______________________________

l. Estimate the value of your household's total earnings and other assets for 1973-74, $________________

m. Estimate the current total average weekly income of your household, $______________

n. How many bathrooms does your household have?________

3. Sealy Affairs

a. What organizations in Sealy do you belong to? List them below. If you hold an official position in any organization, list the title alongside.

3. Continued

ORGANIZATION	POSITION
1.______________________	______________________
2.______________________	______________________
3.______________________	______________________
4.______________________	______________________

(Continue on blank page at end, if necessary)

b. Since 1965, have you belonged to a group to press for change in Sealy?

Yes________ No__________

Briefly give the reasons for your joining or not joining such a group.

____

____

____

4. Travel Behavior

a. Complete the following table, to show the places inside or outside Sealy, which you normally use for different activities. Leave a blank space if any part of the table is not applicable.

Activity	Most Preferred Place		Estimated Travel
	Name	Visit Frequency*	Time From Home
Shop for groceries			
Shop for fashion clothing			
Shop for a car			
Banking			
Use barber or beauty salon			
Visit doctor			
Indoor recreation			
Outdoor recreation			
Visit friends			
Visit relatives			
Go to a movie			
Use a restaurant			
Use a library			
Go out with close friends			
Take visitors out			

*e.g., Number of visits per week, per month, per year. Please state the time period concerned.

b. If you are gainfully employed, what is the name and street address of your most important place of employment?

Name ______________________________

Street Address ______________________________

The second part of the questionnaire tries to find out how you would rate Sealy as a place to live under different kinds of transportation system. Six kinds of system are listed across the page. One comprises present facilities, the others are just suggestions. Down the page you will find attributes of Sealy which the existence of each system might affect. Rate Sealy under each system, using the following method. Take each attribute in turn, and place a score for the effects on Sealy of each transportation alternative; 1 = very advantageous
7 = very disadvantageous

PART B

ATTRIBUTES OF SEALY LIVING	PRESENT FACILITIES AFTER IH 10 1	FACILITIES BEFORE IH 10 STARTED 2	PRESENT FACILITIES + AMTRAK STOP 3	PRESENT FACILITIES + IMPROVED BUS 4	PRESENT FACILITIES W/O BUS SERVICE 5	PRESENT FACILITIES + AIRSTRIP FOR INTRASTATE CARRIERS 6
A. Economic-Public						
1. Attractiveness to industry						
2. Attractiveness to retailing/offices						
3. Your household income						
4. Community land values						
5. Your neighborhood land values						
6. Population growth						
B. Personal						
1. Preservation of family ties & friendships						
2. Enjoyable outdoor recreation with others						

CONTINUED

ATTRIBUTES OF SEALY LIVING	PRESENT FACILITIES AFTER IH 10 1	FACILITIES BEFORE IH 10 STARTED 2	PRESENT FACILITIES + AMTRAK STOP 3	PRESENT FACILITIES + IMPROVED BUS 4	PRESENT FACILITIES W/O BUS SERVICE 5	PRESENT FACILITIES + AIRSTRIP FOR INTRASTATE CARRIERS 6
3. Personal freedom						
4. Country-Western activities						
5. Access to sophisticated entertainment						
6. Restraints on behavior because everyone knows you						
7. Challenge, excitement, & adventure						
8. Informality of relationships						
9. Access to luxuries of life						
10. Pressure to achieve						
11. Peace, tranquillity						
12. Relaxation; relaxed environment						
13. Attractive rural surroundings						
14. Intellectual stimulation						
15. Accessibility to people & places						

CONTINUED

ATTRIBUTES OF SEALY LIVING	PRESENT FACILITIES AFTER IH 10 1	FACILITIES BEFORE IH 10 STARTED 2	PRESENT FACILITIES + AMTRAK STOP 3	PRESENT FACILITIES + IMPROVED BUS 4	PRESENT FACILITIES W/O BUS SERVICE 5	PRESENT FACILITIES + AIRSTRIP FOR INTRASTATE CARRIERS 6
16. Personal privacy						

Finally, would you give us your telephone number in case we need to check back with you over some parts of this questionnaire? ______________________.

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APPENDIX I
Exhibit 6

PERCEIVED ENVIRONMENTAL UTILITY UNDER ALTERNATIVE TRANSPORTATION SYSTEMS: A FRAMEWORK FOR ANALYSIS

Pat Burnett

March 1976
Research Report

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NOTICE

EXECUTIVE SUMMARY

INTRODUCTION

This report is concerned with one phase of a research project entitled, "The Influence on the Rural Environment of Interurban Transportation Systems." It presents the final phase in the attempt to develop a model for predicting how different groups in small urban areas will respond to proposed or actual changes in the interurban transportation system. At the same time, the research is part of a larger effort aimed toward developing improved models of behavior within urban activity spaces in general.

PROBLEM STUDIED

The nature of the activity spaces which people use for recurrent activities (shopping, work, recreation, etc.) has received considerable attention in recent studies. At the same time, transportation planning is marked by concern about citizen involvement in the planning process. This is manifest by the studies on highways and expressway controversies.[1] It is also evident in attempts to create opportunities for citizen participation[2] and to examine the social consequences of road construction.[3] The concern with citizen involvement occurs at all scales of analysis, from the metropolitan area[4] to the small urban community.[5]

It is often noted that, in response to transportation plans, private individuals are most concerned about protection, conservation, and enhancement of their physical and social space.[6] However, little work has been done on how individuals themselves perceive the effects on their environment of new routes or other kinds of transportation innovation, such as transit services or airports. The emphasis in this report is, therefore, on developing an analytical framework for examining resident's perception of their environmental utility under different transportation alternatives. The analytical framework is intended for application at any scale; the usefulness of the framework, however, is demonstrated through a case study of a small urban community.

RESULTS ACHIEVED

The analytical framework developed is two-phase in design. First, a methodology is briefly outlined for defining the general attributes of the perceived environment of a class of urban residents. Then, a conceptual framework is developed for delineating homogeneous population groups within an example of such an environment and measuring each group's differential cognition and evaluation of the effects of transportation alternatives.

The first phase of the analytical framework is discussed fully in Research Report 18, available through NTIS under Report No. DOT-TST-75-135. The second phase of the research, namely, developing a conceptual framework for delineating homogeneous population groups and for measuring each group's differential cognition and the evaluation of the effects of transportation alternatives is the focus of this report.

Within a general kind of residential environment (small town, metropolitan neighborhood) we may consider a population distribution at time t. Let there be a spatially random sample of m households drawn from this population. Then we may expect some number y of households to be defined where the clusters will be homogeneous, at least in terms of (1) socio-economic status (broadly defined), stage in life cycle and ethnicity, and (2) their activity patterns. Such groups may also have distinctive cognitions and evaluations of the attributes of their perceived environment under alternative transportation systems. Given an extended set of variables describing both the socio-economic characteristics and activity patterns of the sample, y internally similar household clusters may be first defined using factor analysis and a grouping algorithm; each cluster's cognition and evaluation of its environment under alternative transport systems can then later be probed.

Given this framework, one small town, Sealy, Texas, was selected for analysis. Within the area, a three percent sample of households was drawn for home interviews to determine household socio-economic characteristics and travel habits. Interviews were carried out with one respondent in each household until 80 complete returns were compiled: two were later deleted owing to response inaccuracies. Subsequent analysis of the data and the questionnaire showed that the sample obtained was reasonably representative of the different strata of the town's population. Information was collected on 58 variables describing household socio-economic characteristics and travel habits. To find the basic dimensions which might differentiate households into clusters, a principal components analysis with varimax rotation to simple structure was performed on the 78 household by 58 variable matrix. The analysis produced 16 factors with eigenvalues greater than one; these may be treated as basic factors differentiating households. The well-known life cycle phase and income/ethnicity factors appeared with loadings on the component variables that were readily interpretable. A third socio-economic factor also appears, namely, familiarity with the town; this increases both as the year the respondent first moved into Sealy increases and as his/her total length of residence there increases. The remaining 13 basic factors were those underlying household travel behavior and were more difficult to interpret. However, all 16 factors were interpretable, so scores for each household on each factor were computed. The algorithm CONGRUP was then used to cluster households with like scores on the 16 factors. CONGRUP delineated four main clusters of households, with two major groupings of 43 and 29 members respectively, and two deviant minor groupings of four and two members. The number of component groupings was subjectively chosen, but the appearance of two major groupings conforms with Hunter's delineation of two major kinds of households in Sealy in the late sixties and early seventies.[7] Thus, the sample clusterings appear to reflect the general community makeup of the area.

Given the identification of members of various groups and their rating of environments under different transportation alternatives, we may envisage a matrix with r rows representing components of the residential environment elicited by the Personal Construct theory and Repertory Grid methodologies (as described in Research Report 18); the columns represent different possible alternative transportation strategies for an urban area. An entry in the cell of the matrix represents how much a group member perceives an urban area component to be affected by the transportation system. Thus, the matrix represents the application of rating scales to evaluate the quality of the urban environment under alternate transportation systems. The matrices for the members of the homogeneous population groups may be manipulated using the INDSCAL model to summarize the groups' cognition and evaluation of the effects of transportation alternatives on their urban environment.[8] The input to the INDSCAL model is a similarities matrix for each person of a group. The matrix for each group member has to be preprocessed so that similarities between possible pairs of transportation systems can be measured. There are various methods for doing this step. Where the ratings data have been collected from illeducated, semi-literate respondents, less refined methods of deriving similarities may be justified. In this report a simple method for preprocessing the data for INDSCAL was used: in particular, the absolute differences between each pair of systems in their average component scores over all environmental components. This step may be formally expressed using the notation in equation one. This yielded a six by six matrix of similarities for each respondent.

$$S^i_{jk} = \frac{\left| \sum_{t=1}^{r} X^i_{jt} - \sum_{t=1}^{r} X^i_{kt} \right|}{r} \tag{1}$$

Given these similarities for each group of respondents, the INDSCAL model permits the calculation of the utility of each transportation system as far as the environment is concerned for each group member. This is given by

$$U_{ij} = \sum_{d=1}^{p} W_{id} \cdot x_{jd} \tag{2}$$

where U_{ij} is the environmental utility of the jth transportation strategy for household i, W_{id} is the household's weight or importance attached to dimension d, and x_{jd} is the position of the transportation strategy on the dimension. For each group, the analysis recovered the scales comprising the group evaluation space, the position of transportation alternatives in the space, the weights of each scale for each respondent, and the environmental utilities of each transportation alternative for each respondent. For each of the four groups, three basic environmental dimensions explain the maximum amount of variance in the input data. Accordingly, these three basic factors comprise the most important dimensions on which the groups rate their environmental utilities for different transportation systems. Because the positioning of the transportation alternatives on the dimensions is different for each group, it seems clear each group has its own criteria on which transportation alternatives are evaluated.

The fact that the four groups show some communality in their dimensions suggests that the town is unified rather than divided about the advantages and disadvantages of alternative transportation systems. This is not the case, however; the INDSCAL analysis presents only composite or group viewpoints. Additional analysis shows that the individuals within the group can vary on the importance which they attach to the different dimensions. The analysis reveals that the differential cognitions and evaluations of group members lead to interest groups with supporters drawn from different socio-economic strata.

UTILIZATION OF RESULTS

While the results of the analysis are interesting in their own right, the main value is to demonstrate how the INDSCAL framework can be applied to predict political responses to transportation alternatives in an urban area. Thus, the results of this research should be of value to federal, state, and local planning agencies and to research groups interested in how groups and individuals may perceive and respond to alternative transportation systems and investments in an urban area.

CONCLUSION

This report presents a framework for analyzing how residents of urban environments perceive and evaluate transportation alternatives. A two-phase design is described. In the first phase, a procedure is developed for eliciting the components which residents conceive as comprising their environments under a transportation system. In the second phase, it was hypothesized that, in a sample population, there might be groups who would be (a) homogeneous according to a very wide range of non-traditional socio-economic and activity variables and (b) evaluate the components of their kind of environment in the same way under alternative transportation systems. This framework was successfully tested with the definition of four homogeneous groups in a case study in a small town. Finally, the INDSCAL model was employed to determine whether each homogeneous group does evaluate the components of their environment under alternative transportation systems in a distinctive way. For the kinds of homogeneous groups in the case study town it was found that they do not. Each group evaluates transportation systems along similar dimensions, but individual differences within groups are so great that some members derive maximum utility from one alternative and some from another. Thus, other kinds of interest groups which support or oppose transportation innovations are drawn from different soci-economic and activity groupings. The conceptual framework of this report demonstrates how such interest groups are derived.

REFERENCES

1. See, for example, S. Amir, "Highway Location and Public Opposition," Environment and Behavior, 4 (1972), 413-436; J. E. Burkhardt, "Community Reactions to Anticipated Freeways: Fears and Actual Effects," Highway Research Record No. 470, Highway Research Board, Washington, D.C. (1973); and G. Fellman, "Neighborhood Protest of an Urban Highway," Journal of the American Institute of Planners, 35 (1969), 118-122.

2. See, for example, D. F. Fretzsche, "Consumer Response Information - A Potential Tool for Regulatory Decisionmakers," Transportation Journal, 14 (1974), 22-26.

3. See, Kaplans, Gans and Kahn. Social Characteristics of Neighborhoods as Indicators of the Effects of Highway Improvements. San Francisco: Marshall Kaplan, Gans and Kahn, 1972.

4. Sloan, A. K., Citizen Participation in Transportation Planning: The Boston Experience. Cambridge, Mass.: Ballinger, 1974.

5. Hunter, G. C., "Rural Communities and Inter-Urban Transportation Systems: A Study of the Stages of Inter-Action," Master's Thesis, Department of Architecture, The University of Texas at Austin, 1974.

6. Hinman, J., "Controversial Facility-Complex Programs: Coalitions, Side-Payments, Social Decisions," Discussion Paper No. 8, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970.

7. Hunter, op. cit.

8. Shepard, R. N., A. K. Romney, and S. B. Nerlove (Eds.). Multidimensional Scaling, Vol. I: Theory. New York: Seminal Press, 1972.

ACKNOWLEDGEMENTS

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INTRODUCTION

Transportation planning is marked by a concern about citizen involvement in the process. This is manifested by the plethora of studies on highway and expressway controversies.[1] It is also evident in attempts to create opportunities for citizen participation[2] and to examine the social consequences of road construction.[3] The concern with citizen involvement occurs at all scales of analysis, from the metropolitan area[4] to the small urban community.[5]

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[1] Amir, S., "Highway Location and Public Opposition." Environment and Behavior, 4 (1972), 413-436; J. E. Burkhardt, "Community Reactions to Anticipated Freeways: Fears and Actual Effects," Highway Research Record, No. 470 (1973), 22-31; G. Fellman, "Neighborhood Protest of an Urban Highway," Journal of the American Institute of Planners, 35 (1969), 118-122; A. Gonen, "The Spadina Expressway Conflict in Toronto: Decision and Opposition," Discussed Paper No. 5, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970; A. J. Mumphrey, "The New Orleans Riverfront Expressway Controversy: An Analytical Account," Discussion Paper No. 1, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970; A. J. Mumphrey, "A Monte Carlo Simulation of Highway Planning and Citizen Opposition: The Pennsylvania Planning Opposition Simulation," Discussion Paper No. 9, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1971; J. H. Schermer, "Interest Group Impact Assessment in Transportation Planning." Traffic Quarterly, 39 (1975), 29-49; J. E. Seley, "Development of a Sophisticated Opposition: The Lower Manhattan Expressway Issue," Discussion Paper No. 2, Research on Conflict in Locational Decisions, Department of Regional Science. University of Pennsylvania, 1970.

[2] Fretzsche, D. J., "Consumer Response Information - A Potential Tool for Regulatory Decisionmakers," Transportation Journal, 14 (1974), 22-26; M. L. Manheim, et al. Community Values in Highway Location and Design: A Procedural Guide: Final Report. Cambridge, Mass.: The M.I.T. Urban Systems Laboratory, 1971; C. Ryan, et al., "A Review of the Public Hearing Process as a Means of Obtaining Citizens' Views and Values," Highway Research Record, No. 467 (1974), 24-25.

[3] Kaplan, Gans and Kahn, Social Characteristics of Neighborhoods as Indicators of the Effects of Highway Improvements. San Francisco: Marshall Kaplan, Gans and Kahn, 1972; D. Nasatir, The Social Consequences of BARTS Environmental Impact: Some Preliminary Considerations and Hypotheses. Berkeley, California: University of California at Berkeley, 1974.

[4] Sloan, A. K. Citizen Participation in Transportation Planning: The Boston Experience. Cambridge, Mass: Ballinger, 1974.

[5] Hunter, G. C., "Rural Communities and Inter-Urban Transportation Systems: A Study of the Stages of Interaction," Master's Thesis, Department of Architecture, The University of Texas at Austin, 1974.

It has often been noted that, in response to transportation plans, private individuals are most concerned about the protection, conservation, and enhancement of their physical and social space.[6] However, little work has been done on how individuals themselves perceive the effects on their environment of new routes or other kinds of transportation innovation, such as transit services or airports. The emphasis in this report is therefore on developing an analytical framework for examining residents' perceptions of their environmental utility under different transportation alternatives. The analytical framework is intended for application at any scale; the usefulness of the framework, however, is demonstrated through a case study of a small urban community.

The analytical framework is two-phase in design. First, a methodology is briefly outlined for defining the general attributes of the perceived environment of a class of urban residents, for example, small town residents or residents in neighborhoods within a city. Then a conceptual framework is developed for delineating homogeneous population groups within an example of such an environment and for measuring each group's differential cognition and evaluation of the effects of transportation alternatives.

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6 Himman, J., "Controversial Facility-Complex Programs: Coalitions, Side-Payments, Social Decisions," Discussion Paper No. 8, Research on Conflict in Locational Decisions, Department of Regional Science, University of Pennsylvania, 1970.

PART I

DEFINING THE GENERAL ATTRIBUTES OF THE PERCEIVED ENVIRONMENT

Proposed alterations in transportation affect the behavior of residents in the vicinity. Conceptually, each person can be viewed as having an individual activity space containing a unique set of n elements or places to which he/she attaches some utility.[7] Following Harrison and Sarre, each element i can be viewed as defined by a number of constructs, m_i $(i = 1, \ldots, n)$, that is, meanings which the individual ascribes to the place.[8] Constructs are subjectively percieved characteristics of all the places a person uses or values in his/her activity space under a transportation system. However, constructs may also be conceived as bipolar scales (e.g., near, far) describing all the elements which make up the percieved environment for the individual.

Although each person will have a unique set of elements and constructs comprising his/her own activity space, it is plausible to argue that similarities will exist in the systems of individuals in similar locations and with similar backgrounds - for example, residents of small towns or residents within metropolitan neighborhoods. Thus, to study the effects of transportation proposals on perceived environments, the constructs defining places in the environment must first be elicited.

For a class of urban residents of interest, Kelly's Personal Construct Theory and related procedures may be used, together with their extensions by Bannister; Bannister and Mair; Bonnarius; Epting,

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7 Brown, L. and E. G.. Moore, "The Intra-Urban Migration Process: A Perspective," Geografiska Annaler, 52, Series B. (1970), 1-13; F. E. Horton and D. R. Reynolds, "The Investigation of Individual Action Spaces: A Progress Report." Proceedings of the Association of American Geographers, 1 (1969), 70-74.

8 Harrison, J. and P. Sarre, "Personal Construct Theory in the Measurement of Environmental Images: Problems and Methods," Environment and Behavior, 3 (1971), 351-374.

Suchman and Nickerson; and Slater.[9] The procedures employ a small sample of the population of interest but provide a rigorous method whereby the constructs of places in activity spaces can be suggested by residents rather than researchers.

To illustrate the use of the theory and the procedure for one general class of urban residents, we can take the elicitation of the constructs which define places for small town residents. (The population sizes of the towns range from 2,000 to 20,000). Since the details of this survey have been described elsewhere only a brief outline is required here.[10] First, a sample of small town residents was drawn: in this case 31 freshmen University students were selected to demonstrate the procedures involved. Each respondent listed all the places he/she used or valued about his/her home town, that is, all the elements of his/her activity space. Examples of listed elements are home, church, and corner store. Although each respondent listed a different set of places, there is no reason to believe that overall the lists did not provide a representative sample of places used by small town residents in general.

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9 Kelly, G. A. The Psychology of Personal Constructs. New York: W. W. Norton, 1955; D. Bannister, "Personal Construct Theory: A Summary and Experimental Paradigm," Acta Psychologica, 20 (1962), 104-120; D. Bannister and J. M. M. Mair, The Evaluation of Personal Constructs. London: Academic Press, 1963; J. C. J. Bonnarius, "Research in the Personal Construct Theory of George A. Kelly: Role Construct Repertory Test and Basic Theory," in B. A. Mahr (Ed.) Progress in Experimental Personality Research. New York: Academic Press, 1965, pp. 1-46; F. R. Epting, D. I. Suchman, and G. J. Nickerson, "An Evaluation of Elicitation Procedures for Personal Constructs," British Journal of Psychology, 62 (1971), 513-517; P. Slater, "Theory and Techniques of the Repertory Grid," British Journal of Psychiatry, 115 (1969), 1287-1296; P. Slater, Notes on INGRID 72. London: Institute of Psychiatry.

10 Burnett, K. P., et al. Transportation-Related Constructs of Activity Spaces of Small Town Residents, Research Report 18, Council for Advanced Transportation Studies, The University of Texas at Austin, 1974.

Next the triadic comparison method was utilized to elicit all the constructs defining all the elements on each respondent's list. Sets of three elements on the list were presented at random to each respondent; each time two elements considered similar were placed together and the third contrasting element was placed apart. The reason for the similarity and contrast between places was asked; this yielded descriptions such as "secure" and "insecure," that is, the contrasting poles of the construct or characteristic defining the triad of places. Triads were presented to every respondent until no new constructs were elicited. Thus, overall, the cognitive meanings ascribed to the range of places listed within small towns were elicited from all the respondents.

The triadic comparison procedure obviously can be yield a very large number of constructs or environmental descriptions even with a small sample. Slater's algorithm INGRID was developed to present such information in a more parsimonious form.[11] To utilize the algorithm, repertory grids must be constructed for each respondent: in our sample case, these took the form of the matrix outlined in Figure 1, where rows represent the preferred poles of the respondent's constructs, columns represent the elements of his or her activity space, and the entry in cell ij is the rating of how much of the preferred characteristic each element possessed (the ratings ranged from 1, most or top-scoring, to 7, least). The INGRID algorithm is a modified principal components analysis of each respondent's grid, such that clusters of preferred construct poles, or attributes, result. This leads to the extraction of the essential definitive substance of respondents' perceptions of their environment--for example, 38 constructs elicited from three subjects were reduced to only eight environmental components in the case study. In addition, 17 components occurred more than once for different respondents. These are listed in Table 1 and indicate communalities in the perception of small town environments. Although there are obvious problems of small sample size and aggregation, these 17 components were taken as

[11] Slater, Notes . . ., op cit.

Preferred Pole of Construct	Element (Place) in Town																	
	Home 1	School 2	Church 3	Weekend Shop 4	Supermarket 5	Hangout 6	.	.	.	.	.	.	.	.	.	Coffee House 22	Coke Street 23	Bakery 24
1 Affectionate	1	4	3	7	4	1	.	.	.	.	.	.	.	.	.	3	7	7
2 Calm	5	5	6	4	6	3	.	.	.	.	.	.	.	.	.	2	6	7
3 Private	4	5	4	4	7	2	.	.	.	.	.	.	.	.	.	2	5	7
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
13 Exciting	4	2	6	2	1	1	.	.	.	.	.	.	.	.	.	2	6	6
14 Educational	3	2	6	2	1	1	.	.	.	.	.	.	.	.	.	3	6	7

Figure 1. Example of a repertory grid.

bundles of constructs defining the perceived environment of small town residents. Components like those in Table 1 can readily be seen to provide adjectives which can be used in semantic differentials or other forms to rate the environment.

The foregoing has illustrated an analytical framework for defining a general kind of residential environment as it is perceived by its inhabitants. We now turn to a methodology for delineating population groups within an example of such a residential environment and for measuring each group's differential cognition and evaluation of the effects of transportation alternatives.

PART II

THE DELINEATION OF HOMOGENEOUS POPULATION GROUPS

Conceptualization

Within a general kind of residential environment (small towns, metropolitan neighborhoods) we may consider a population distribution at time t. Let there be a spatially random sample of m households drawn from this population. Then we may expect some number y of household clusters to be defined where the clusters will be homogeneous, at least in terms of (1) socio-economic status (broadly defined), stage in life cycle, and ethnicity and (2) their activity patterns. Such groups may also have distinctive cognitions and evaluations of the attributes of their perceived environment under alternative transportation systems. These expectations follow from Burnett and the well-known work by Berry and others on urban factorial ecology.[12] It also draws on work by Brail and Chapin which demonstrates correlation of activity patterns with the demographic characteristics of urban residents.[13] Finally, there is some evidence that environmental cognition and evaluation varies with socio-economic status.[14]

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[12] Burnett, K. P., "Decision Processes and Innovations: A Transportation Example," Economic Geography, 51 (1975), 278-289 B. J. L. Berry (Ed.) Comparative Factorial Ecology (Special Edition) Economic Geography, 47, Supplement (1971); B. J. L. Berry and P. Rees, "The Factorial Ecology of Calcutta," American Journal of Sociology (1969), 445-491; L. S. Bourne and R. A. Murdie, "Interrelationships of Social and Physical Space in the City: A Multivariate Analysis of Metropolitan Toronto," Canadian Geographer, 16 (1972), 211-229.

[13] Brail, R. K. and F. S. Chapin, "Activity Patterns of Urban Residents," Environment and Behavior, 5 (1973), 163-190.

[14] Horton and Reynolds, "The Investigation . . .," op cit.; R. J. Johnston, "Activity Spaces and Residential Preferences: Some Tests of the Hypotheses of Sectoral Maps," Economic Geography, 48 (1972), 199-211.

TABLE 1.

COMPONENTS DEFINING THE PERCEIVED ENVIRONMENT

FOR SMALL TOWN RESIDENTS

1. Preservation of family ties and friendships
2. Enjoyable outdoor recreation with others
3. Personal freedom
4. Country-western activities
5. Access to sophisticated entertainment
6. Restraints on behavior because everyone knows you
7. Challenge, excitement, adventure
8. Informal relationships
9. Access to luxuries of life
10. Pressure to achieve
11. Peace, tranquillity
12. Relaxation
13. Routine activities
14. Attractive rural surroundings
15. Intellectual stimulation
16. Accessibility to people and places
17. Personal privacy

Given an extended set of variables describing both the socio-economic characteristics and activity patterns of the sample, y internally similar household clusters may first be defined using factor analysis and a grouping algorithm; each cluster's cognition and evaluation of its environment under alternative transport systems can then later be probed. The initial formation of household clusters may first be demonstrated for a case study situation.

The Case Study Population Groups

Given that the general perceived environment of small towns was described above, one small town, Sealy, Texas, was selected for analysis. This town had a population of 2685 in the 1970 Census. Within the area, a 3 per cent sample of households was drawn for home interviews to determine household socio-economic characteristics and travel habits. Since there was no listing of households by address to provide a sampling frame, block fronts on a street map were numbered and then selected using a table of random numbers. As many households on a selected blockfront were contacted as possible, producing a spatially random clustered sample. One callback per household was used. Interviews were carried out with one respondent in each household during August, 1974, until 80 completed returns were compiled: two were later deleted owing to response inaccuracies. A map of the sampled households is shown in Figure 2. Subsequent analysis of the data in the questionnaires showed that the sample obtained in this way was reasonably representative of different strata in the town's population (Table 2).

Information was collected on 58 variables describing household socio-economic characteristics and travel habits. These variables comprise the S and A sets of Table 3. To find the basic dimensions which might differentiate households into clusters, a principal components analysis with varimax rotation to simple structure was performed on the 78 household by 58 variable matrix.[15] Since some

[15] The program used for the factor analysis was Veldman's "Factor," a special program written for the CDC 6600 system at the University of Texas at Austin. (Donald J. Veldman, VSTAT User Manual. University of Texas at Austin, 1974, p. 28).

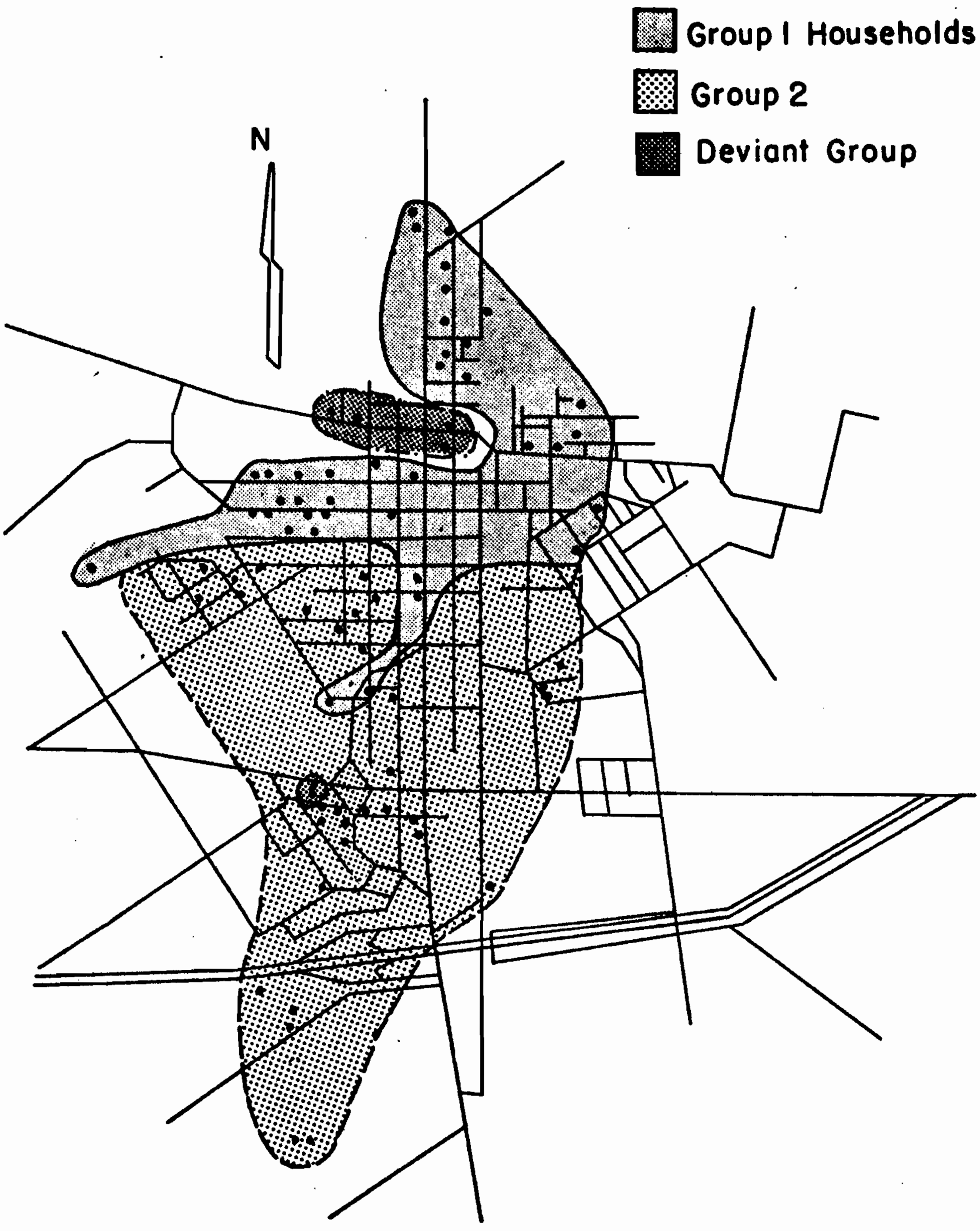

Figure 2. Locations and kinds of households in Sealy, Texas.

TABLE 2. PROPORTION OF 1970 POPULATION AND 1974 SAMPLE IN DIFFERENT STRATA.

	Percent Foreign Born	Females 16 Years & Older-Percent in Labor Force	Employed Persons-Percent in Manufacturing	Percent Negro & Other Races	Percent 18-64 Years	Percent 65 Years & Older	Males Over 14 Years-Percent Married	Females Over 14 Years-Percent Married	Persons 18 Years & Older-Percent Male
Population (1970)	3.8	23	4	9	68	25	30	42	40
Sample	3.7	21	6	7	63	26	32	38	37

Source: General Social and Economic characteristics of Sealy, Texas PC(1) - C45, L.S. Department of Commerce, Social and Economics Statistics Administration, Bureau of the Census, issued April 1972, Table 16.

of the variables were categorical (for example, religion of respondent), they were treated as dummies, with each category assigned a number.

The analysis produced sixteen factors with eigenvalues greater than one; these may be treated as basic factors differentiating households (Table 4).[16] The well-known life cycle phase and income/ethnicity factors appeared with loadings on the component variables that were readily interpretable. For example, as the life cycle phase factor increases, number of residents in household decline and age of respondent and life stage of household increase. A third socio-economic factor also appears, namely, familiarity with the town; this increases both as the year the respondent first moved into Sealy increases and as his/her total length of residence there increases.

The remaining 13 basic factors were those underlying household travel behavior and were more difficult to interpret. Some examples may be taken, however. Indoor recreation (Factor 7, Table 4) increases as the place of recreation changes and as the time taken to get there decreases. However, indoor recreation also increases as frequency of visit decreases, perhaps indicating that as travel time decreases, more time is spent at the recreation center and fewer trips are made. In contrast, for speciality goods like car purchasing (Factor 13, Table 4), as the time to the place of purchase increases, so does the frequency of the trip. This may well be because larger towns further away from Sealy offer a better array of automobiles and other speciality goods from which to shop. A final example of a less easily interpretable factor may be taken, that of opportunity for private indoor activities (Factor 15, Table 4). This opportunity increases as the frequency of using a restaurant decreases, and as the place used for a library changes. However, it also increases as the time to a restaurant decreases. This apparent anomoly may be explained by the fact that restaurants far from Sealy are preferred, compared with the limited facilities available in Sealy itself.

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16 Rummel, R. J., "Understanding Factor Analysis," Journal of Conflict Resolution, 40 (1967), 440-480.

TABLE 3. VARIABLES USED IN THE FACTOR ANALYSIS

3A S (SOCIO-ECONOMIC) SET

1	Year respondent first moved to Sealy
2	Total length of residence in Sealy of respondent
3	Number of persons permanently resident in household
4*	Occupation of respondent
5	Years of schooling of respondent
6	Number of cars in household
7*	Country or origin of respondent
8	Number of rooms in dwelling
9	Age of respondent
10*	Religion of respondent
11	Total weekly income of household ($ US)
12	Number of bathrooms in dwelling
13*	Sex of respondent
14*	Racial descent of respondent
15*	Place of employment of respondent
16**	Life stage of household

* Dummy variable

** Categories based on the ages of the household head and spouse, and ages of children, if any.

TABLE 3. VARIABLES USED IN THE FACTOR ANALYSIS (cont.)

3B A (ACTIVITY) SET

17*	Place usually shopped for groceries
18	Frequency of groceries shopping
19	Time to place for groceries
20*	Place usually shopped for clothing
21	Frequency of clothing shopping
22	Time to place for clothing
23*	Place used to shop for a car
24	Frequency of shopping for a car
25	Time to place for a car
26*	Place used for banking
27	Frequency of banking
28	Time to place for banking
29*	Place used for hairdressing
30	Frequency of hairdressing
31	Time to place for hairdressing
32*	Place used for doctor
33	Frequency of doctor's visits
34	Time to place for doctor
35*	Place used for indoor recreation
36	Frequency of indoor recreation
37	Time to place for indoor recreation
38*	Place usually used to see close relatives
39	Frequency of visiting relatives
40	Time to relatives' place

(cont.)

TABLE 3. VARIABLES USED IN THE FACTOR ANALYSIS (cont.)

3B A (ACTIVITY) SET

41*	Place usually used for a movie
42	Frequency of seeing movie
43	Time to place of movie
44*	Place usually used for a restaurant
45	Frequency of using restaurant
46	Time to restaurant
47*	Place usually used as library
48	Frequency of use of library
49	Time to library
50*	Place usually used to see friends
51	Frequency of visiting friends
52	Time to place of friends
53*	Place used to take visitors out
54	Frequency of taking visitors out
55	Time to place to take visitors out
56*	Place usually used for distant relatives
57	Frequency of visiting distant relatives
58	Time to place of distant relatives

TABLE 4. FACTORS WITH EIGENVALUES GREATER THAN ONE.

Factor	% Var.	Variables and loadings (in parenthesis)
1. Life cycle phase	4.85	3(-.67); 9(.64); 16(.74)
2. Ethnicity/Income	5.27	8(.74); 12(.80); 14(.56); 29(.57); 30(.52)
3. Familiarity with town	4.34	1(.91); 2(.90)
4. Non-family socializing	5.77	40(.72); 41(.76)
5. Banking opportunities	5.45	27(-.87); 28(-.85)
6. Occupation trips	4.39	4(-.78); 15(-.70); 30(-.51); 31(-.55)
7. Indoor recreation	4.41	35(-.60); 36(-.90); 37(-.89)
8. Infrequent types of trips	6.73	23(.55); 48(.60); 54(.50); 57(.62); 58(.77)
9. Socializing with friends	5.28	50(-.70); 51(-.85); 52(-.83)
10. Opportunities for doctor's visits	2.77	32(.78)
11. Grocery shopping opportunities	3.74	18(-.75); 19(-.70)
12. Choice of quality professional care	3.25	5(.53); 32(-.57)
13. Car purchase opportunities	2.98	24(.68); 25(.73)
14. Intellectual companionship	3.18	49(.72); 50(.74)
15. Opportunity for private indoor activities	5.90	45(.-.81); 56(-.84); 47(-.74)
16. Opportunities for clothing purchases	2.70	22(.74)

All 16 factors are interpretable as exemplified, so scores for each household on each factor were computed. The algorithm CONGRUP was then used to cluster households with like scores on the 16 factors.[17] As well as using constraints on the similarity of factor scores in forming household clusters, CONGRUP also employs a well-known 'contiguity' constraint: that is, households have to be contiguous to each other to be included in a group. Accordingly, CONGRUP delineated four main clusters of neighboring households, with two major groupings of 43 and 29 members respectively, and two deviant minor groupings of four and two members (Figure 2). The number of component groupings was subjectively chosen, but the appearance of two major groupings conforms with Hunter's delineation of two major kinds of households in Sealy in the late 60's and early 70's.[18] Thus, the sample clusterings appear to reflect the general community makeup of the area. To the north is a zone of older housing with residents of older age and lower socio-economic status; this area also contains the ethnic ghetto of the town. To the south and the west, the residents are more youthful, have lived in Sealy for a less lengthy period, and are generally of higher socio-economic status (Figure 2). Given a manner in which homogeneous groupings of the population can be defined, we may now turn our attention to a method of analysis of their cognition and evaluation of environmental attributes under alternative transport systems.

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17 The program CONGRUP was adapted to the CDC 6600 system at the University of Texas at Austin by Dr. R. Briggs, Department of Geography. It is based on Ward (1963).

18 Hunter "Rural Communities . . .," op cit.

PART III

THE DIFFERENTIAL COGNITION AND EVALUATION OF THE ENVIRONMENT UNDER ALTERNATIVE TRANSPORT SYSTEMS

Conceptualization

The first part of the report delineates the components (bundles of constructs) which define the residential environment for a class of urban dwellers. Different population groups may perceive their environment as desirably or adversely affected by alterations in the transportation systems of an urban area. For example, one group could perceive the attribute of small towns "preservation of family ties and relationships" (Table 1) as severely disrupted by an interstate highway.

To conceive how members of various groups rate their environments under different transportation alternatives, we may envisage a matrix of the kind shown in Figure 3. In this figure, the r rows represent components of the residential environment elicited by the Personal Construct Theory and Repertory Grid methodologies; the columns represent different possible alternative transportation strategies for an urban area. An entry in the cell of the matrix represents how much a group member perceives an urban area component to be affected by the transportation system, ranging from 1, extremely favorably, to 7, extremely unfavorably. The matrix thus represents the application of 7 point rating scales to evaluate the quality of the urban environment under alternative transportation systems. If it is desired to investigate the effects of environmental components not elicited from the residents themselves (for example, town growth in the case of the small town residents of Table 1), these components can be added as extra rows. The stress in this report, however, is on evaluating the urban environment from the resident's point of view. Consequently, the rows of the matrix of Figure 3 are viewed as composed entirely, or mostly, of residents' elicited perceptions of urban area attributes.

The matrices for the members of a homogeneous population group may be manipulated using the INDSCAL model to summarize the group's

Transportation System Alternative

Environmental Component	Before Freeway 1	After Freeway 2	With Dial-a-bus 3	With Train 4
1. Accessibility to friends	7	1	4	4
2. Peace, tranquility	1	7	3	5
3. Preservation of friendship	6	3	4	4
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
r Personal freedom	7	2	3	3

Figure 3. Group member's evaluation of the effects of alternative transportation strategies on his/her residential environment.

cognition and evaluation of the effects of transportation alternatives on their urban environment.[19] The input to the INDSCAL model is a similarities matrix for each person of a group. Accordingly, a matrix like Figure 3 for each group member has to be preprocessed so that similarities between each possible pair of transportation systems can be measured. There are various methods of doing this, for example, by using the program DISTAN after ratings across the n stimuli (transportation systems) have been standardized to zero mean and unit standard deviation.[20] Or, alternatively, following Nicholaidis, the scores for a transportation system can be conceived as represented by a vector [21]

$$X^i_{jt} = (X_{j1}, X_{j2}, \ldots, X_{jr})$$

in a space of the r environmental attributes of Figure 3, where i = a group member, j = the transportation system, and t is an environmental component. The perceived similarity of any pair of transportation systems by a group member is then given by

$$S^i_{jk} = \sum_{t=1}^{r} \left[X^i_{jt} - X^i_{kt}\right]^2 \quad j, k = 1 \ldots n \text{ (number of transportation systems)}. \qquad (1)$$

Where the ratings data have been collected from illeducated, semi-illiterate respondents, less refined methods of deriving similarities may be justified: for example, the use of the absolute differences between each pair of systems in their total or average scores over all environmental components. Formally, using the same notation as above, this becomes

$$S^i_{jk} = \left|\left(\sum_{t=1}^{r} X^i_{jt}\right) - \left(\sum_{t=1}^{r} X^i_{kt}\right)\right|, \quad j, k=1 \ldots n \qquad (2)$$

in the former case and

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19 Shepard, R. N., A. K. Romney and S. B. Nerlove (Eds.) Multidimensional Scaling. Volume 1: Theory. New York: Seminar Press, 1972.

20 Green, P. E. and V. R. Rao. Applied Multidimensional Scaling. New York: Holt, Rinehart and Winston, 1972.

21 Nicholaidis, G. C., "Quantification of the Comfort Variable," Transportation Research, 9 (1975), 55-66.

$$S^{i}_{jk} = \frac{\left| \sum_{t=1}^{r} X^{i}_{jt} - \sum_{t=1}^{r} X^{i}_{kt} \right|}{r} \qquad (3)$$

in the latter case.

The similarities between transportation systems have been calculated according to the systems' evaluated effects on a relatively large number of components of the urban residential environment. The application of INDSCAL enables the identification of the few most important latent, subjective scales which 'lie behind' each group member's evaluation of the effects of the transportation systems on their environment. Following Carroll, assume that there exists a set of a few important but latent environmental scales which generate group members' similarities judgements.[22] Let there be p such scales. Assume further that all the latent scales are common to the households in a homogeneous group. Then the p scales represent the most important dimensions of the group's evaluation space, and x_{jd} (j = 1 . . .n, d = 1 . . . p) represents the value of each of the transportation alternatives on each of the important environmental dimensions in the group evaluation space.

Assuming that the latent scales are common to all the households in a cluster seems a very strong homogeneity assumption. However, under the INDSCAL model, any household, i, has a unique set of weights $W_i = (W_{i1}, W_{i2}, W_{i3}, \ldots, W_{ip})$ which it attaches to each of the p scales. Theoretically, any of the W_i can equal 0 and thus some group members can attach no importance to some environmental dimensions. However, it is anticipated that within a homeogeneous cluster of households, none of the weights will equal zero (that is, households will share a common set of important dimensions to evaluate transportation alternatives). Nonetheless, there may be inter-household differences in weights, reflecting realistic inter-household differences in the importance attached to the basic dimensions used to evaluate the environment.

[22] Carroll, J. D., "Individual Differences and Multidimensional Scaling", in R. M. Shepard, A. K. Romney, and S. B. Nerlove (Eds.) Multidimensional . . ., op cit., pp. 105-155.

The INDSCAL model also permits the calculation of the utility of each transportation system as far as the environment is concerned for each group member. This is given by

$$U_{ij} = \sum_{d=1}^{p} W_{id} \cdot x_{jd} \qquad (4)$$

where U_{ij} is the environmental utility of the j^{th} transportation strategy for household i, W_{id} is the household's weight or importance attached to dimension d, and x_{jd} is the position of the transportation strategy on the dimension (this is similar to Nicholaidis' derivation of utilities for modal attributes). It will be of concern to note whether all households in a group find that the same transportation system alternative maximizes their environmental utility, that is, whether they form an environmental interest group.

Many other sources contain further details of the INDSCAL model.[23] However, sufficient of its details have been presented to provide the conceptual framework for the analysis of this report. The manner in which the INDSCAL model is actually fit to (dis)similarities matrices, like those of each household in a cluster here, is also presented in the noted sources. It remains to demonstrate how the environmental effects of different transportation alternatives could be measured.

The Case Study: Respondents' Environmental Cognition and Evaluation

In 1974 the residents of the case study town either had experience of, or were exposed to, debate about six alternative transportation systems. They had experience of a period prior to the opening of an interstate highway in 1968 and after it; there were also discussions of the addition of an AMTRAK train stop in the town, the upgrading or the downgrading of country bus services in terms of scheduling and destination, and the addition of a local intrastate airstrip.[24]

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23. Ibid., Green and Rao, Applied . . ., op cit.,Nicholaidis, "Quantification . . ., " op cit.

24. Hunter, "Rural Communities . . .", op cit.

Accordingly, every member of the four groups in the town rated the 17 elicited components of their residential environment (Table 1) under each transportation alternative, from 1, most advantageously affected, to 7, most disadvantageously affected. This produced a matrix for each sampled household of the kind shown in Figure 4. In addition, each respondent similarly rated the effects of the transportation facilities on six other components of their community. These components were suggested as important by Hunter after perusal of the local town newspaper and included[25]

(a) the attractiveness of the town to industry,

(b) the attractiveness of the town to retailing and office use,

(c) the respondent's household income,

(d) the community income,

(e) neighborhood land values, and

(f) population growth.

This produced a 23 x 6 matrix of ratings for each member of each of the four household groups in the town. It should be noted that each respondent was asked to use all the numbers between 1 and 7 where possible in rating, but that most of the small town residents were ill-educated and had considerable trouble filling out a matrix of the type shown in Figure 4.

The simplest method of preprocessing the data for INDSCAL analysis was therefore used. For each member of each homogeneous population group a similarities matrix was prepared. The similarities measure used was the difference between the average component scores for each pair of transportation systems (Equation 3). This yielded a six by six matrix of similarities for each respondent, of which an example is shown in Table 5.

The similarities matrix for each group of respondents in turn was next subjected to INDSCAL analysis. For each group, the analysis recovered the scales comprising the group evaluation space, the position of transportation alternatives in the space, the weights of each scale for each respondent, and the environmental utilities for each

[25] Ibid.

Environmental Component	Transportation System Alternative Before Interstate Highway 1	After Interstate Highway 2	Present Facilities Plus Train Stop 3	Improved Bus Services 4	No Bus Services 5	Local Intrastate Airstrip 6
1. Preservation of family ties	1	6	4	4	6	2
2. Outdoor recreation	3	1	3	3	5	2
3. Personal freedom	7	3	3	3	6	2
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
17. Personal privacy	7	2	3	3	6	1

Figure 4. Group member's evaluation of the effects of alternative transportation strategies on his/her residential environment in Sealy.

TABLE 5. SIMILARITIES MATRIX FOR RESPONDENT 1, GROUP 1.

Transportation System	1	2	3	4	5	6
1	.00	.37	.50	.40	.83	.53
2	.37	.00	.13	.03	.47	.17
3	.50	.13	.00	.10	.33	.03
4	.40	.03	.10	.00	.43	.13
5	.83	.47	.33	.43	.00	.30
6	.53	.17	.03	.13	.30	.00

transportation alternative for each respondent.

For each of the four groups three basic environmental dimensions explained the maximum amount of variance in the input data (Table 6). Accordingly, these three basic factors comprised the most important dimensions on which the groups rated their environment under different transportation systems. Because the positioning of the transportation alternatives on the dimensions is different for each group, it seems clear each group has its own criteria on which it evaluates transportation alternatives. The different positionings of the alternatives with respect to each dimension are shown in Figures 5a through 8b.

The average scores for each group of all the systems on each of the original 23 components were used to name the scales (dimensions) (Table 7). For Group 1, environmental Dimension 1 (Figure 5a) ranges from a high associated with improved mass transit and freeway services to a low associated with the absence of both, particularly mass transit. This correlates with favorable average scores being given by the group to facilities which promote access to outdoor recreation, to sophisticated amenities, and to people and places which give personal freedom as against small town intimacy (Table 7, Column 1). The accent on bus services on this dimension makes it plausible to assume that it is an access to personal freedom and relaxation dimension. Dimension 2, on the other hand, places negative weights in high access systems (bus, freeway, Amtrak, airstrip) and positive ones on an environment with little or no mass or freeway transportation. This is labeled as a rural community dimension; systems scored favorably on average where they preserved family ties while maintaining population growth (Table 7, Column 1). The third dimension appears to be an anti-economic growth dimension; the three transportation systems promoting growth score low, while the three which do not or are dubious (the airstrip) score high. There is evidence of mixed feelings in the town towards systems promoting growth. Although many persons scored them unfavorably, many also scored them favorably, so that overall the antigrowth dimension appears (Table 7, Column 1).

TABLE 6. VARIANCE EXPLAINED BY DIMENSIONS FOR CASE STUDY POPULATION GROUPS.

No. Dimensions	% Variance Explained for Group			
	1	2	3	4
1	45.62	46.75	52.86	55.26
2	69.32	63.32	70.32	73.33
3	78.51	73.92	75.16	78.41
4	68.24	67.56	66.51	62.37

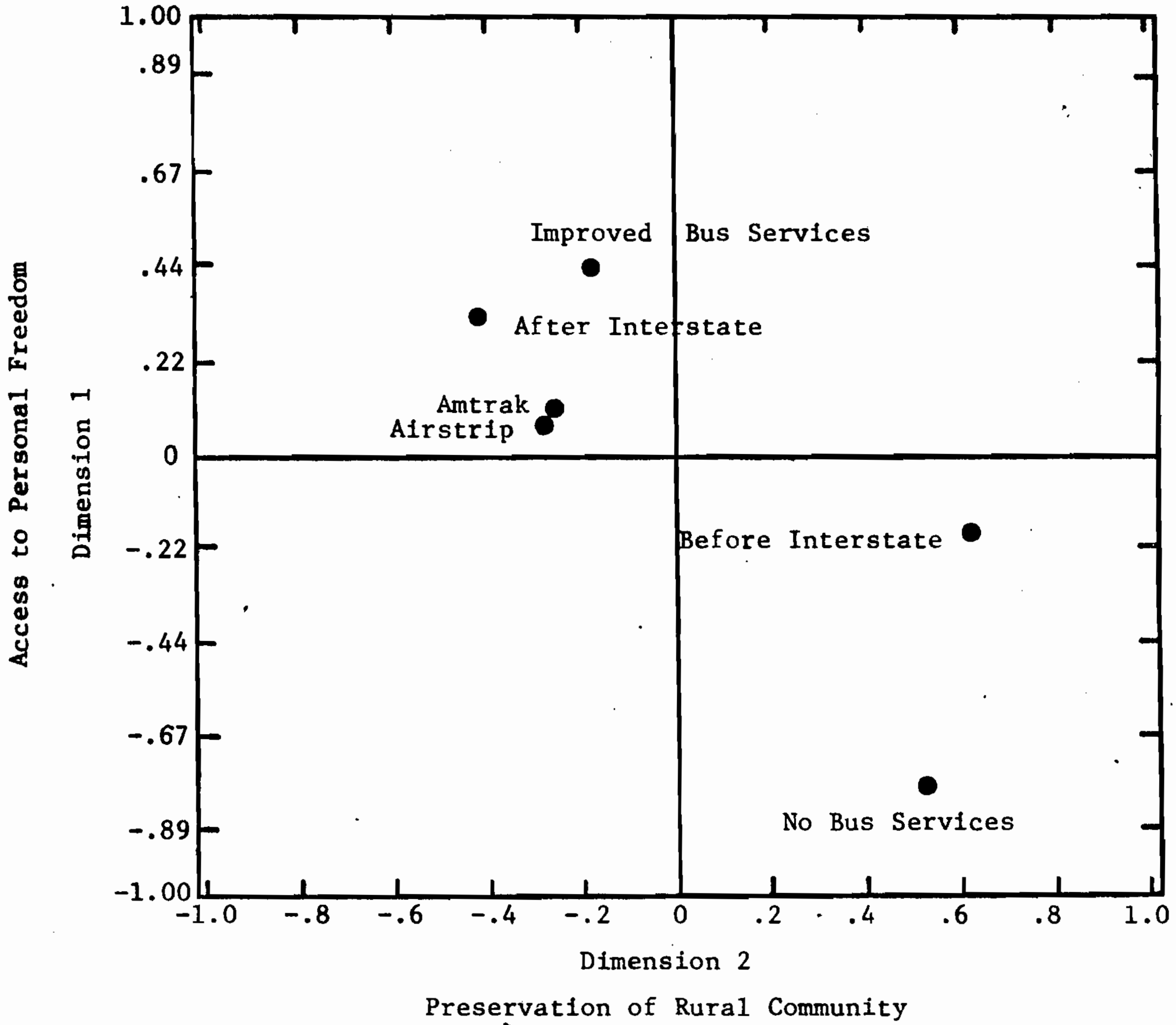

Figure 5a. INDSCAL plot of transportation alternatives-Group 1, Dimensions 1 and 2.

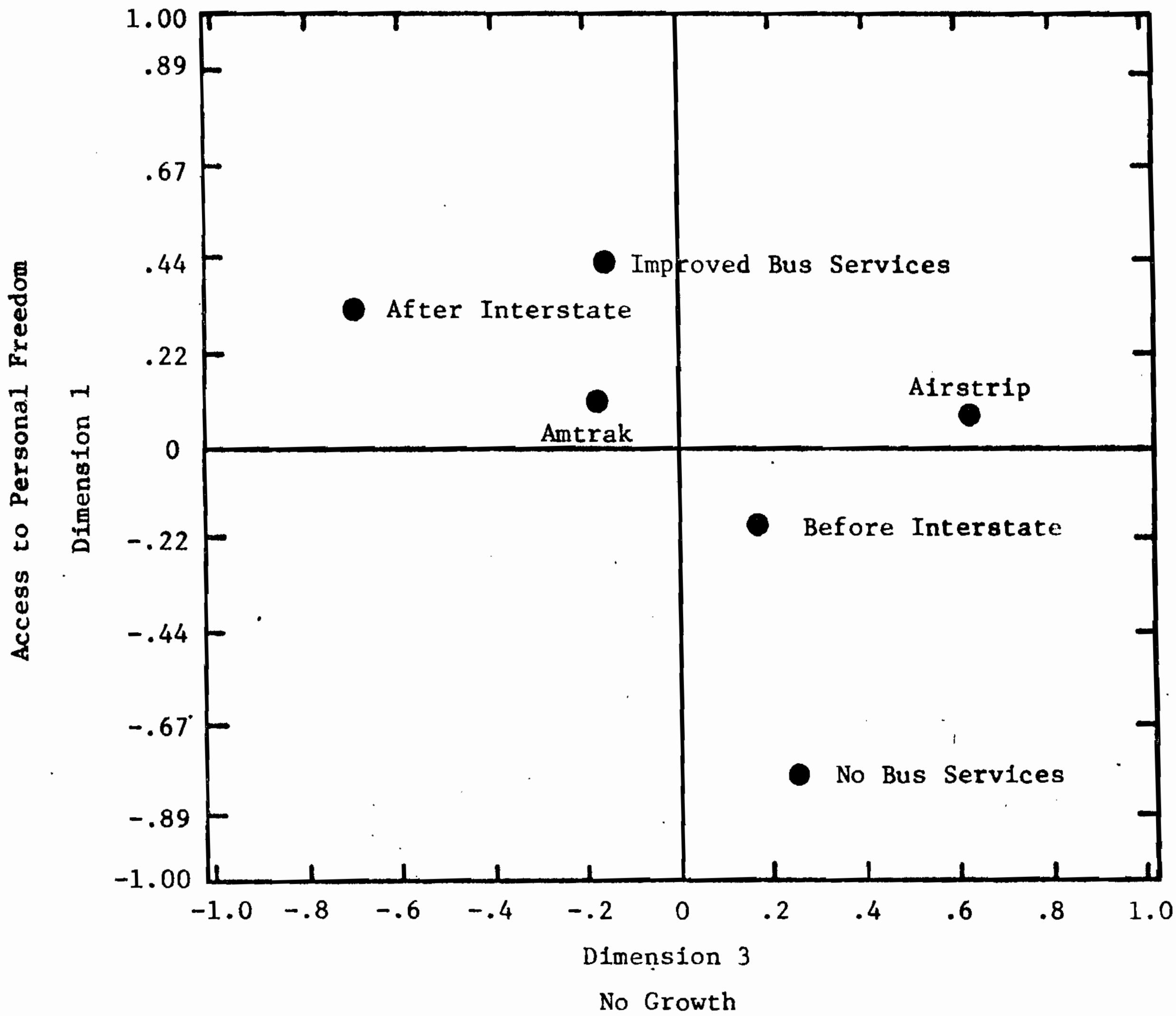

Figure 5b. INDSCAL plot of transportation alternatives-Group 1, Dimensions 1 and 3.

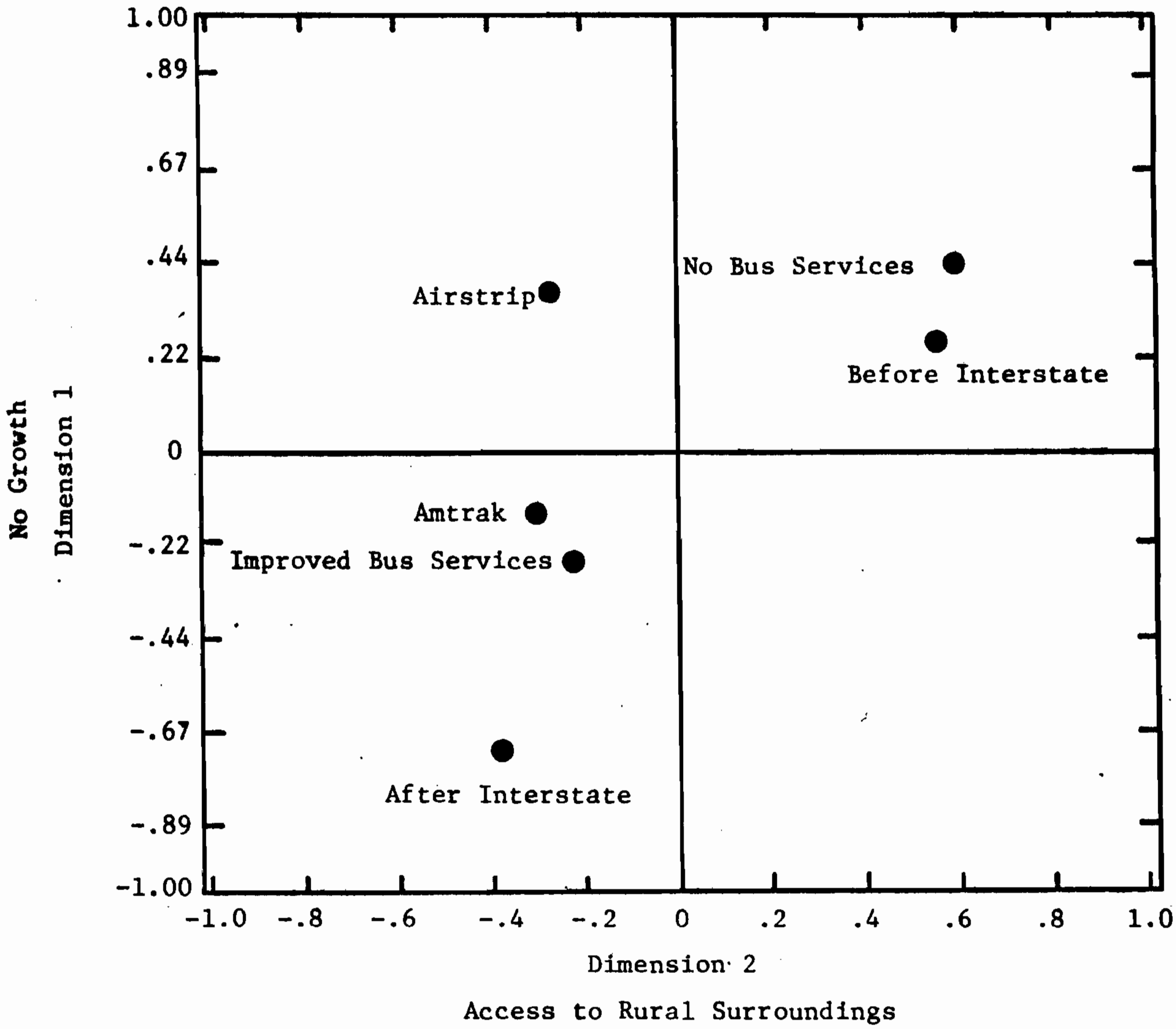

Figure 6a. INDSCAL plot of transportation alternatives-Group 2, Dimensions 1 and 2.

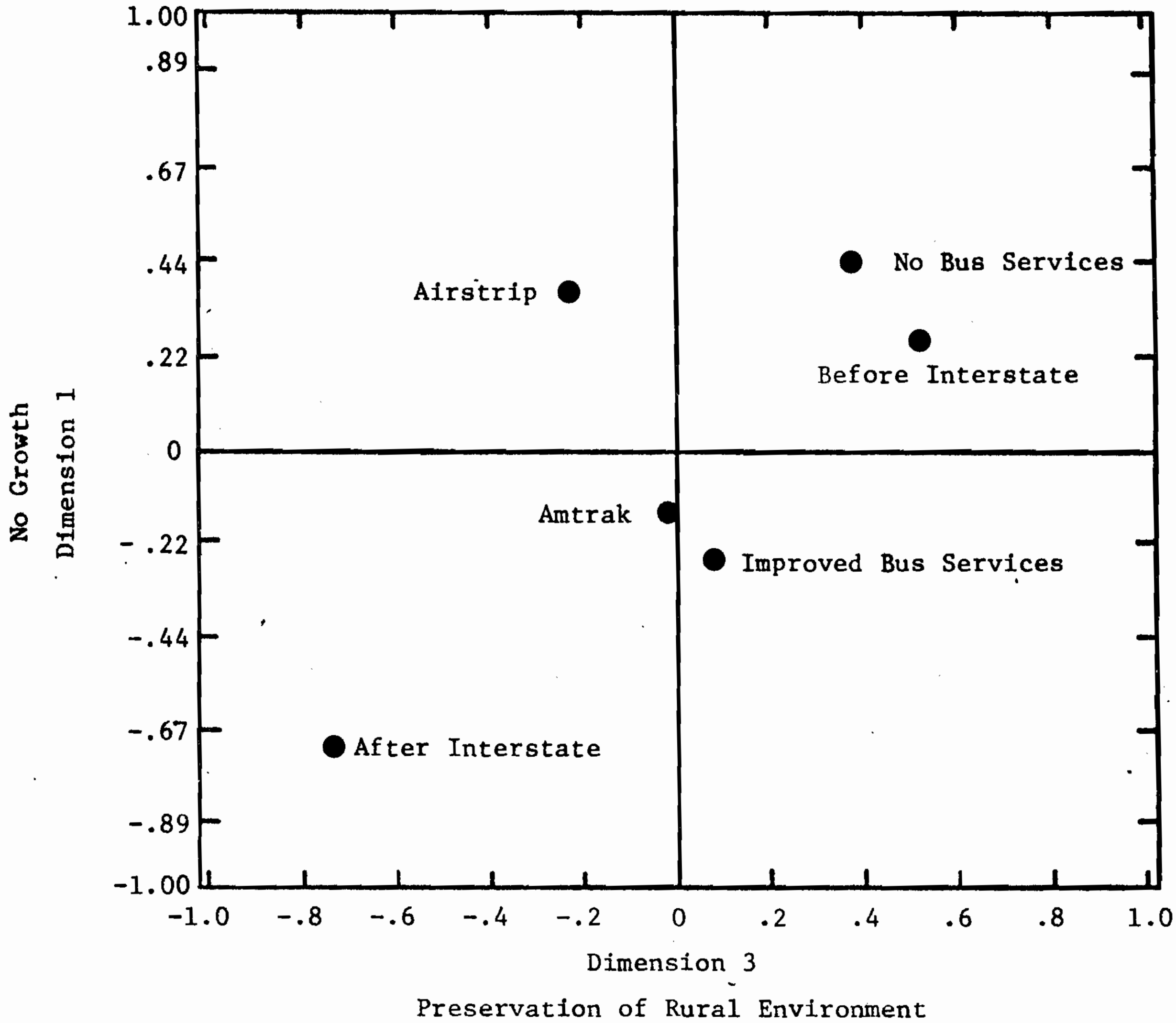

Figure 6b. INDSCAL plot of transportation alternatives-Group 2, Dimensions 1 and 3.

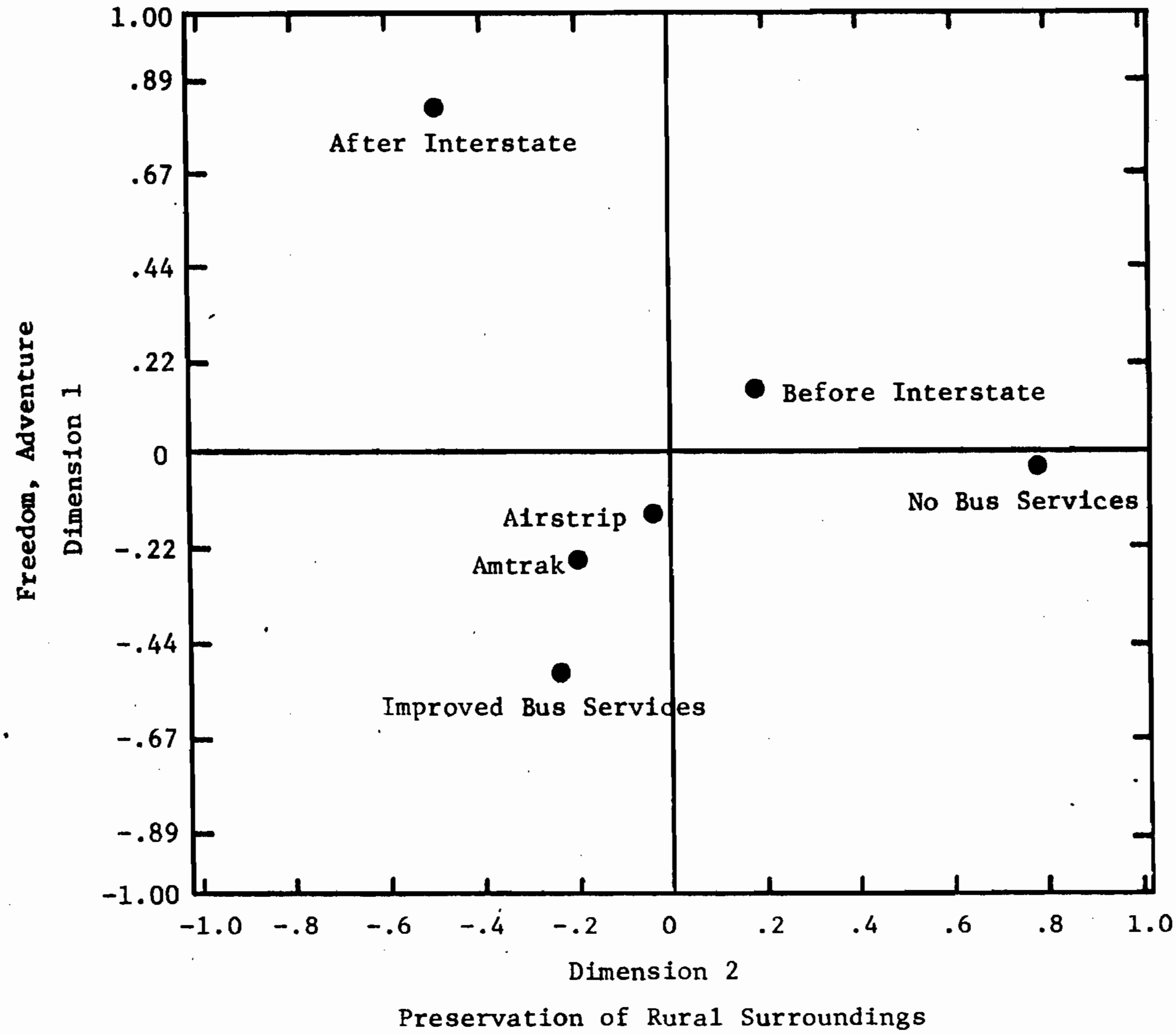

Figure 7a. INDSCAL plot of transportation alternatives-Group 3, Dimensions 1 and 2.

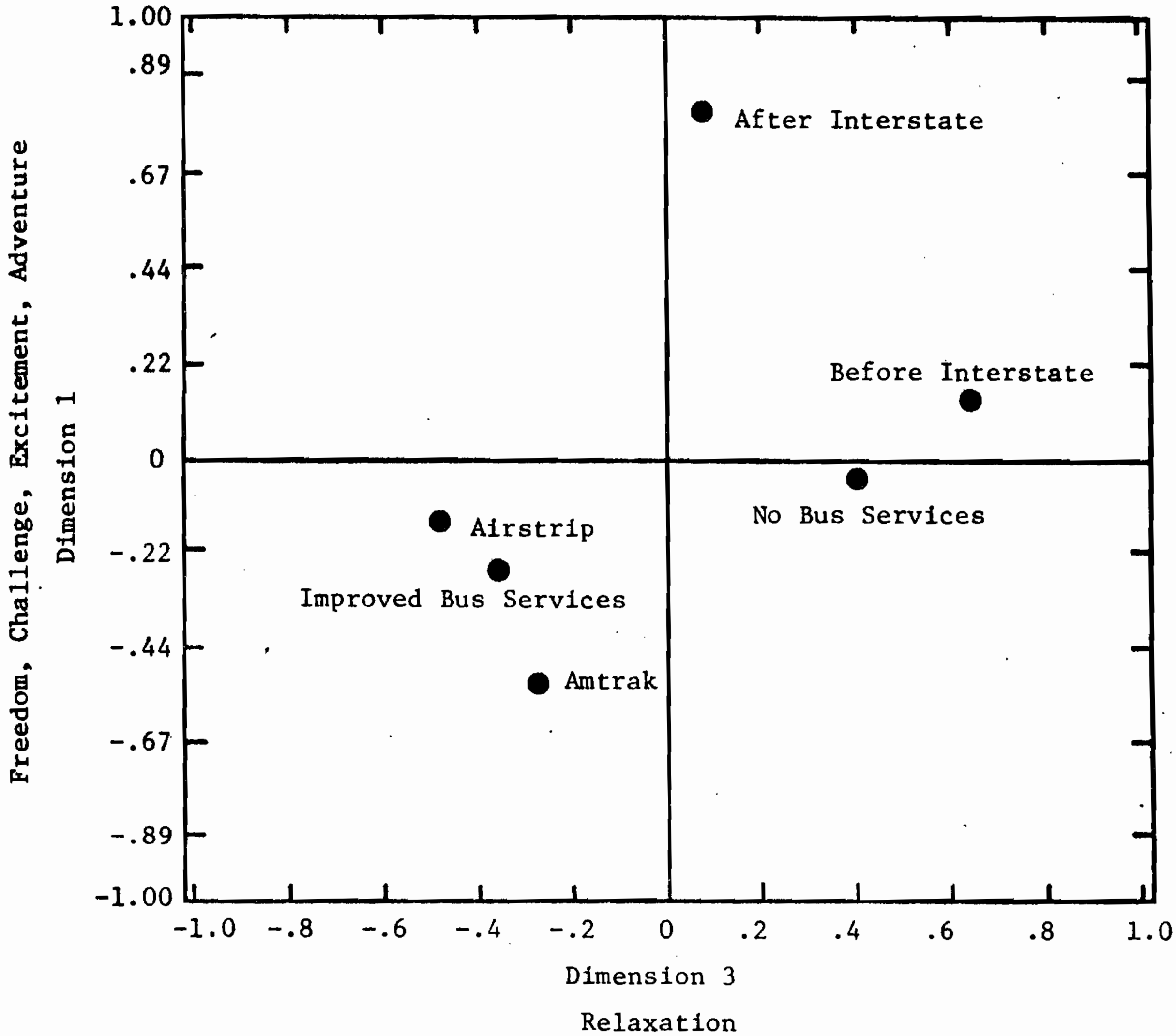

Figure 7b. INDSCAL plot of transportation alternatives-Group 3, Dimensions 1 and 3.

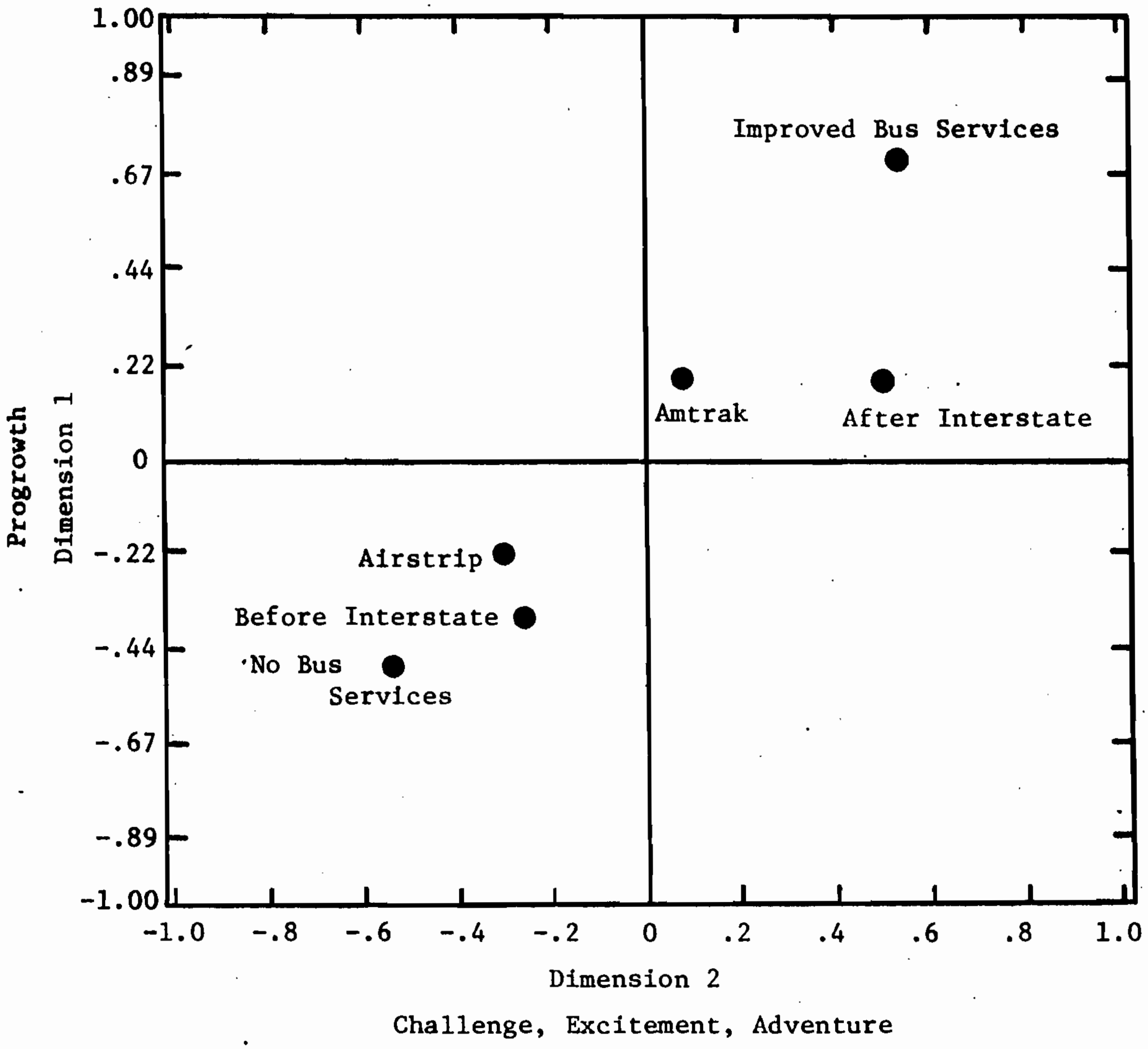

Figure 8a. INDSCAL plot of transportation alternatives-Group 4, Dimensions 1 and 2.

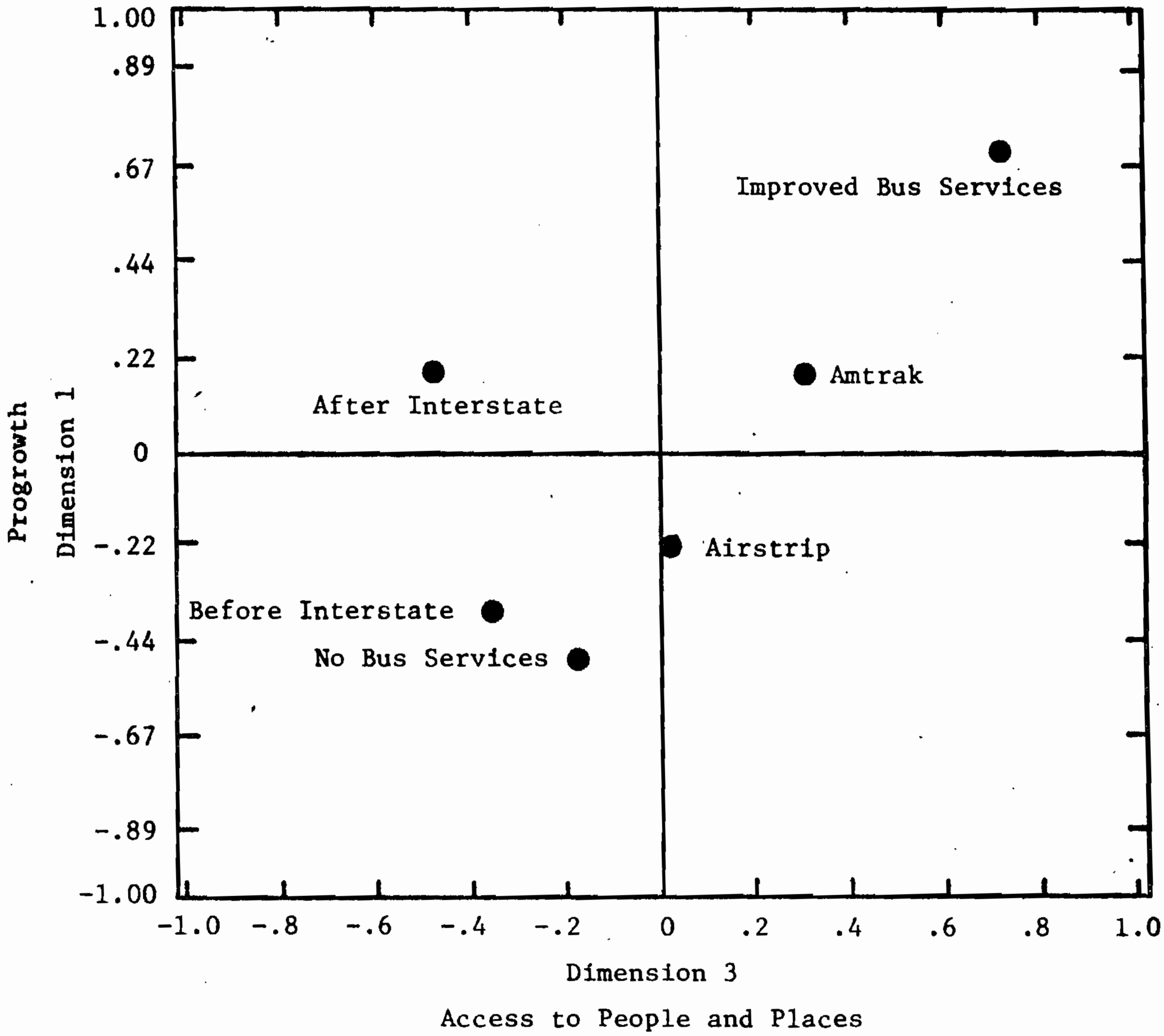

Figure 8b. INDSCAL plot of transportation alternatives-Group 4, Dimensions 1 and 3.

TABLE 7. AVERAGE SCORES FOR ALL TRANSPORTATION SYSTEMS ON ENVIRONMENTAL COMPONENTS (1.000 = HIGHEST; 7.000 = LOWEST)

Component	Group 1	Group 2	Group 3	Group 4
1. Attractiveness to industry	3.8	3.9	3.8	4.0
2. Attractiveness to retailing and office	3.6	3.2	3.4	4.0
3. Respondent's household income	3.4	3.1	3.5	2.2
4. Community income	3.7	3.9	3.8	4.0
5. Neighbourhood land values	3.6	3.7	4.0	3.9
6. Population growth	3.4	3.2	3.0	2.6
7. Preservation of family ties and friendships	3.4	3.3	3.7	3.2
8. Enjoyable outdoor recreation with others	3.5	3.4	3.4	3.6
9. Personal freedom	3.4	3.4	3.3	3.3
10. Country-western activities	3.9	3.9	4.0	4.0
11. Access to sophisticated entertainment	3.6	3.6	4.6	3.5
12. Restraints on behaviour	3.7	3.8	3.7	4.0
13. Challenge, excitement, adventure	3.3	3.5	3.3	3.7
14. Informal relationships	3.6	3.5	3.7	4.0
15. Access to luxuries of life	3.4	3.3	3.6	3.3
16. Pressure to achieve	3.7	3.8	3.7	4.0

(Cont.)

TABLE 7. AVERAGE SCORES FOR ALL TRANSPORTATION SYSTEMS ON ENVIRONMENTAL COMPONENTS (1.000 = HIGHEST; 7.000 = LOWEST) (Cont.)

	Component	Group 1	Group 2	Group 3	Group 4
17.	Peace, tranquility	3.7	4.0	4.7	2.7
18.	Relaxation	3.9	4.0	3.8	3.1
19.	Routine activities	3.7	3.5	3.9	3.1
20.	Attractive rural surroundings	3.7	3.4	3.9	3.5
21.	Intellectual stimulation	3.7	3.5	4.5	3.0
22.	Accessibility to people and places	3.7	3.4	4.3	4.4
23.	Personal privacy	3.8	3.8	4.8	4.0

Group 2 is not too dissimilar from Group 1 in that it scores very high for systems which generate low economic growth and is slightly more concerned about the effects of growth on the environment (Table 7, Column 2). Thus, for this group too, Dimension 1 seems a no-growth dimension, with facilities leading to growth given an unfavorable score and those not doing so being given a favorable score (Figure 6a). Dimension 2 seems a dimension associated with access to places for informal but stimulating relationships: facilities providing close countryside access score favorably while those providing access to distant, more sophisticated places score unfavorably (Table 7, Column 2). Dimension 3 seems associated with the stability of the rural community before modern transportation systems were suggested: the presence of the freeway scores negatively and is polarized against its absence (Figure 6b). This group scored favorably systems giving routine activities and the preservation of family ties and friendships. Consequently, this dimension is named preservation of rural environment.

The dimensions for the other groups were named in a similar fashion and are as follows: (a) Group 3: access to personal freedom; preservation of rural surroundings; relaxation; (b) Group 4: growth rather than antigrowth; challenge, excitement, and adventure; access to people and places.

The fact that the four groups showed some communality in their dimensions suggests that the town is unified rather than divided about the advantages and disadvantages of alternative transportation systems. This is not the case, however; the INDSCAL diagrams present only composite or group viewpoints. Figure 9 shows how much individuals within a group can vary in the importance which they attach to the different dimensions. The dispersion of weights shown for Group 1 is typical.[26] It is therefore of interest whether these

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26. Some of the weights in the space are negative. A personal communication from Prof. R. G. Golledge, Ohio State University, July 16, 1975, indicated that this is not too uncommon a result. In a case like the present one, some subjects could plausibly be negatively weighting some of the dimensions, for example, the dimension concerning economic growth. Considerable controversy over the importance of the dimensions is to be expected in a small town.

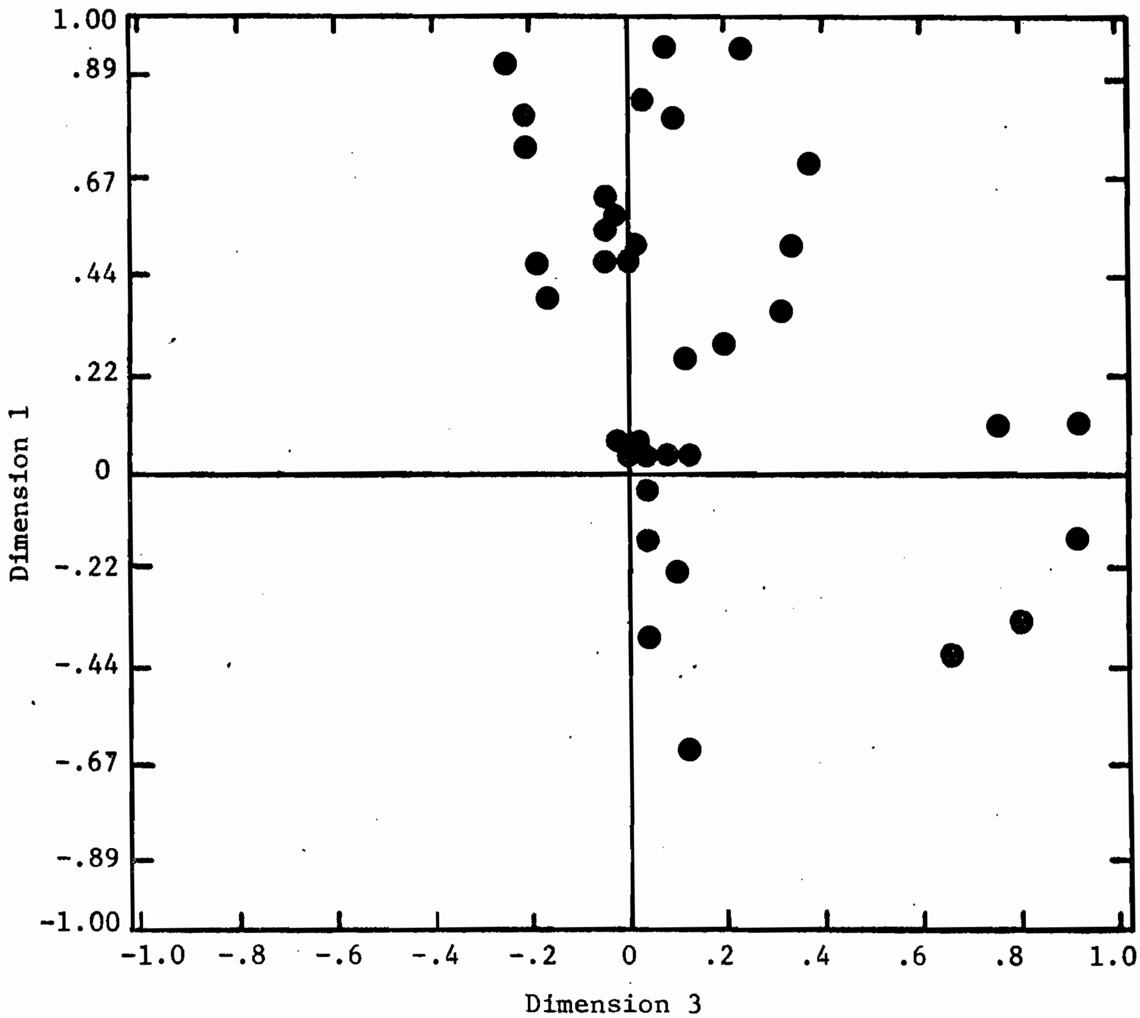

Figure 9. Subject weights for Group 1 on Dimensions 1 and 3.

groups, which are homogeneous socioeconomically and in terms of activity patterns, do represent, as previously believed, homogeneous interest groups in terms of the transport systems, particularly with respect to whether their different members will oppose or defend such systems. The analyses of the utilities which INDSCAL supplied for each respondent help answer this question.

Table 8 has been drawn up to show how different members within a group may derive their maximum environmental utilities under different transportation systems. For example, in Group 1, 17/43 people (39.5%) saw their maximum utility coming under the status quo, after the introduction of the interstate highway. However, 26 (60.4%) wanted alterations in the transportation systems to make the environment more desirable: 9 (20.9%) perceived greater benefit with improved bus services, 8 (18.6%) wanted mass transit facilities deleted altogether, and 9 (20.9%) saw their maximum benefit with the addition of an airstrip.

Thus, despite the one central hypothesis in this paper that different homogeneous socioeconomic groups would be supportive of one favorite alternative, the INDSCAL analysis reveals this is not the case. The differential cognitions and evaluations of group members lead to interest groups with supporters drawn from different socioeconomic strata. For example, Column 2 of Table 8 shows that the post-highway status quo is supported by 17 (39.5%) members of homogeneous Group 1, 14 (48.3%) of Group 2, and 2 (50.0%) of Group 3 in the case study community. This result is interesting in itself. However, its main value is to demonstrate how the INDSCAL framework can be applied to predict ultimately political responses to transportation alternatives in an urban area.

TABLE 8. NUMBER AND PERCENTAGE OF RESPONDENTS WITH MAXIMUM UTILITIES FOR TRANSPORTATION ALTERNATIVES

	Before Highway	After Highway	Add Train Stop	Improve Bus Services	Delete Bus Services	Add Air Strip	Totals
Group 1		17(39.5)		9(20.9)	8(18.6)	9(20.9)	43(100.0)
Group 2		14(48.3)			13(44.8)	2(6.9)	29(100.00)
Group 3	1(25.0)	2(50.0)			1(25.0)		4(100.0)
Group 4				2(100.0)			2(100.0)
Total	1(1.2)	33(42.3)		11(14.1)	22(28.2)	11(14.1)	78(100.0)

Percentages in parentheses

PART IV

CONCLUSION

This report has presented a framework for analyzing how residents of urban environments themselves perceive and evaluate transportation alternatives. A two phase design was described. In the first phase, a procedure was developed for eliciting the components which residents conceive as comprising their environment under a transportation system. For this, Kelly's Personal Construct Theory and Repertory Grid procedures were used. An example was given of the elicitation of the components which describe the environments of small town residents.

The second phase was more complex. It was hypothesized that, in a sample population, there might be groups who would (a) be homogeneous according to a very wide range of non-traditional socioeconomic and activity variables and (b) evaluate the components of their kind of environment in the same way under alternative transportation systems. Accordingly, the conceptual framework was extended to define statistically homogeneous groups, using income, occupation, age, and many different kinds of travel behaviors. This framework was successfully tested with the definition of four homogeneous groups in a case study small town. Finally, the INDSCAL model was employed to determine whether each homogeneous group does evaluate the components of their kind of environment under alternative transportation systems in a distinctive way. For the kinds of homogeneous groups in the case study town it was found that they do not. Each group evaluates transportation systems along similar dimensions, but individual differences within groups are so great that some members derive maximum utility from one alternative and some from another. Thus, other kinds of interest groups which support or oppose transportation innovations are drawn from different socioeconomic and activity groupings. The conceptual framework of this paper demonstrates how such interest groups are derived.

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REGIONAL AND COMMUNITY TRANSPORTATION PLANNING ISSUES - A SELECTED ANNOTATED BIBLIOGRAPHY

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INTRODUCTION

This memorandum is a by-product of the research effort currently being conducted under the topic, "The Influence of Interurban Transportation Systems on the Rural Environment." The first aim of the research is to produce two planning manuals, one for the use of the professional, the other for the lay person in small urban and rural communities. In order to develop these two documents, the research effort has been divided into several sub-areas, specifically including: planning resources and policies pertaining to rural areas and small communities; the growth potential of small communities in a regional context; the social and economic variables most relevant to interurban transportation planning; and the techniques currently used in the various stages of the planning process, including techniques for citizen participation.

The bibliography contained in this memorandum is a selected and annotated list of works reviewed by various members of the research team in the course of their separate investigations. It is divided into five sections, which reflect the areas of greatest relevance to the final planning documents. These are: I. Planning and Policy; II. Transportation and Regional Growth; III. Socio-Economic Variables in Transportation Planning; IV. Evaluation Techniques and Models; and V. Citizen Participation. The books and articles included do not constitute an exhaustive list, but rather a selected group representative of the diversity and of the state of the art in these five areas. These works were dealt with in some detail during the course of the research; it is hoped that the comments on each will be of use in guiding other researchers to works appropriate to their particular concerns.

It should be noted that the inclusion of a work in one section of the bibliography as opposed to another is sometimes a matter of subjective judgment. The areas of the bibliography overlap to some degree. For example, discussions of policy often include recommending that certain social and economic variables be included in future planning decisions, and attempts to define the social or economic factors relevant to planning may often require considerations of policy matters or of evaluation techniques. The final decision on classifying a particular work was based on its emphasis or on the value of its content to a particular concern of the research.

I. PLANNING AND POLICY

1. Altshuler, Alan. "The Values of Urban Transportation Policy." HRB Special Report 105, Highway Research Board, 1969, pp. 75-86.

   The author first discusses the problems inherent in developing a national policy that can both reconcile different interests and offer sufficient scope for a variety of state and local preferences to make themselves felt. He offers three broad recommendations, two within the framework of existing policy and one involving a change in the current policy structure: 1) increase side-payments; 2) increase the opportunities for citizens to make their views count in decision making; 3) change policy to offer wider scope for imaginative side-payments and expression of local values in transportation planning. Focusing on the need for change, he offers five "key policy directions": 1) combining highway and transit finance; 2) making the highway program more flexible in the kinds of projects supported; 3) experimenting with street use pricing; 4) more widely applying the urban design concept team and the multipurpose corridor development ideas; 5) offering more compensation to and participation for those directly affected by highways. Each of these suggestions is then discussed in detail.

2. Ashford, Norman. "The Planning Function in State Departments of Transportation." Traffic Quarterly, Volume 27, Number 1, January 1973, pp. 49-63.

   The author describes the development of DOT's at state level, which may be a response to (1) urban needs (2) new social orientation at federal level (3) need for in-house reorganization. He states there are 2 kinds of organizations being legislated: equal status divisions and advisory staff agencies. He argues for strong DOT's with a mandatory review of sub-state regional plans by a state transportation agency, which is then integrated with plans for economic development, social services, etc., although the functions of policy planning, line level planning and research may be decentralized.

3. Beckman, Norman. "Toward the Development of a National Urban Growth Policy: Legislative Review 1971." American Institute of Planners Journal, July 1972, pp. 231-249.

   The article examines growth policy legislation of 1971 to include transportation, manpower, revenue sharing, education, housing, land use and their intended impacts on both rural and urban areas. Special attention is given to legislative intent in rural development with reviews of the Appalachian Redevelopment Act, the Economic Redevelopment Act, and expenditures under the Public Works Act.

4. Beckman, Norman, and Susan Harding. "National Urban Growth Policy: 1972 Congressional and Executive Action." American Institute of Planners Journal, July 1973, pp. 229-243.

This article describes the "consolidation" of legislative action into 5 areas: (1) areawide planning, (2) urban-rural balance, (3) the future of the central city, (4) housing, and (5) environment. It outlines the projected impacts of the Rural Development Act of 1972.

5. Breur, Robert, and F. David Schad. Resource Paper on "Policy Planning." TRB Special Report 146, Transportation Research Board, Washington, D. C., 1974.

This paper gives an overview of the role of transportation policy as an instrument of planning, although the distinction between planning and policy planning is not always adhered to. Six groups of transportation policy issues are discussed: 1) Allocation of responsibilities for providing facilities and services; 2) Decision making process; 3) Integration of privately provided public transportation into the state system; 4) Changing the demand for facilities and services; 5) Funds for transportation; and 6) Charging for transportation. The discussion includes the historical background behind each group of issues as well as suggested directions for future policy developments.

6. Brown, Stuart, John Hoffmann and Leslie Pollock. "Public Investment Strategies for Regional Planning." Paper presented at the AIP Conference, October 1974.

This paper develops an overview of various strategies for planning and guiding the development of a region. It underscores the importance of perceiving present trends and understanding how these must be modified or strengthened. Goal identification and evaluation of progress are exemplified for selected strategies such as intensive economic development and intensive environmental protection.

7. Harkness, Glenn E. "The Changing Transportation Planning Evaluation Process." Paper presented at the AIP Conference, October 1974.

The paper describes the evolution of transportation planning and its changing scope and direction. After an increasing consolidation of decision making powers at higher levels, recent developments suggest more local participation with emphasis on citizen input and community needs.

8. Hoel, L. A. "Summary of Conference Proceedings." HRB Special Report No. 120, 1971, pp. 4-10.

Five summary sections which deal with (1) urban commodity flow, (2) public policy, (3) the role of federal government, (4) the planning processes and urban form including industry location, and (5) research.

9. National Research Council, "Issues in Statewide Transportation Planning." TRB Special Report No. 146, Transportation Research Board, Washington, D. C., 1974, 262 pp.

This is a summary of the proceedings of a conference held in February of 1974. It contains a series of reports, resource papers, and discussions covering a broad range of administrative, economic and social issues involved in developing transportation planning policy at the state, regional and substate level. (Several papers on specific issues are covered under the authors' names in this bibliography.) The report lists the findings of the conference's workshops, most of which bear directly or indirectly on the formulation of state and federal transportation policy.

10. Neumann, L. A., W. M. Pecknold, A. T. Reno and M. L. Manheim. "Integrating System and Project Planning for the Effective Programming of Transportation Investments." Transportation Research Record No. 499, 1974, pp. 83-93.

The purpose of this paper is to discuss the problem of integrating system and project planning to systematically include environmental and community concerns. The paper first identifies the major problems in the current system-project relationship (e.g., many system impacts are long-term and area-wide and therefore cannot be handled on a project basis.) Also, system impacts are difficult to predict because of a lack of understanding of complex cause-and-effect relationships. The paper then discusses a philosophy for integrating the activities at these different levels of planning. System and project planning must be integrated so that the "go/no-go" decision to implement any project or a particular design will not disrupt the ability to allocate funds smoothly to other high-priority projects. Finally, the paper presents some practical techniques for more effectively integrating system and project plans by changing the documentation requirements to support a continuous planning process. An example is strengthening the ties that exist between system planning and the programming process that focuses on near-term implementation of sets of projects or programs.

11. Raymond, George M. "Issues in Non-Metropolitan Growth." Urban Land, February 1973, pp. 4-8.

The author considers (1) areas near SMSA's impacted by urban growth and (2) declining rural areas. In the first case, attention is called to the need for social services (including transportation) and strong involvement in land use on all levels of government. In the second case there is a call for coordinated efforts at transportation and renewal within a "growth center" oriented policy.

12. Thomas, Nicholas P., and Jeffrey J. Orum. Resource paper on "State and Regional Development." TRB Special Report 146, Transportation Research Board, Washington, D. C., 1974, pp. 186-242.

This paper constitutes a wide review of existing regional agencies, their planning functions, and the policies which guide or have led to their development. Examining the many multi-state and substate regional organizations and their relation to state and federal policy and stated objectives, the authors make a great number of recommendations on transportation planning policy and its potential to coordinate the various aims of functional and comprehensive planning at regional, state and substate levels. While citing a variety of different approaches to organization and structure as models, the authors wish to see greater uniformity nation wide.

13. U. S. Department of Agriculture. Rural People in the American Economy. Agricultural Economic Report No. 101, Economic Research Service, Economic Development Division, U. S. Department of Agriculture, October 1966, 125 pp.

This is a study of the changing face of rural America and how public services and planning for economic activities must be supplied to rural areas. Factors affecting the participation of rural people in the nation's development are emphasized. Economic development to achieve three goals is emphasized: bettering the lot of rural people, increasing the number of job opportunities for rural people, and bettering the lot of all people. This work serves as a general text on the problems facing the rural population in the United States.

14. U. S. Department of Agriculture, Economic Research Service. "Transportation in Rural America: An Interim Report." U. S. Government Printing Office, Washington, D. C., April 1974, 18 pp.

This was prepared for the Senate Committee on Agriculture and Forestry. The report is a general attempt to identify the problems of rural transportation in order to develop a transportation policy that is integrated with that for other sectors. The report reviews recent experience in the inability of the existing transportation system to meet demand and takes note of the lack of sufficient data and the need for research in order to evaluate the system as a whole.

15. Walton, C. Michael. Mobility and Rurality: The Value of Transportation. May 1970, North Carolina State University, 101 pp.

This is a study of the need to develop a transportation model for the rural community. Increased transportation mobility for rural residents through a reorientation of transportation planning concepts is needed to help eliminate rural poverty.

16. Wingo, Lowdon. "A National Urban Development Strategy for the United States." Urban Studies, Volume 9, February 1972, pp. 3-27.

This article traces the decline in population and economic leverage of non-metropolitan areas in the U. S. and calls for an organized research approach in areas such as (1) optimum city size, (2) private costs and benefits as a function of city size, (3) externalities (pollution, social costs, economic advantages) as a function of city size, etc., which will lead to a better understanding of structural growth.

II. TRANSPORTATION AND REGIONAL GROWTH

1. Arianin, A. "Interregional and Intraregional Analysis of Location of Productive Forces." Regional Science Association Papers, Volume 24, 1970, pp. 163-170.

The study suggests a comprehensive multi-stage "intersectional" analysis (input-output variety) in conjunction with an intra-regional cost-of-production and resource availability model to predict optimal locations.

2. Berry, Brian J. L. "Approaches to Regional Analysis: A Synthesis." Annals of the Association of American Geographers, 1964, pp. 54 ff.

The author employs general systems theory to analyze geographic study, its approaches and bases for synthesis, and to detect those areas in it requiring development such that a substantial understanding of U. S. economic regionalization can be reached.

3. Cella, Francis R. "Highway Location and Economic Development." Highway Research Board, Bulletin 327, 1962, pp. 73-76.

This paper asserts that a highway's location along with other factors can affect an area's economic development. It regards transportation as an industry contributing to the area's per capita income. The author develops a mathematical model using historical data on highway locations to measure their impact on the area's development.

4. Chorley, Richard, and Peter Hagget (Eds.) Models in Geography. Methuen and Company, Ltd., London, 1967.

This is a text which identifies various uses of models in geography and includes a section on models of socio-economic systems. Various model approaches to industrial location are explored by F. E. Ian Hamilton beginning with Weber and covering briefly Monte-Carlo and Markov chain models, allocation-location models, and settlement hierarchies.

5. Duis, R. W., T. H. Dudgeon, et al. "Highway Transportation and Appalachian Development." Appalachian Regional Commission, September 1970.

This report deals with the early phases of social and economic impact of a highway project in a region. It includes a discussion of market areas both inside and outside the region, with some reference to industries which are located in the region.

6. Friedman, J. "Regional Development in Post-Industrial Society." American Institute of Planners Journal, 1964, pp. 84-90.

This article discusses the locational aspects of regional development, citing national policy as the major determinant given an economy like the U. S.'s "where service industries predominate and where spatial immobilities are progressively losing their importance." Additionally, it considers formative distinction between "developmental" and "adaptive" approaches to planning. Because of its predominant formative role, increased research is urged on the spatially differentiated effects of national policy.

7. Fulton, Maurice. "Problems and Advantages of Selecting Rural Areas for Plant Location." Coastal Plains Commission, March 25, 1970.

Pros and cons of industrial growth in rural areas are discussed. Rural areas have available utility services, are accessible to metropolitan areas by new freeway networks, consider personal amenities vital and offer property for unusual developments. On the other hand, in the city, industries offer easy access to the plant for customers, are accessible to unusual forms of shipment and are near technical advice and equipment. Other pros and cons are discussed.

8. Fulton, M., and E. Hoch. "Transportation Factors Affecting Location Decisions." Economic Geography, Volume 35, Number 1, 1959, pp. 51-59.

The article includes a general background discussion of location theory and the evolution of the part played by transportation in determining "optimal" locations. It suggests that transportation facilities are an integral part of the market-oriented view and suggests areas of further investigation.

9. Gauthier, W. L. "Geography Transportation and Regional Development." Economic Geography, Volume 46, Number 4, October 1970, pp. 614 ff.

This article discusses the failures in integrating geographic and economic theory in transportation planning. The problem of evaluating industrial commitment versus infrastructure commitment in inducing accelerated economic development is examined.

10. Guthrie, John. "Economies of Scale and Regional Development." Regional Science Association Papers, Volume I, 1955, pp. 1-10.

The article presents an economic approach to location factors. It breaks down locational pressures into impacts of internal and external economies. It also shows how the scale or size of the plant influences location choice. It suggests that at a point in the evolution of industries, they tend to disperse operations due to decreasing advantages offered by agglomeration.

11. Grossman, David A., and Melvin R. Levin. "Area Development and Highway Transportation." Highway Research Record No. 16, Highway Research Board, 1963, pp. 24-31.

This article briefly considers the extent to which highways can be employed in such economic development as is sought by the Area Redevelopment Act of 1961. The problems in different types of distressed areas -- including old textile cities, mining regions, and marginal farming areas -- are described, and the degree to which highway improvements would help is in each case noted. The article calls for a realistic appraisal of highway programs within a human resource-oriented framework in serious redevelopment efforts.

12. Hale, Carl W. "The Mechanism of the Spread Effect in Regional Development." Land Economics, Volume 43, Number 4, November 1967, 437 pp.

This article discusses mechanisms affecting spread between leading and lagging areas during periods of U. S. economic growth. Those mechanisms considered are: the geographic separation of economic functions of business firms, wage differentials, local industrial development subsidies, urban development and zoning, and localized investment in social overhead capital, and inter- and intra-regional migration. Systems of integrated communications and highway transportation are considered preconditions of growth patterns.

13. Hale, Carl W., and Joe Walters. "Appalachian Regional Development and the Distribution of Highway Benefits." Growth and Change, Volume 5, Number 1, 1971, pp. 3-11.

The authors discuss the long range regional impacts of the technological changes in Appalachia associated with highway construction programs. They describe the effect of highways on accessibility to cities within and on the periphery of the Appalachia region and predict the probable increase in the economic potential of smaller growth centers in the region as a result of changes in accessibility.

14. Kuehn, John A., and Jerry G. West. "Highways and Regional Development." Growth and Change, Volume 2, Number 3, July 1971, pp. 23-35.

After an initial "review of conflicting ideas about the impact of highways on regional economic development," the article summarizes a correlation survey of economic development and highway location in the Ozark region. It concludes that highways have only a "permissive" effect in such development.

15. Straszheim, Mahlon. "Researching the Role of Transportation in Regional Development." Land Economics, August 1972, pp. 212-219.

This article points out the problems in assuming the positive relationship between capital transportation investments or user pricing policies and regional economic development. Three approaches to evaluating the importance of transportation systems in regional development are outlined and criticized: (1) classical location theory, (2) statistical models, (3) large-scale systems simulation models. The author underscores the problems of data gathering within all three approaches but suggests the third as a fruitful method.

III. SOCIO-ECONOMIC VARIABLES IN TRANSPORTATION PLANNING

1. Bouchard, Richard J., E. L. Lehr, M. J. Redding, and G. R. Thomas. "Techniques for Considering Social, Economic and Environmental Factors in Planning Transportation Systems." Highway Research Record No. 410, Highway Research Board, 1972, pp. 1-7.

   A general discussion of the considerations which should be made in order to take community values into account at each stage of the planning process and facility construction. Noting that only at the project phase do community values become clearly identifiable, the authors attempt to categorize the relevant factors of social, economic and environmental values which could enter into the system and corridor planning stages as well as the project planning, construction, and operation phases of development. A list of eleven categories of impact factors is offered along with a discussion of the general techniques for identifying them and incorporating them into the separate stages of planning. The three categories most relevant to systems, corridor, and project planning are: 1) Economic (land values, tax base, employment, housing and public services, business, and income); 2) Socio-political (life style and activities, perception of cost and benefit by groups, personal safety, effect on government); and 3) Land Use (changes in density, usage, activity).

2. Boyd, J. H. "Research Needs in Economic and Financial Factors of Highway Transportation: In Search of Improved Strategy." Highway Research Record No. 356, Highway Research Board, 1971, pp. 158-167.

   The report describes the scope and content of economic and financial research in highway transportation. It contains a discussion of methodologies, including those employed in impact and cost/benefit studies, and recommends separation of the two kinds of studies. The author is critical of the application of economic techniques in highway research. Particular emphasis is given to problems in the specification and quantification of travel demand and to the analysis of transferred benefits from users to non-users.

3. Burkhardt, Jon E. "Impact of Highways on Urban Neighborhoods: A Model of Social Change." Highway Research Record No. 356, Highway Research Board, 1971, pp. 85-94.

   A "Neighborhood social interaction index" is developed for measuring highway improvement impact on neighborhoods. Behavioral patterns (e.g., personal interaction and participation in local organizations) and perceptual patterns (e.g., identification with local area) were used to develop this index using factor analysis. Such data as mobility of population, land-use mix, and housing density are employed for predicting the NSII index. The NSII index could be used in making decisions regarding highway location and its impact within a certain neighborhood. The index has possible application to the measurement of impact on small communities.

4. Burkhardt, Jon E. <u>A Study of the Transportation Problems of the Rural Poor</u>. Volume I, January 7, 1972.

   This work is an analysis of the transportation needs of poor persons in five rural areas of the U. S. along with recommended systems for each area. A significant portion of the rural poor have a dire or strong need for transportation. Considering such factors as area characteristics, transportation behavior of the population, and attitudes toward population, various systems are recommended. Such systems include: a bus-like service in several states, a transportation grant program in Arizona (i.e., cars for the poor), and a reorganized and coordinated taxi system in North Carolina.

5. Burkhardt, Jon E. <u>A Study of the Transportation Problems of the Rural Poor</u>. Volume II, January 7, 1972.

   This work is an analysis of area characteristics, transportation inventories and present travel patterns and attitudes which document the systems proposed in Volume I. Each of the five study areas are characterized and discussed. Available transportation resources include school systems, commercial bus lines, taxi companies, and parcel delivery services. Use of such resources by the poor is restricted by legal limitations, scheduling problems and lack of concern by present operators. Travel patterns and behavior are described by trip purpose, mode of travel, trip cost, frequency, mode, distance time and purpose and origin-destination relationships.

6. Campbell, Wilson E. "Social and Economic Factors in Highway Location." Paper No. 4926, <u>Journal of the Highway Division</u>, ASCE Proceedings, October 1966.

   The paper presents methods derived by the Chicago Area Transportation Study for quantifying certain economic and social aspects pertinent to alternate highway route and structure selection. For balanced highway network evaluation, a minimum cost/maximum benefit analysis is proposed traversing a variably weighted checklist of considerations including both user and non-user criteria, such as traffic flow in the former case and relocation in the latter.

7. Hennes, R. G. "Highways as an Investment of Economic and Social Change." National Research Council, Highway Research Board, Special Report 56, 1960.

The study summarizes the history of highway project evaluation and cites developments in highway utility to be reckoned with in subsequent evaluations and reflected in subsequent projects. It notes the relative simplicity of former vehicular oriented evaluations and indicates that distribution standards be developed for the economic and social benefits afforded communities by highway constructions.

8. Horn, John W., and James L. Coril. The Impact of Industrial Development on Traffic Generation in Rural Areas of North Carolina. North Carolina State College, June 30, 1962, 121 pp.

Characteristics of traffic generated by the rural inhabitants of North Carolina are examined and interpreted. Home interview data as well as industrial interview data reveal travel-influence factors and characteristics needed for planning. Home interview analyses show increase in trip generation comes with increase in number of registered vehicles per residence, increase in number of licensed drivers residing at a dwelling unit, and in the summer. Industrial interview data analyses show differences in travel and employee characteristics for the regional areas of the state. Variations were found as well between both travel and employee characteristics in rural as opposed to urban areas.

9. Horn, John W. The Impact of Industrial Development on Traffic Generation in Rural Areas of North Carolina - Part I. North Carolina State College, June 30, 1960, 143 pp.

An analysis of elements which affect traffic generation from the rural home is presented. Involved is the calculation of the relationship between family travel and numerous factors such as family, vocation and race. Results indicate that family, vocation and race are related to family travel. The part-time farm vocational is the most active. Work trips were found to account for 27.3% of total trips made. Per day, the average number of trips and miles per dwelling was 3.1 trips and 22.1 miles. Fifty-five percent of the people interviewed had members of the family living at home who worked in business or industry.

10. Horwood, Edgar M., Carl A. Zellner and Richard Ludwig. "Community Consequences of Highway Improvement." NCHRP Report No. 18, Highway Research Board, 1965, 37 pp.

A review of the existing body of literature on non-user or community consequences of highway improvements. The two largest bodies of literature concern by-pass routes and radial urban freeway studies. In the first case, the studies show that trade area boundaries are altered differentially -- thus, a by-pass can substantially depreciate economic activity in one area and appreciate it in another. The consistent conclusion in urban radial freeway studies is that land values are materially enhanced through their proximity to an urban radial corridor. Gaps in knowledge are indicated through interviews which show that most people responsible for commissioning impact studies are uncertain about the nature of particular impacts and the approaches to measuring them.

11. Hurst, Michael E. Eliot. "Transportation and the Societal Framework." Economic Geography, April 1973, pp. 163-180.

The author gives an overview of the thrust of transportation geography but suggests its goals have been too limited. He argues for the inclusion of "sociopolitical" variables instead of the "all too frequent . . . treatment of conduits and units . . ." He outlines a tentative approach (Holistic) to the extension of transportation in a geographical context.

12. Lang, A. S., and Martin Wohl. "Evaluation of Highway Impact." Bulletin 268, Highway Research Board, 1960, pp. 105-118.

This article takes issue with available highway impact analyses, contending that they offer no substantial economic, let alone social, aesthetic or political justifications for highway location and design. It argues that differentials usually accounted as economic benefits, i.e., non-user benefits, can be generally more aptly considered secondary user benefits; it further suggests that since transportation renders benefit only as a means, expenditures on transportation facilities and what they afford should be measured against direct expenditures towards the desired objects. Some of the factors requiring consideration in a useable economic evaluation, such as production costs and highway costs, are noted.

13. Pillsbury, Warren A. "Economics of Highway Location: A Critique of Collateral Effect Analysis." Highway Research Record No. 75, Highway Research Board, 1965, pp. 53-61.

The article first classifies the methodologies used to measure and predict the economic effects of highways into three categories: 1) the engineering economy method based on primary user cost/benefit; 2) collateral effect method, which takes into account secondary or tertiary costs and benefits; 3) marginal analysis, based on marginal user benefits and costs. The author proceeds to a defense of collateral effect analysis as an adequate method for predicting the effects of different location proposals in spite of various conceptual problems associated with the method.

14. Robinson, John. Highways and Our Environment. McGraw-Hill, 1971, 340 pp.

A broadly illustrated survey of highway impact problems (such as pollution, land encroachment, signs), how they occur, and examples of failures and successes in dealing with them. With a view towards effecting more sensitive solutions, it includes appendices of highway lobbies and citizen action groups.

15. Robley, Winfrey, and Carl Zellner. "Summary and Evaluation of Economic Consequences of Highway Improvements." NCHRP Report No. 122, Highway Research Board, 1971, 324 pp.

The report combines the social, economic, environmental and engineering factors to be considered by officials responsible for decision, authorization, location and design of highways. Concentrations rest on the social and economic community changes brought on by highway improvements. Some consequences are: 1) traffic generation, 2) increases in spendable income or population, and 3) increase in land-use change. How people use their time and space provide an indication of their values and preferences. Changes in either of these brought on by highway improvement can be of social consequence.

16. University of Texas, An Introductory Set of Community Indicators. Pamphlet I of the Community Analysis Research Project, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Spring 1973.

"Community indicators" which would provide decision-makers with an "overview of the social and physical conditions" in a community are categorized into twelve basic groups. These include economic base, land use and recreation, public service delivery, and transportation. Specific measures are suggested for each indicator, and the value of the various indicators in different modes of analysis is discussed. In a useful appendix, data sources for each indicator are listed, and the limitations of the data described.

17. University of Texas, A Resource Handbook for Developing Community Indicators. Pamphlet II of the Community Analysis Research Project, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin, Spring 1973.

This pamphlet is designed to extend and complement that described above. In particular, it is meant to help identify the indicators most useful to specific communities with specific policies as well as identify and suggest ways of improving the initial set of community indicators.

IV. EVALUATION TECHNIQUES AND MODELS

1. Carter, E. C., J. W. Hall and L. E. Haefner. "Incorporating Environmental Impacts in the Transportation System Evaluation Process." Highway Research Record No. 467, Highway Research Board, 1973, pp. 1-11, Bibliography.

   The report includes general discussion of evaluation techniques in choosing among alternatives. These techniques include: ranking method, rating method, rank-based expected value, value matrix, desirability rating (utility theory), and competitive decision-making (game theory).

2. Coyle, John H., H. Kirk Dansereau, John C. Frey and Robert Pashek. "Interchange Protection and Community Structure." Highway Research Record No. 75, Highway Research Board, 1965, pp. 62-74.

   The paper first outlines a model for developing land-use planning at interchange communities. Through computer simulation of traffic patterns in an actual interchange area, incorporating a variety of possible land use changes, the article attempts to arrive at an "arrangement of land management units which will protect the highway against congestion and at the same time maximize the development of the interchange area." In a final section of the paper, the authors consider the relationship between community social structure and the potential for implementing land use plans that would minimize negative impact.

3. Dickey, John W., and Robert C. Stuart. "Implementation of Urban Transportation Decisions: A Simultaneous Category Model." Highway Research Record No. 348, Highway Research Board, 1971, pp. 16-34.

   A "non-parametric simultaneous category" model, called IMPLEM, is described in the article. The model deals with nominal variables, i.e., those measured in categories rather than continuums, and with dependent variables related to each other. The purpose of the model is to allow a planner to estimate the probabilities of implementing a plan given the complexity of the process. Using data from surveys sent to various public officials and eight dependent category variables relating to the planning process (including "technical complexity," "political complexity," and "time to implementation"), the model develops categorical relations among the variables which may then be used to estimate probabilities that various categories of the dependent variables will arise under a given set of conditions. In the creation of the model, it is found that the ease of communication created by the planner is related to the various implementation factors as well as to factors beyond his control (e.g., influence of state agency). Under the assumptions of the model, however, it turns out that the degree of planner influence through the communications factor is relatively small.

4. Haefner, L. E., and M. J. Redding. "An Analytic Structure of Community Public Works Decision Processes." EDRA Proceedings of the Annual Conference, Environmental Design Research Association, 1972.

In this article the authors formulate a strategy for resolving contentions over community public works into compromised decisions, using applied mathematics in linear programming and game theory. The relative values and costs (or results) involved in a given project are factored to produce a compatible program that reduces group-specific costs. Although admittedly limited, their conceptual approach was instrumentally applied in reaching a Pareto Optimal solution in a certain midwestern transportation project.

5. Harris, C. C., S. J. Hill, C. E. Olson and M. M. Stein. "Long Range Transportation Investment Planning." Highway Research Record No. 458, Highway Research Board, 1973, pp. 13-20.

The study suggests that cost-benefit analysis is not an adequate approach to evaluating proposed highway alternatives since it may not include "social" and "locational" impacts. A model is presented which incorporates population and industry factors to forecast impacts at a regional level.

6. Harvey, Thomas N. "A Method of Network Evaluation Using the Output of Traffic Assignment Process." Highway Research Record No. 238, Highway Research Board, 1968, pp. 46-63.

A study of some methods for determining the effect of change in a traffic network and who may benefit or lose from such a change. Consumer surplus was used as a measure of benefit.

7. Hejal, S. S. "An Economic Priority Model for Rural Highway Improvements." Purdue University and the Indiana State Highway Commission, December 1970.

This research develops an economic model to provide the highway planner with suggested construction projects whose priorities could be based on their economic merits. Using a benefit-cost ratio analysis, a final discretion can be made between improvement alternatives at the same site and a priority rank assigned for various sections. Road user costs and construction costs are estimated, using a travel time model and various regression models, respectively.

8. Kassoff, H., and D. S. Gendell. "An Approach to Multiregional Urban Transportation Policy Planning." Highway Research Record No. 348, Highway Research Board, 1971, pp. 76-93.

This article reports on a resource allocation study designed to predict economic and other consequences of alternative transportation

investments. The model includes user and non-user benefits and impacts. The model begins with land development, travel generation and a system of performance measures evaluated by economic investment-return analysis and "non-costable" constraints.

9. Mumphrey, Anthony and Julian Wolpert. "Equity Considerations and Concessions in the Siting of Public Facilities." Economic Geography, 1973, pp. 109-121.

The article presents a model which employs "allocative efficiency," "spatial equity," and citizen preference in the location of a bridge.

10. Rothman, Richard, "Access Versus Environment?" Traffic Quarterly, Volume XXVII, Number 1, January 1973, pp. 111-132.

This study uses the technique developed by Morris Hill and others to determine measures for evaluating potential impacts of transportation systems. The technique involves selecting a sample of those who might be affected and asking them to "vote" on the relative importance of various objectives of a transportation plan. The votes are averaged in order to determine "relative weights" for each objective. The relative weights are then used in combination with expert evaluation to score the various objectives of a particular plan. The study uses the method to evaluate Chicago's 1990 transportation plan and concludes that the plan "emphasizes access at the expense of environment."

11. Smith, William L. "Rational Location of a Highway Corridor: A Probablistic Approach." Highway Research Record No. 348, Highway Research Board, 1971, pp. 42-60.

The article discusses a systems' approach to the location of a freeway corridor which included both rural and urban elements. In order to make the various elements in the analysis comparable, one criterion was chosen -- "least social cost." This is defined in terms of the resources (regardless of kind) that people would have to give up in order to obtain the facility. Separate models were developed to measure the supply and demand for the various human and natural resources involved. The location of least social cost for each element was then determined. The output of the individual models could then be used as input to form a composite model yielding the corridor for the facility with the least social cost.

12. Steinberg, Eleanor B. "Benefit-Cost Analysis and the Location of Urban Highways." Highway Research Record No. 348, Highway Research Board, 1971, pp. 35-41.

Noting that increasing opposition to freeway location is related to the problem of the distribution of costs and benefits, the author

questions the various attempts to introduce equity considerations into cost benefit analysis during the planning stages of a public project (e.g., a highway). "The root of the problem is that benefit/cost methodology assumes that a dollar's worth of any kind of benefit (or cost) has the same value for all of the individuals on whom the highway has a direct impact." Since other modes of analysis have not solved the problem, the author suggests that equity judgments be made by elected public officials rather than by technicians or appointed administrators. Thus, the final determination of a facility's location would be left to those who are directly accountable to the electorate.

13. Thomas, Edwin N., and Joseph L. Schofer. "Final Report Criteria for Evaluating Alternative Transportation Plans." NCHRP Project 8-4, Transportation Center, Northwestern University, Evanston, Illinois, July, 1967.

The report explores means for more comprehensive evaluation of alternative transportation plans that include social, aesthetic, political and other criteria not accountable by current evaluation processes. Decisional problems are analyzed and resolutions offered especially through open-ended "systems" analyses and modeling which consider transportation inputs, interfaces, and outputs, both functional and concomitant.

14. Turner, Christopher. "A Model Framework for Transportation and Community Plan Analysis." American Institute of Planners Journal, September 1972, pp. 325-331.

The author suggests a model for evaluation of the impact of transportation changes on various groups within a community. Groups are analyzed in terms of the "resources" to which they have access with "attraction" heights fixed to the resources. Transportation plans may be analyzed in light of the projected benefits which accrue to given groups.

15. Weiner, Paul, and Edward J. Deak. "Non-user Effects in Highway Planning." Highway Research Record No. 356, Highway Research Board, 1971, pp. 55-68.

The objective of the study is to "formalize potential community concerns regarding the relative importance of most commonly encountered non-user impacts." Using questionnaires sent to regional planners, state highway engineers and regional planning agencies, the authors develop a weighting system which indicates the relative importance of different factors of impact to different groups, as well as the degree of "stability," "variability," and "volatility," of the weights themselves. The authors conclude that relative weights for non-user impacts are useful to planners in determining trade-off ratios based on the actual attitudes of citizens.

V. PUBLIC ATTITUDES AND CITIZEN PARTICIPATION

1. Bishop, Bruce A., C. H. Oglesby and Gene E. Willeke. "Socio-Economic and Community Factors in Planning Urban Freeways." Project on Engineering-Economic Planning, Stanford University, September 1970.

   The report discusses the need for a workable relationship between "change agents" in planning (e.g., highway engineers) and "change clients" (the community), a relationship that would legitimize and improve the chances of success for the planning process. It describes several strategies for community participation in the planning process: (1) strategy of information, (2) strategy of information with feedback, (3) the coordinator, (4) the coordinator-catalyst, (5) community advocacy planning, (6) arbitrative planning, and (7) rural planning. Each of these represents a different relationship between community and planners. Having reviewed community participation in highway planning in California, the authors recommend that improvement could be made by using the "coordinator-catalyst" strategy, where the planner works to both stimulate and coordinate community groups' and individuals' interactions.

2. Bleiker, Hans, John H. Suhrbier and Marvin L. Mannheim. "Community Interaction as an Integral Part of the Highway Decision-Making Process." Highway Research Record No. 356, Highway Research Board, 1971, pp. 12-25.

   Defining "community interaction" as "all the formal and informal, direct and indirect mutual intercourse between the highway agency and the community," the authors proceed to identify the objectives of community interaction and the techniques to be used in accomplishing those objectives. Their methodology is based on an analysis of four highway decision-making cases which involved controversy and on concepts drawn from welfare economics, game theory and planning theory. Three main categories of community interaction are identified: (1) responsibility, (2) responsiveness, and (3) effectiveness. The objectives listed under these categories include maintaining agency and process legitimacy, exploring community values, maintaining credibility, and searching for consensus. Some 30 techniques are listed, though only three are discussed -- holding meetings, providing a build-in communication effectiveness test, and citizen's advisory committees. The article ends with a discussion of the management of community interaction and the need to coordinate the activities designed to meet the various objectives.

3. Burkhardt, Jon E. "Community Reactions to Anticipated Highways: Fears and Actual Effects." Highway Research Record No. 470, Highway Research Board, 1973, pp. 22-31.

This study evaluates a hypothesis that residents and businessmen within a highway corridor see themselves as victims of adverse effects of highway improvements. These fearful expectations lead to adverse effects even before the final route selection. The study distinguishes between effects resulting only from these preconceptions and those that would have occurred anyway. The author also develops procedures to alleviate the unnecessary concerns of residents and businessmen and to ease the strain of transition. Regression analyses of time-service data reveal that to offset unwarranted expectations, highway departments should take a much more active role in giving out information and in monitoring community reaction.

4. Cohen, A. R. Attitude Change and Social Influence. New York Basic Books, 1964.

The author presents the operational principles of attitude change and social influence as deduced from experiments conducted in psychology. Data obtained through general survey processes, however, are excluded from the discussion. The book examines the components involved in persuasion -- the individual subject, the communication and communicator, and the given environment -- and it notes what variations in these components affect the process, according to current cognitive theory.

5. Culford, Frank C., Jr. "Transportation and Political Culture." Highway Research Record No. 356, Highway Research Board, 1971, pp. 32-42.

The author discusses conflicts and agreements between various groups involved in the transportation planning process, both urban and interurban. He compares European and American "systems," and categorizes types of American cities by the degree of conflict between planners and citizens.

6. Dansereau, H. Kirk, John C. Frey and Robert D. Pashek. "Highway Development: Community Attitudes and Organization." Highway Research Record No. 16, Highway Research Board, 1963, pp. 44-58.

This is a survey of three Pennsylvania sites seeking to measure community and community leader views of highway development, changes in population characteristics, and changes in the complexity (planning functions) of local government. Quantification shows views to be favorable and complexity to develop independent of size.

7. Dansereau, H. Kirk. "Attitude and Economic Climate." Highway Research Record No. 187, Highway Research Board, 1967, pp. 21-32.

A study of the influence of public relations efforts of planners on the attitudes of community leaders and citizens. Highway-community relationships are approached by predicting economic development, the design of land use plans for highway protection, and the determination of protective measures for interchange sites. Attitudes toward planning and zoning are correlated with professional and socio-economic characteristics of the respondents. In general, the authors find a favorable attitude towards planning and zoning.

8. Hahn, Alan J. "Planning in Rural Areas." American Institute of Planners Journal, January 1970, pp. 44-50.

The article describes resistance of local officials and inhabitants to planning efforts and attempts to explain that resistance. Observations are drawn from experience in a regional developmental education project in rural counties in upstate New York. Education projects through extant agencies is suggested as the correct approach.

9. Kemp, Barbara H. "Social Impact of a Highway on an Urban Community," Highway Research Record No. 75, Highway Research Board, 1965, pp. 92-102.

The article reports on a study conducted for the National Capital Planning Commission to determine the possible social effects of a proposed major highway link on three neighborhoods in Washington, D. C. Neighborhood residents were interviewed, and each was shown three alternate proposals and asked to give his/her views on the possible effects of the different alternatives. The general attitudes of the respondents are summarized; these include: resistance to personal relocation, concern for the elderly who would be displaced, and hopes that there would be adequate aid in helping people to relocate. The article concludes with four "propositions" concerning the general social effects of highway location and with a set of recommendations for highway and urban planners designed to minimize the negative effects of dislocation and maximize the positive social consequences of new transportation facilities.

10. Klatzmann, Joseph, Benjamin Y. Alan and Leir Yair (Eds.). The Role of Group Action in the Industrialization of Rural Areas. 1971.

This is a collection of papers presented and discussions held during a 1969 international symposium of the same title. Included in the materials are arguments on the desirability and form of rural industry, analysis of the agriculture co-operative as a means for development, and employment of cooperative or group action concepts for the integration, from village to center, of rural regional industrialization.

11. Mason, Joseph Berry, and Charles Thomas Moore. "Development of Guides for Community Acceptance of Highway Location, Development and Construction." Highway Research Record No. 356, Highway Research Board, 1971, pp. 43-54.

The basic objective of this research was to develop and test a methodology for determining goals that have the highest priority in terms of both desirability and importance as perceived by public officials and private citizens. Through attitude surveys of public officials and private citizens, areas of agreement and disagreement between the two groups were identified. Of particular interest are the differences in priorities placed on "aesthetic" vs. "economic" goals. Private citizens tend to place higher priorities on the former than do public officials. In general, citizens want a greater say in planning procedures for any major investment that would affect their lives. The authors conclude that the survey developed in the study represents one way of increasing public participation.

12. Ryan, Charles. "A Review of the Public Hearing Process as a Means of Obtaining Citizen Views and Values." Highway Research Record No. 467, Highway Research Board, 1973, pp. 24-25.

A follow-up study contrasting results of a community attitude survey with expression at public hearings. It was found that opposition is much higher (95%) at public hearings than in the community as a whole (45%).

13. Ryan, Charles R., Brian P. Nedwek and Edward A. Beimborn. "An Evaluation of the Feasibility of Social Diagnostic Techniques in the Transportation Planning Process." Highway Research Record No. 410, Highway Research Board, 1972, pp. 8-23.

The article presents results of a questionnaire survey conducted coincident with the proposal of a Milwaukee freeway, and evaluates the feasibility of the practice. It finds demographic, attitudinal, etc., analysis of freeway support/opposition yields information useful in transportation considerations. Fractional costs for insights yielded suggests implementation and standardization into the transportation planning process.

14. Shaffer, Margret T. "Attitudes, Community Values, and Highway Planning." Highway Research Record No. 187, Highway Research Board, 1967, pp. 55-61.

The article gives a brief summary and analysis of different techniques used in designing instruments used for measuring public attitudes and values in order to anticipate potential responses to highway development. Three techniques evaluated are: (1) word association, (2) sentence completion, and (3) semantic differential. The author argues that techniques of identifying <u>attitudes</u> are more important than surveys of <u>opinion</u>. The responses to attitude items may be correlated with socio-economic characteristics and then the values of a given community determined.

15. Ueland and Junker, Architects and Planners. A Manual for Achieving Effective Community Participation in Transportation Planning. Prepared for Pennsylvania Department of Transportation, Harrisburg, Pennsylvania, 1974.

A comprehensive, step-by-step guide for planners to use in obtaining citizen participation in the planning process. It contains an outline of the basic planning procedure, identifies the points where citizen input becomes necessary or valuable, and describes techniques for eliciting and evaluating citizen input at each stage of a project. Alternative techniques are suggested for different groups of citizens and for different planning and community situations.

THE AUTHORS

John Huddleston holds both the B.A. and M.A. in English from UCLA and taught English at the University of California, Irvine before serving on the UT English faculty from 1968 to 1973. Since 1973 he has been involved in transportation research for CATS. Current investigation centers around the local decision-making process in small communities and the social impact of transportation services.

Ronald Linehan, having completed work for the Master of Science degree in Community and Regional Planning through the School of Architecture in 1975, is currently involved in an investigation centered around industrial growth in rural areas in relation to transportation systems for the Council for Advanced Transportation Studies.

Abdulla Sayyari holds a Bachelor of Science degree from Arizona State University in Civil Engineering and a Master of Science degree from the University of Texas at Austin in Transportation. He is currently pursuing a Ph.D. degree in Civil Engineering and is involved in the development and analysis of an intercity transportation impact model for rural communities which has led to his research participation in the CATS program.

Richard L. Dodge has been Associate Professor of Architecture since September 1972. He completed his Bachelor's degree in Architecture at the University of California at Berkeley in 1961 and his Master's degree in Architecture at Yale University in 1967. His experience includes works as a Designer and Project Architect for Hatch, White, Hermann & Steinau in San Francisco, California, and for Stone, Marraccini and Peterson in San Francisco, California; and Project Architect for Charles W. Moore in New Haven, Connecticut designing housing for the elderly. He was also an Assistant Professor of Architecture at The University of Texas at Austin from 1967 until his promotion in 1972.

C. Michael Walton has been Assistant Professor of Civil Engineering since September 1971. He completed his B.S. in Civil Engineering at Virginia Military Institute in 1963, and his Master's and Ph.D. degrees in Civil Engineering at North Carolina State University in 1969 and 1971, respectively. His experience includes research work for North Carolina State University, North Carolina Highway Commission in their Planning and Research Department, the U.S. Department of Transportation, and the U.S. Army Corps of Engineers. He has also been a consultant to the Research Triangle Institute and the Office of Economic Opportunity in Raleigh, North Carolina. In addition, he taught for one year at North Carolina State University.

Marsha L. Hamby is a freshman Civil Engineering student and has assisted in the collection and coding of survey data in her capacity as a Laboratory Research Assistant.

APPENDIX II
Exhibit 2

MAPRINT

A COMPUTER PROGRAM FOR ANALYZING CHANGING LOCATIONS OF NON-RESIDENTIAL ACTIVITIES

by

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Research Memo 11

Prepared for

U.S Department of Transportation

by the

Division of Research
Council for Advanced Transportation Studies
The University of Texas at Austin

PREFACE

This is the eleventh in a series of research memos describing activities and findings as part of the work done under the research project entitled "Transportation to Fulfill Human Needs in the Rural/Urban Environment." The project is divided into five topics, and this is the first research memo under the topic "The Influence of Inter-Urban Transportation Systems on the Rural Environment."

MAPRINT is a FORTRAN computer program developed to analyze the changing location of non-residential activities, including both businesses and public services. It is designed as an aid for the analysis of changes in community activity which are in part due to changes in transportation systems.

Graham Hunter
Richard Dodge
C. Michael Walton

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March 1974

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INTRODUCTION

This memorandum is intented to describe an analytic tool developed as an integral part of the research effort, "The Influence on the Rural Enviroment of Interurban Transportation Systems." It is the basic hypothesis of this research that changes in the operational and physical characteristics of elements of the transportation system, in particular those which can be classified as interurban, to some degree influence the growth and development of rural communities and that changes in the economic, physical and social characteristics of the community can be structured and interrelated to provide a clearer understanding of the dynamic relationship between transportation system change and the changing community.

The case study method is being used in the research. In this method, one particular community was selected to develop descriptive and analytic techniques which will be evaluated and refined when tested in relationship to other similar rural communities. The descriptive phase has been divided into two basic sub-efforts: (1) Community Description and (2) Transportation System Description. Each of these sub-efforts has been further subdivided into separate research efforts. The community description effort will describe the changing characteristics of land and people. Land is being described in terms of size, ownership, value and use. The people, or the socio/economic characteristics of the community, are being described in terms of political characteristics, e.g., the power structure; economic characteristics such as employment, income, job location etc.; and public services, e.g., schools, health care,etc. Two elements of the transportation system are being described: (1) highway and (2) railroad. Other modes were not sufficiently important to this area. Each of these elements is being described to display the changing use characteristics, i.e., traffic volume, frequency and quality of service, and boarding opportunity.

It was hypothesized that, as the operational and physical characteristics of the interurban transportation changed over time, certain types of business activity would be influenced in a variety of ways, that is, market areas would expand or contract, customers would be attracted or repelled, and new opportunities would develop. It was felt that these influences would be reflected to some

Figure 1

BASE MAP OF SEALY

(Showing the Orthogonal Grid and the Straight-line Sections of Road Plotted in MAPRINT

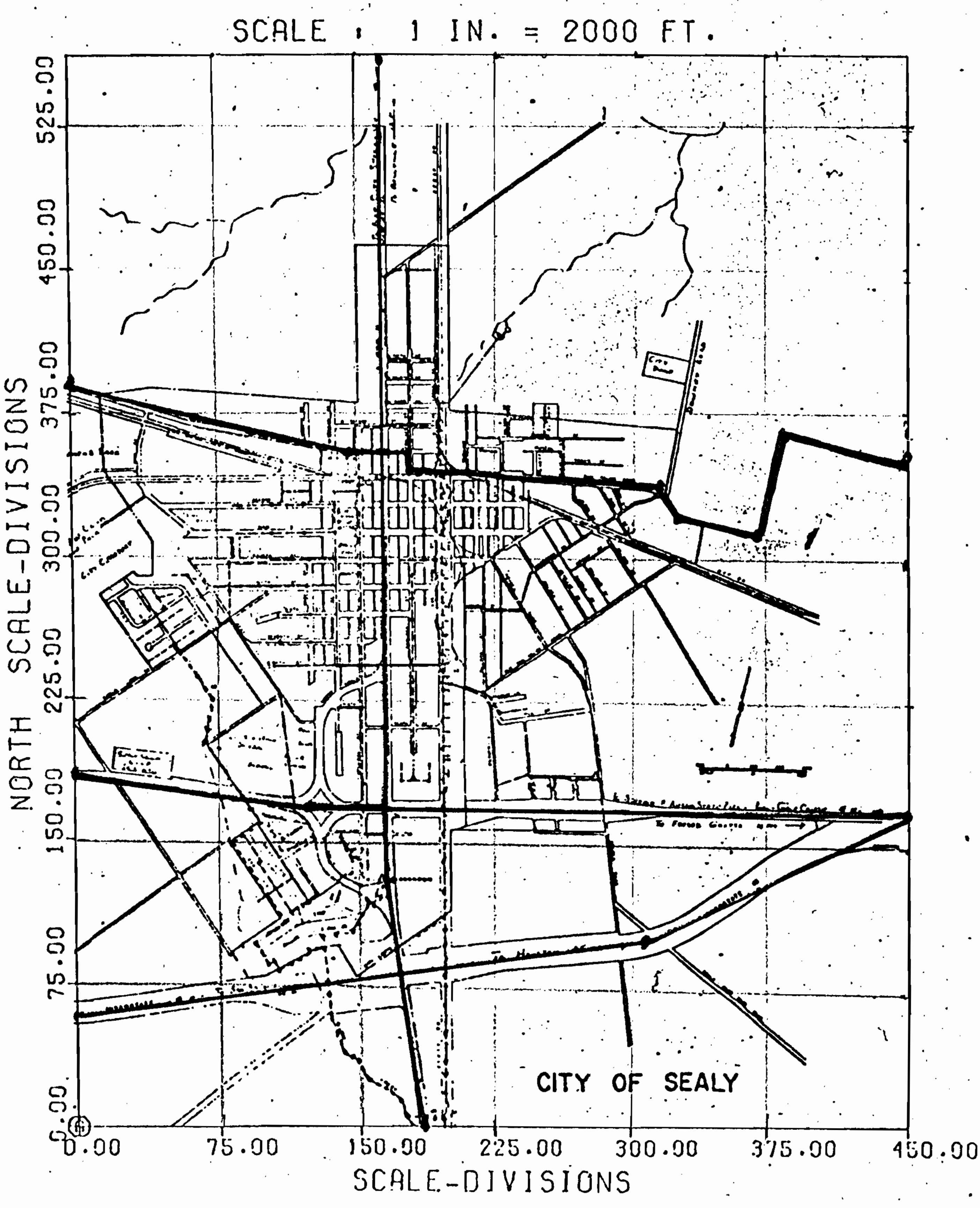


Figure 2

SEALY YEAR 1967

EXPLANATION OF CHANGES

REMMERTS GULF MOVED DURING THE YEAR FROM ITS OLD LOCATION A
105, 166 TO A NEW LOCATION AT 180, 70.
ITS S.I.C. CODE IS 5541 AND IS REPRESENTED BY SYMBOL23.

REMMERTS GULF OPENED AT THE COORDINATES , 180, 70.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

HENDERSONS TXACO OPENED AT THE COORDINATES , 164, 100.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

T BONES CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 165, 500. ITS SIC CODE WAS
5541 AND WAS REPRESENTED BY THE SYMBOL 23.

BAGLEYS SHELL OPENED AT THE COORDINATES , 123, 175.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

QUINTON ENCO SER CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 166, 100. ITS SIC CODE WAS
5541 AND WAS REPRESENTED BY THE SYMBOL 23.

TOTAL CHANGES

DURING THE YEAR 1967:

3 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

1 ACTIVITIES MOVED TO NEW LOCATIONS.

TOTALS BY SYMBOL

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

4 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

(1) S.I.C. number

(2) X, Y, coordinates

(3) Name of activity

(4) Year activity started

(5) Year activity moved

(6) Year activity closed.

In the case of activities which were in existence and/or did not move throughout the study period, items 4, 5, and/or 6 would not appear on the data card.

Data categories 4, 5, and 6 above are important in the program since they represent changes in the pattern of activity. In the printed output, MAPRINT describes each change which occurs. In the plotted output, MAPRINT plots a special symbol at the location of an opening (a square around the regular symbol) or a closing (an octogon), and, in the case of a move, draws a line from the old location to the new location, the latter enclosed by a square (showing that an activity started at that location.)

Road data input is reasonably simple. Each end of straight stretches of road are given X and Y coordinates, and the annual ADT X 10^3 is entered on the data card. A subroutine, ROADPLT, within MAPRINT takes the data, plots a line from one end of the map to the other and plots marks (in this case a hexagon) roughly proportional to the ADT (number marks per inch X 1000 = ADT). Figures 3a, 3b illustrate the combined plotting of the two routines for a particular year, in this case, 1967.

IMPLEMENTATION OF MAPRINT

MAPRINT allows the investigator a number of options. He can study any year or series of years he wants, or he can look at any number of codes, either in ranges (Code X - Code Z) or in series (Code A and Code B and Code F). At the same time, he can have the codes represented in the output by a number of the systems' (CDC 6600) graphic symbols.

The ability to produce a graphic display makes it possible to observe shifting patterns in business activity. The verbal printout which accompanies each graphic display provides the required detail information necessary for a more refined description of the changing spatial relationships of business activity.

SEALY 01 YEAR 67

LEGEND

⊡	ACTIVITY STARTED
⊙	ACTIVITY ENDED
G	CODE 5541
R	CODE 5813 5812
M	CODE 7011
$	CODE 6022
A	CODE 7538

THE MARK ⦶ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.

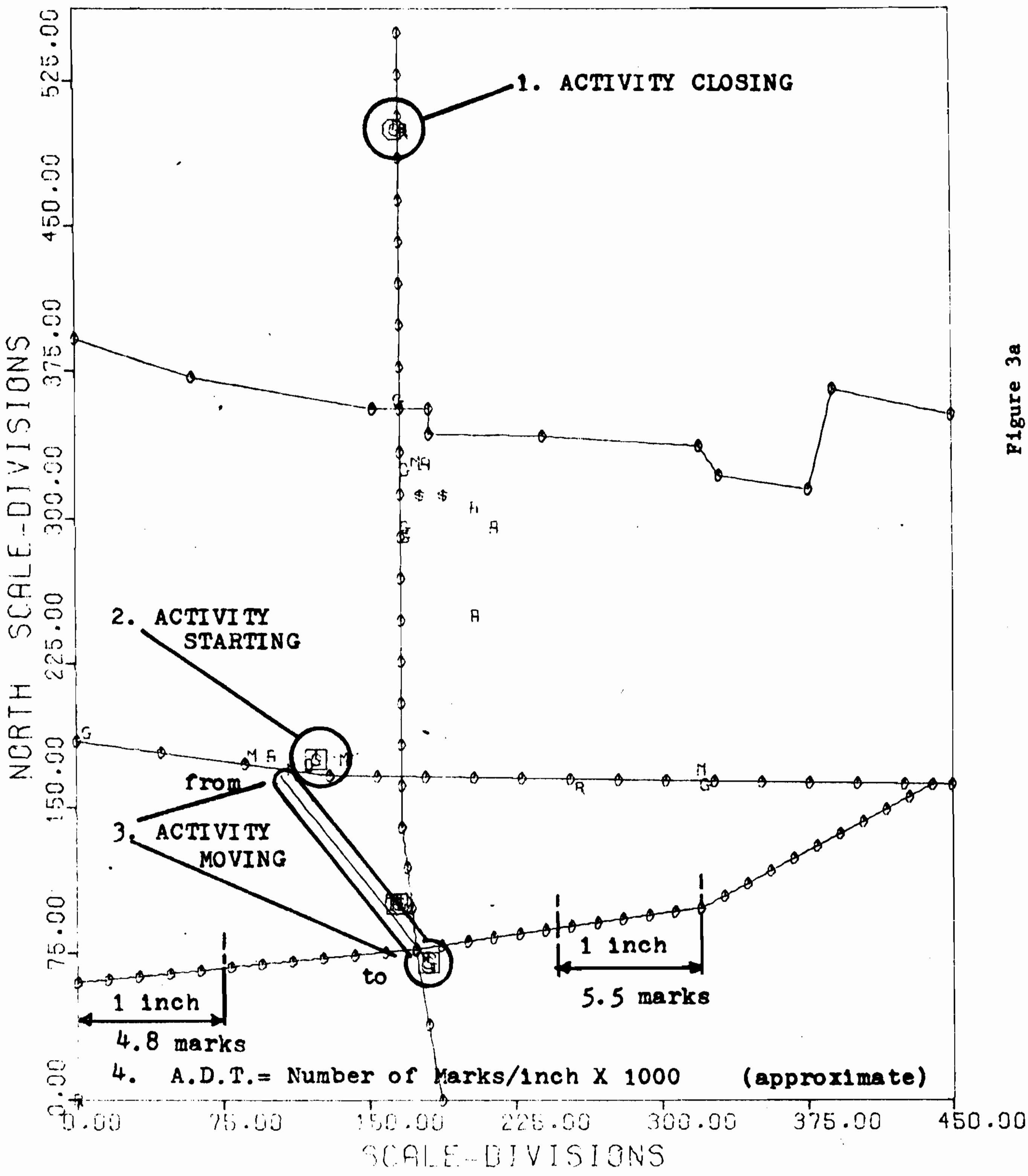


Figure 3a

Figure 3b

SEALY YEAR 1967

REMMERTS GULF MOVED DURING THE YEAR FROM ITS OLD LOCATION AT
(3.) 105, 166 TO A NEW LOCATION AT 180, 70.
ITS S.I.C. CODE IS 5541 AND IS REPRESENTED BY SYMBOL23.

REMMERTS GULF OPENED AT THE COORDINATES , 180, 70.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

HENDERSONS TXACO OPENED AT THE COORDINATES , 164, 100.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

T BONES CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
(1.) THE COORDINATES , 165, 500. ITS SIC CODE WAS
5541 AND WAS REPRESENTED BY THE SYMBOL 23.

(2.) BAGLEYS SHELL OPENED AT THE COORDINATES , 123, 175.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

QUINTON ENCO SER CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 166, 100. ITS SIC CODE WAS
5541 AND WAS REPRESENTED BY THE SYMBOL 23.

DURING THE YEAR 1967:

3 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

1 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

4 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

Other data being collected is also being programmed for graphic display. In particular, data on land use, land market value, parcel size, land ownership, economic intensity of specific business activities and spatial data related to the study of the power base of the community are being programmed for graphic display, compatible with the MAPRINT program. This capability will make it possible to better understand the possible relationships between these various data areas as they have changed over time.

The advantages of MAPRINT can be greatly augmented with the increased data handling capability of a management system such as System 2000. This system allows the researcher to use any piece of data as the control for input to MAPRINT. For example, he could ask for all highway related activities ending in year 1970 that are within a geographic area definable by the coordinates of the map-grid. He can then enter the resulting data sets into MAPRINT to be plotted. If economic data is available, the investigator could split businesses into strata and be able to determine effects on businesses of different sizes. Other forms of data (e.g., land use or land sales) could be chosen at will and plotted.

It is conceivable that this technique may be useful in Public Hearings where feasible impacts can be presented to the community in visual form for their evaluation.

The following sections of this memorandum consist of three appendices. The first contains the computer-generated maps and the accompanying printout for each year from 1955 to 1970. Appendix B contains both the flow-chart for the program and the program itself. The final section presents a set of specific instructions as an aid to anyone wishing to develop a similar program.

Appendix A, the sample output, shows only the activities of road-related retail and of financial services. The following is a description of the activities plotted, their associated SIC codes, and the symbols used in the graphic display.

Activity	SIC code(s)	Symbol no.	Symbol
Garages (automotive)	7538	17	A
Gas stations	5541	23	G
Restaurants and inns	5813,5812	34	R
Motels	7011	29	S
Financial services	6022	59	$

APPENDIX A

SAMPLE OUTPUT

CHANGING LOCATION OF ROAD-RELATED RETAIL

SEALY, TEXAS

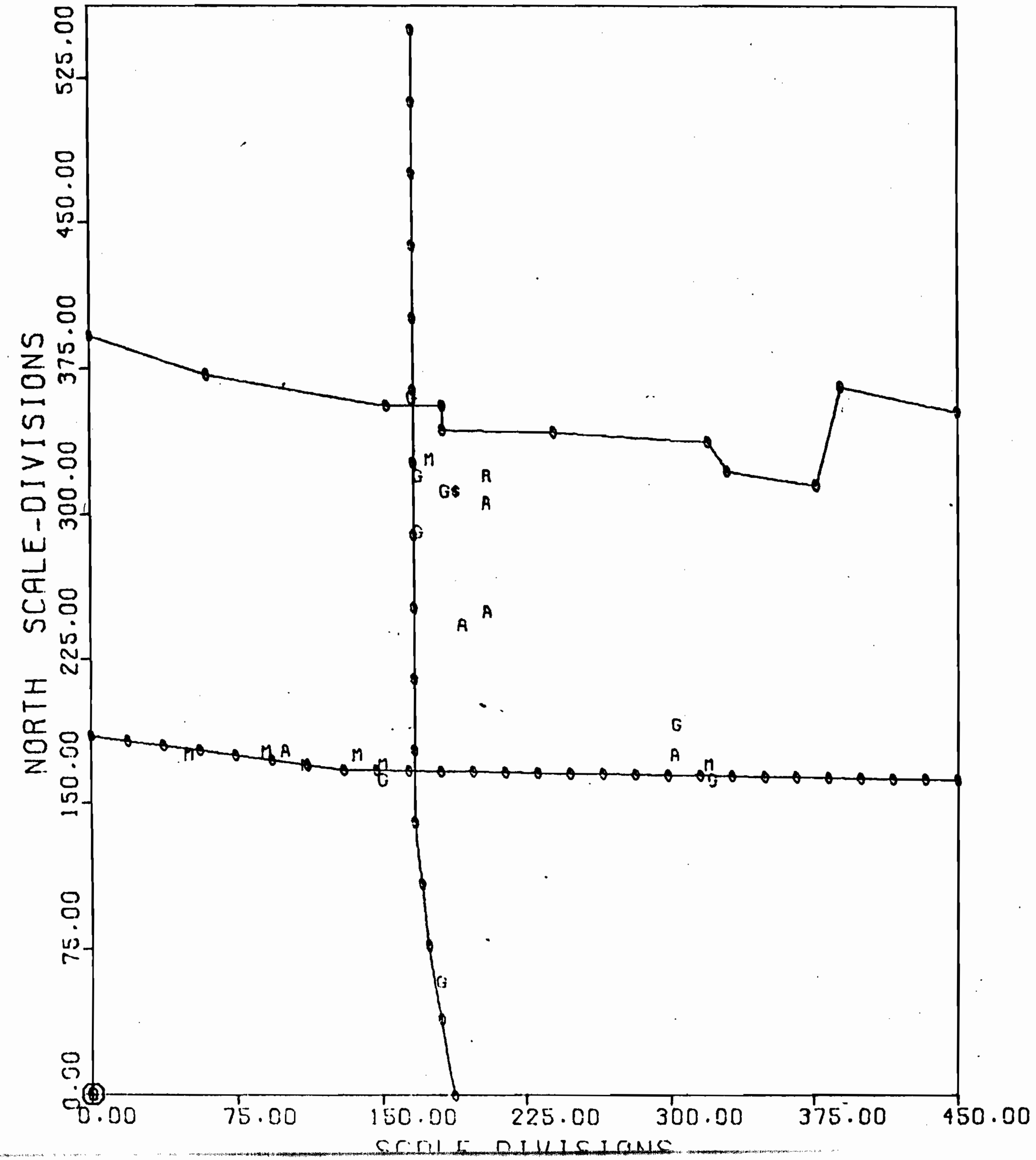
1955 - 1970

SEALY LEGEND YEAR 55

□ ACTIVITY STARTED
○ ACTIVITY ENDED
G CODE 5541
R CODE 5813 5812
M CODE 7011
$ CODE 6022
A CODE 7538

THE MARK 0 ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



EINKAUF GULF CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , -0, -0. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

JOUSANS GULF CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , -0, -0. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

VICENIK SER STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , -0, -0. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

CHARLES GARAGE CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , -0, -0. ITS SIC CODE WAS 7538 AND WAS REPRESENTED BY THE SYMBOL 17.

DURING THE YEAR 1955:

0 ACTIVITIES STARTED,

4 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

12 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 56

□ ACTIVITY STARTED   A CODE 7538
⊙ ACTIVITY ENDED

G CODE 5541

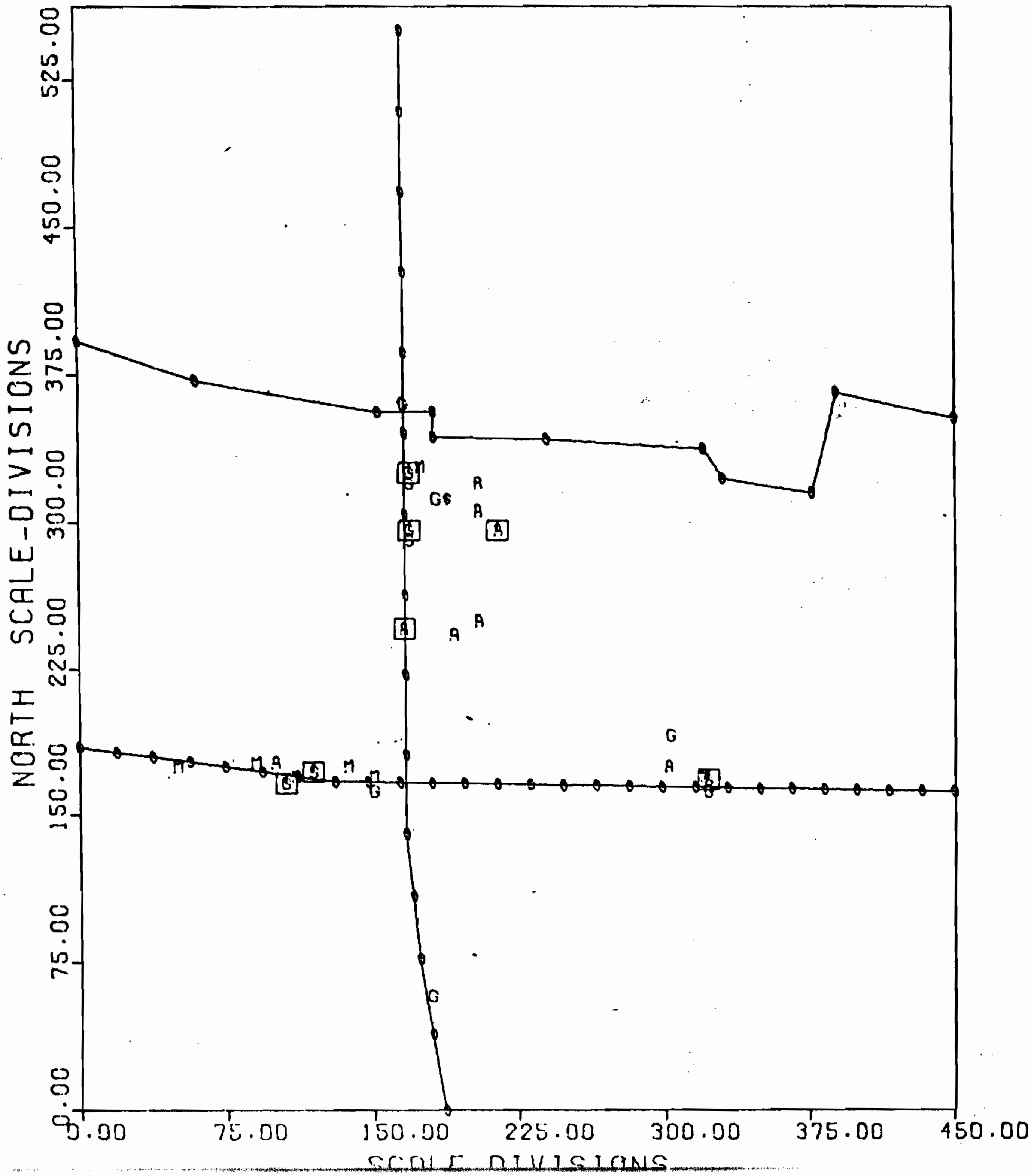
R CODE 5813 5812

M CODE 7011

$ CODE 6022

THE MARK ⊙ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



ADOLPHS GULF OPENED AT THE COORDINATES , 169, 325.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

BEARS GULF OPENED AT THE COORDINATES , 105, 166.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

EZ PLACE OPENED AT THE COORDINATES , 322, 168.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

ENGELKE HUMBLE OPENED AT THE COORDINATES , 119, 172.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

KUCHARA TEXACO OPENED AT THE COORDINATES , 169, 296.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

CHESTERS GARAGE OPENED AT THE COORDINATES , 166, 246.
THE S.I.C. CODE IS , 7538 AND IS REPRESENTED BY THE SYMBOL 17.

MACHALA GARAGE OPENED AT THE COORDINATES , 215, 296.
THE S.I.C. CODE IS , 7538 AND IS REPRESENTED BY THE SYMBOL 17.

DURING THE YEAR 1956:

7 ACTIVITIES STARTED,

0. ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 57

☐ ACTIVITY STARTED
⊙ ACTIVITY ENDED

A CODE 7538

G CODE 5541

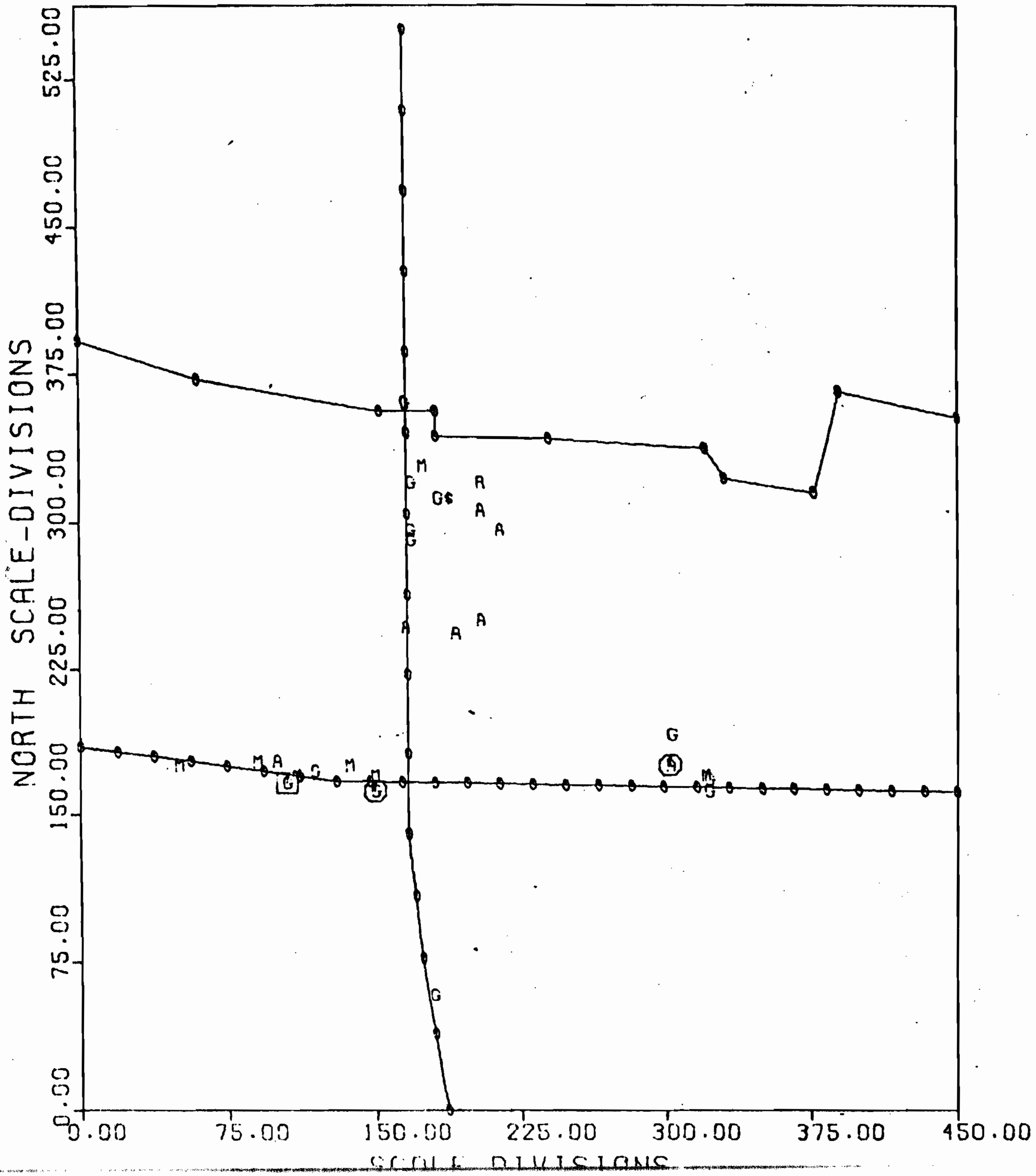
R CODE 5813 5812

M CODE 7011

$ CODE 6022

THE MARK ⊘ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



REMMERTS GULF OPENED AT THE COORDINATES , 105, 166.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

HIWAY 90 SER STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 150, 162. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

GEBHARDTS GARAGE CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 302, 175. ITS SIC CODE WAS 7538 AND WAS REPRESENTED BY THE SYMBOL 17.

DURING THE YEAR 1957:

1 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

13 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

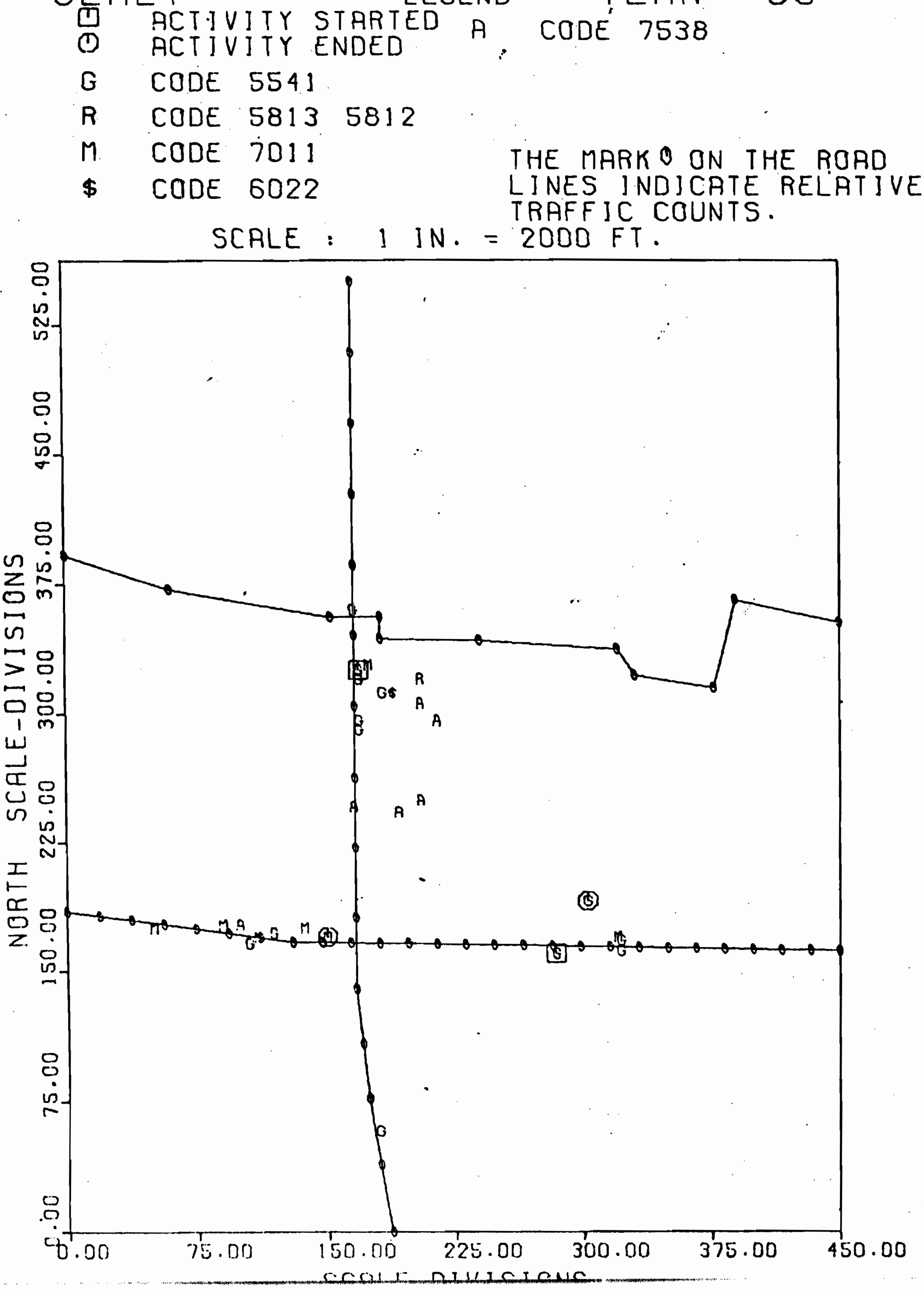
1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 58



SHELL SER STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 303, 191. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

HENRYS GULF OPENED AT THE COORDINATES , 169, 325. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

SCHOPPE OIL CO OPENED AT THE COORDINATES , 284, 160. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

SEALY MOTEL CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 150, 170. ITS SIC CODE WAS 7011 AND WAS REPRESENTED BY THE SYMBOL 29.

DURING THE YEAR 1958:

2 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY

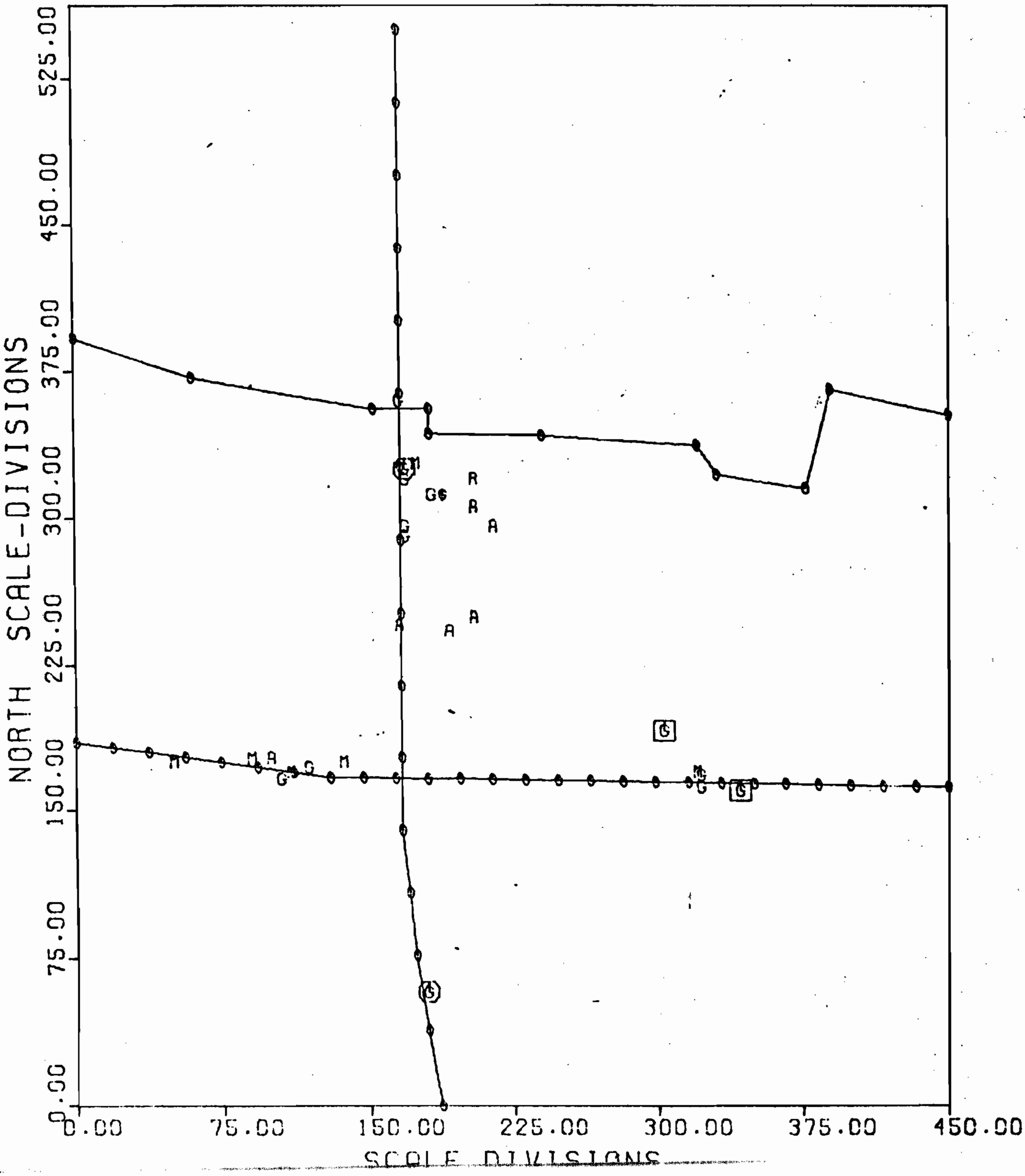
LEGEND

YEAR 59

⊡	ACTIVITY STARTED	
⊙	ACTIVITY ENDED	
A	CODE 7538	
G	CODE 5541	
R	CODE 5813 5812	
M	CODE 7011	
$	CODE 6022	

THE MARK ⊘ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



HAURLAND SERV STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 180, 58. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

WRIGHTS SER STA OPENED AT THE COORDINATES , 303, 191. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

HENRYS GULF CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 169, 325. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

VICTORIA OIL CO OPENED AT THE COORDINATES , 342, 160. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

DURING THE YEAR 1959:

2 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 60

[G] ACTIVITY STARTED A CODE 7538
(G) ACTIVITY ENDED

G CODE 5541

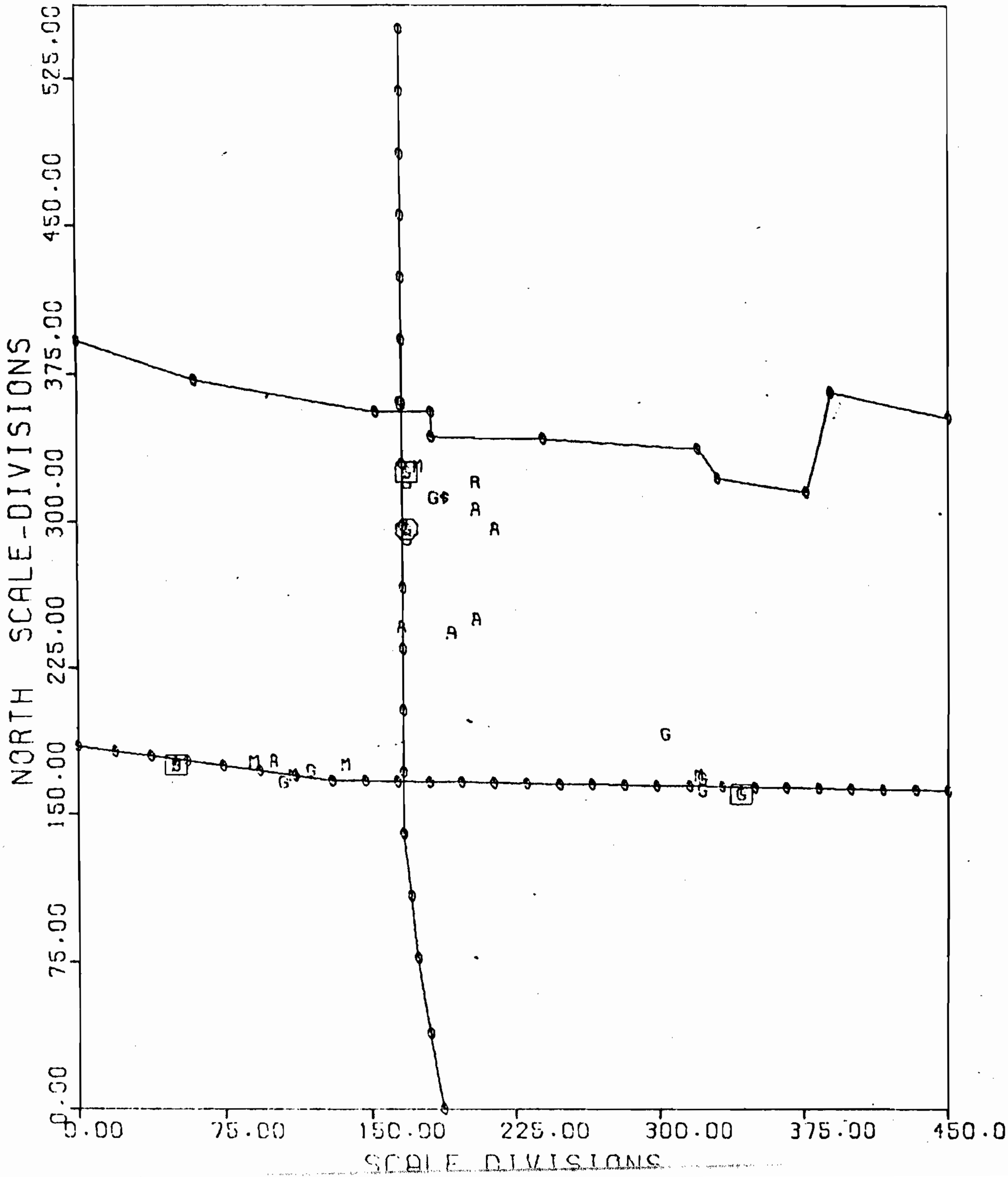
R CODE 5813 5812

M CODE 7011

$ CODE 6022

THE MARK ⍬ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



KUCHARA TEXACO CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 169, 296. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

MILLERS GULF OPENED AT THE COORDINATES , 169, 325. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

KEY OIL OPENED AT THE COORDINATES , 342, 160. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

MAZOCHS HUMBLE OPENED AT THE COORDINATES , 50, 175. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

DURING THE YEAR 1960:

3 ACTIVITIES STARTED,

1 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 61

ACTIVITY STARTED

ACTIVITY ENDED

A CODE 7538

G CODE 5541

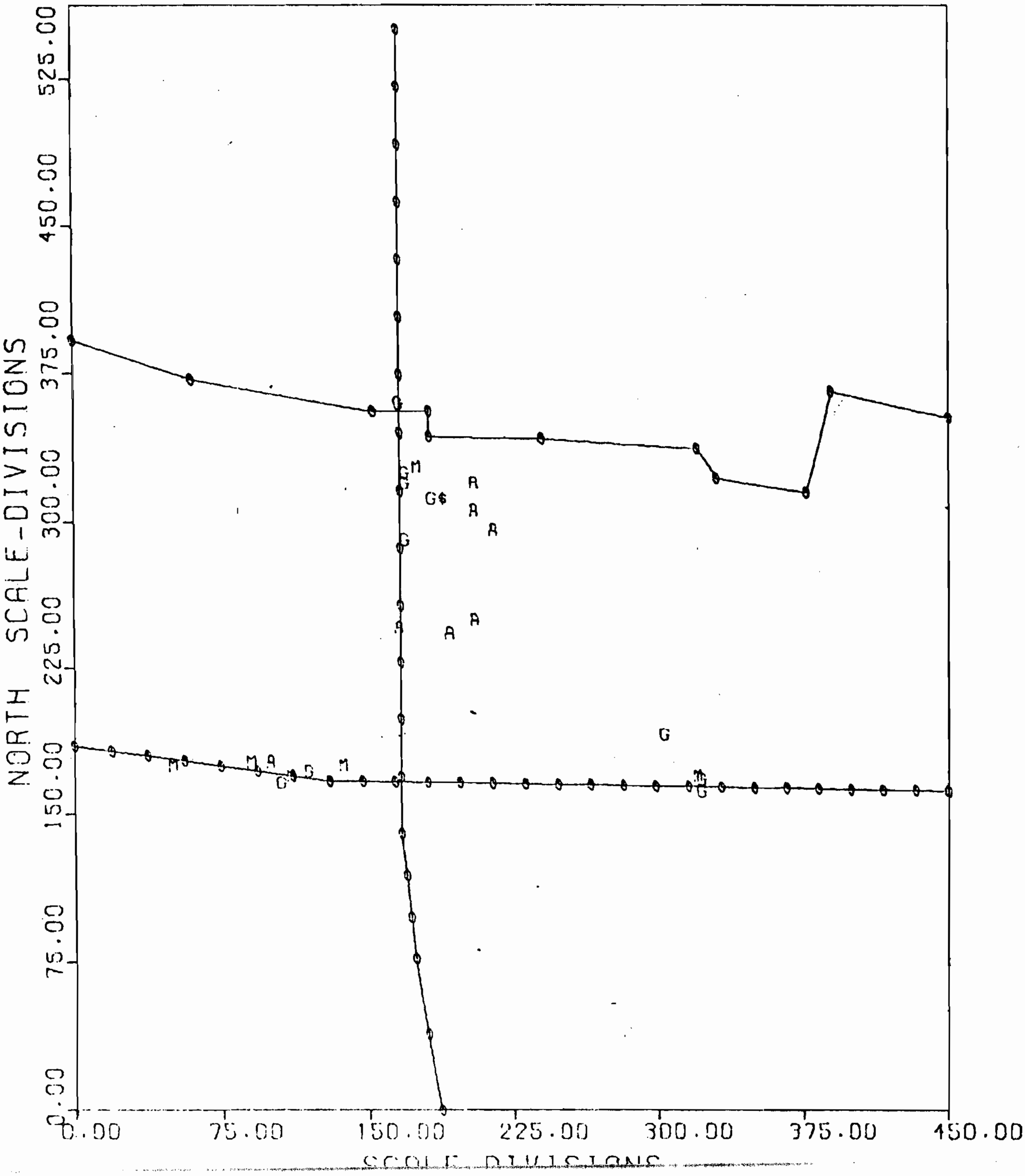
R CODE 5813 5812

M CODE 7011

$ CODE 6022

THE MARK ⊘ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



DURING THE YEAR 1961:

0 ACTIVITIES STARTED.

0 ACTIVITIES CLOSED.

0 ACTIVITIES MOVED TO NEW LOCATIONS.

11 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

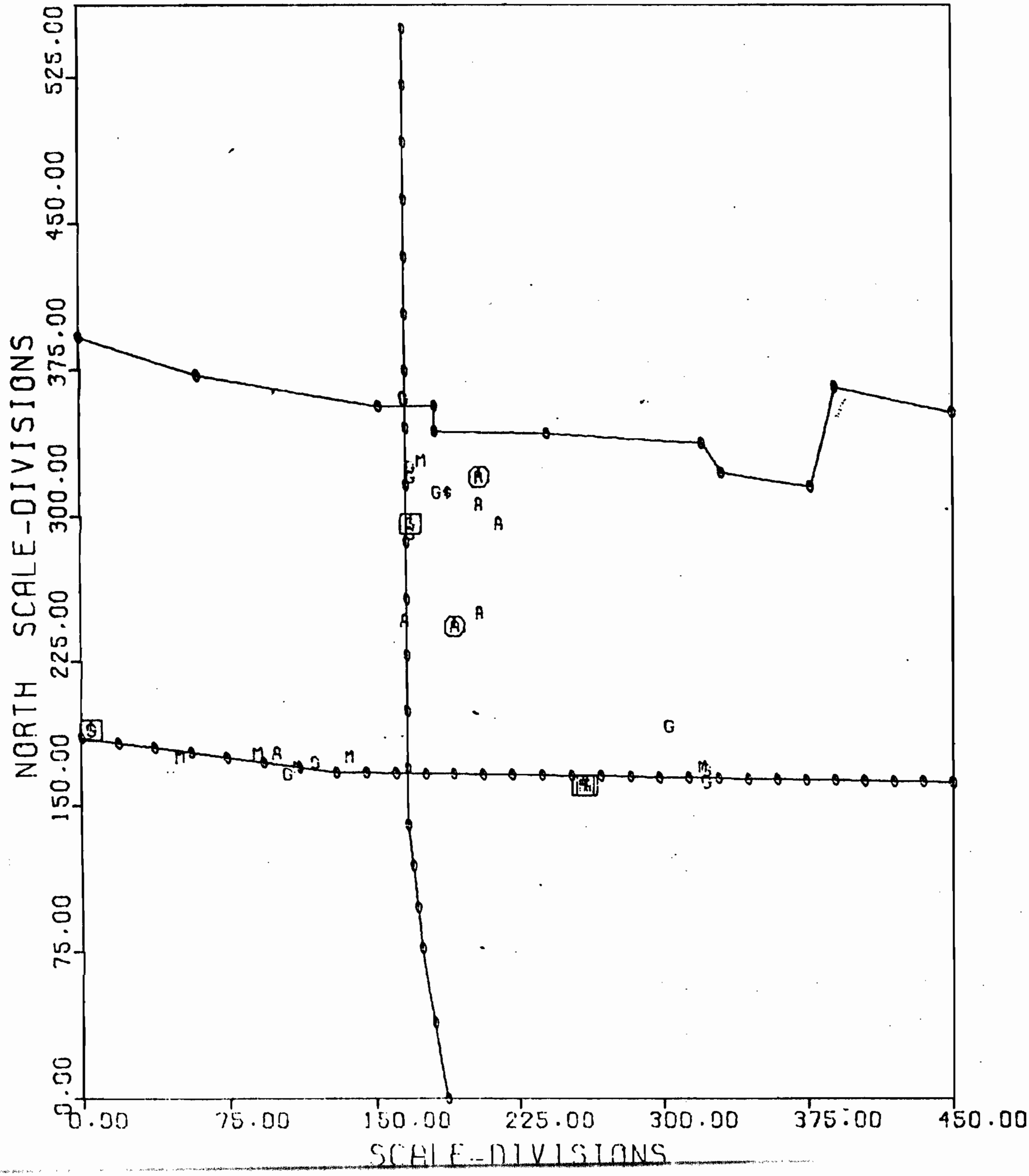
6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 62

- ☐ ACTIVITY STARTED A CODE 7538
- ○ ACTIVITY ENDED
- G CODE 5541
- R CODE 5813 5812
- M CODE 7011
- $ CODE 6022

THE MARK 0 ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



CAMPBELLS SERV OPENED AT THE COORDINATES , 169, 296.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

T L TRUCK STOP OPENED AT THE COORDINATES , 5, 189.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

ZAPALACS PLACE CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 205, 320. ITS SIC CODE WAS
5813 AND WAS REPRESENTED BY THE SYMBOL 34.

SISKAS PLACE OPENED AT THE COORDINATES , 258, 160.
THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

JOHNNIES AUTO CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 192, 243. ITS SIC CODE WAS
7538 AND WAS REPRESENTED BY THE SYMBOL 17.

HENRYS GARAGE OPENED AT THE COORDINATES , 260, 160.
THE S.I.C. CODE IS , 7538 AND IS REPRESENTED BY THE SYMBOL 17.

DURING THE YEAR 1962:

4 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

13 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

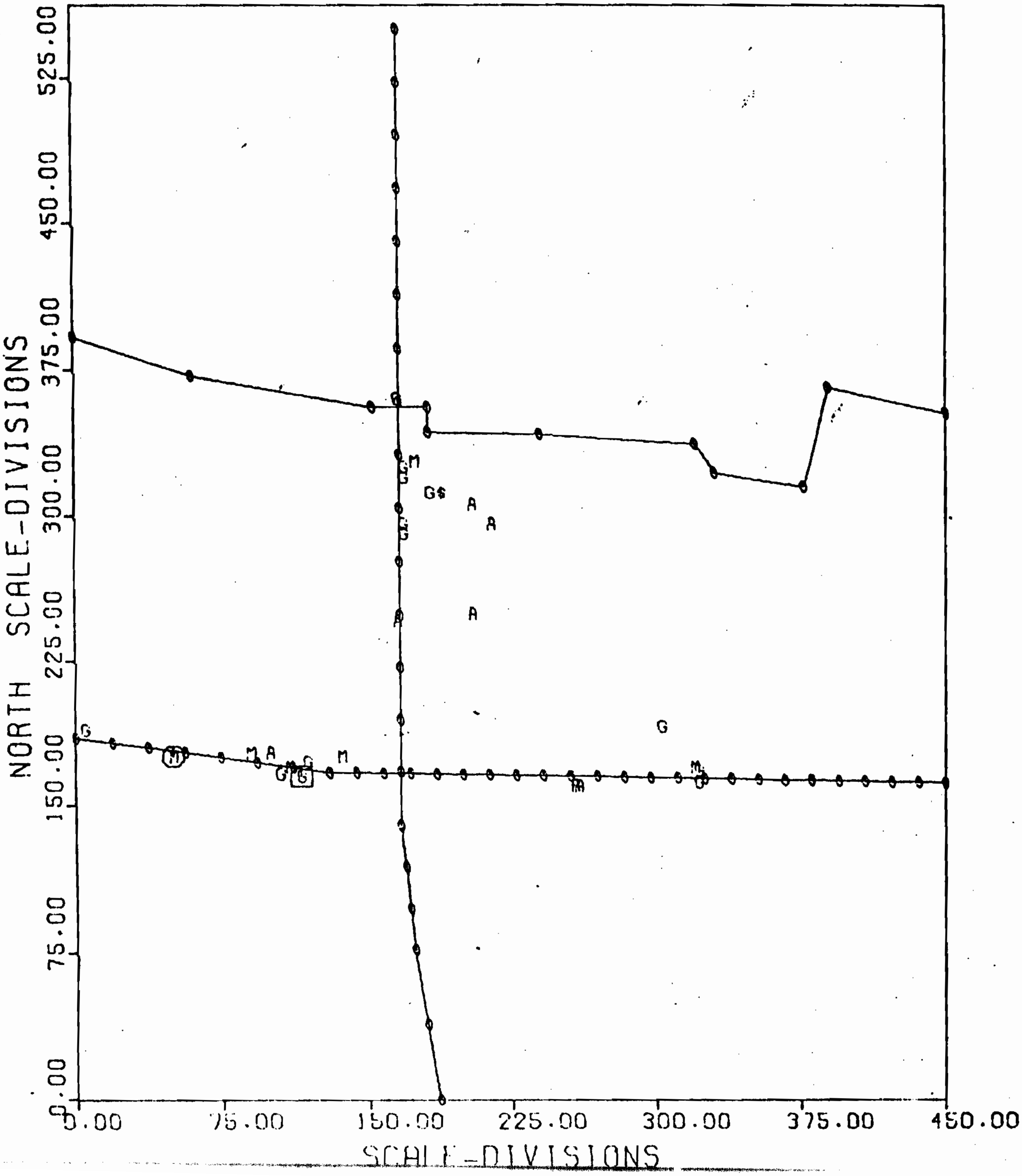
7 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 63

- ⊡ ACTIVITY STARTED   A CODE 7538
- ⊙ ACTIVITY ENDED
- G CODE 5541
- R CODE 5813 5812
- M CODE 7011
- $ CODE 6022

THE MARK ⊙ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



VICTORIA OPENED AT THE COORDINATES , 116, 165.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

LODGE MOTEL CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 50, 175. ITS SIC CODE WAS
7011 AND WAS REPRESENTED BY THE SYMBOL 29.

DURING THE YEAR 1963:

1 ACTIVITIES STARTED,

1 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

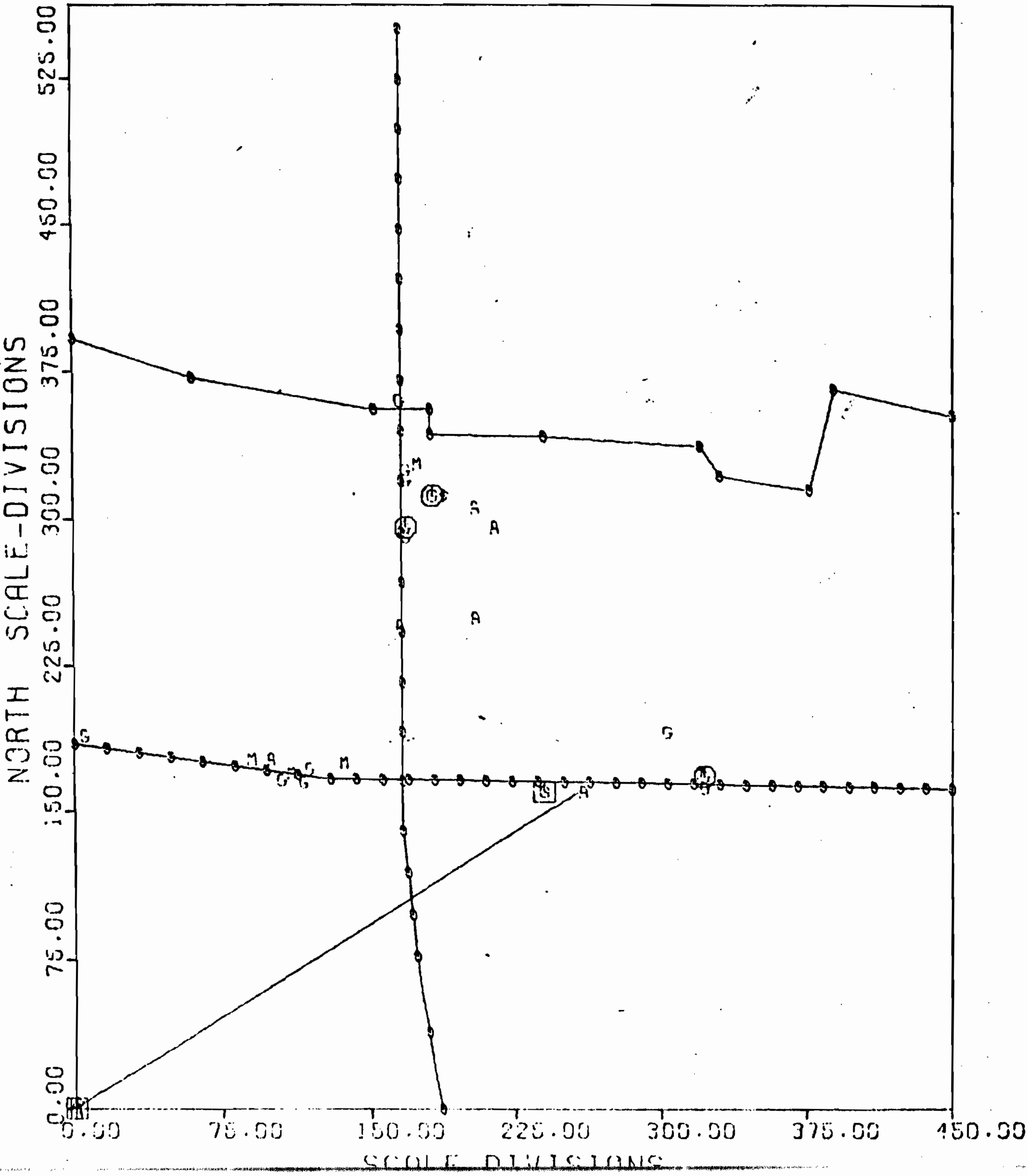
SEALY YEAR 64

LEGEND

- ⊡ ACTIVITY STARTED
- ⊙ ACTIVITY ENDED
- A CODE 7538
- G CODE 5541
- R CODE 5813 5812
- M CODE 7011
- $ CODE 6022

THE MARK ⊙ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



EZ PLACE CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 322, 168. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

MAIN ST SERV STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 183, 312. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

CAMPBELLS SERV CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 169, 296. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

HANCOCK SERV STA OPENED AT THE COORDINATES , 240, 160. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

SISKAS PLACE MOVED DURING THE YEAR FROM ITS OLD LOCATION 258, 160 TO A NEW LOCATION AT -0, -0. ITS S.I.C. CODE IS 5813 AND IS REPRESENTED BY SYMBOL34.

SISKAS PLACE OPENED AT THE COORDINATES , -0, -0. THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

DURING THE YEAR 1964:

2 ACTIVITIES STARTED,

3 ACTIVITIES CLOSED,

1 ACTIVITIES MOVED TO NEW LOCATIONS.

15 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

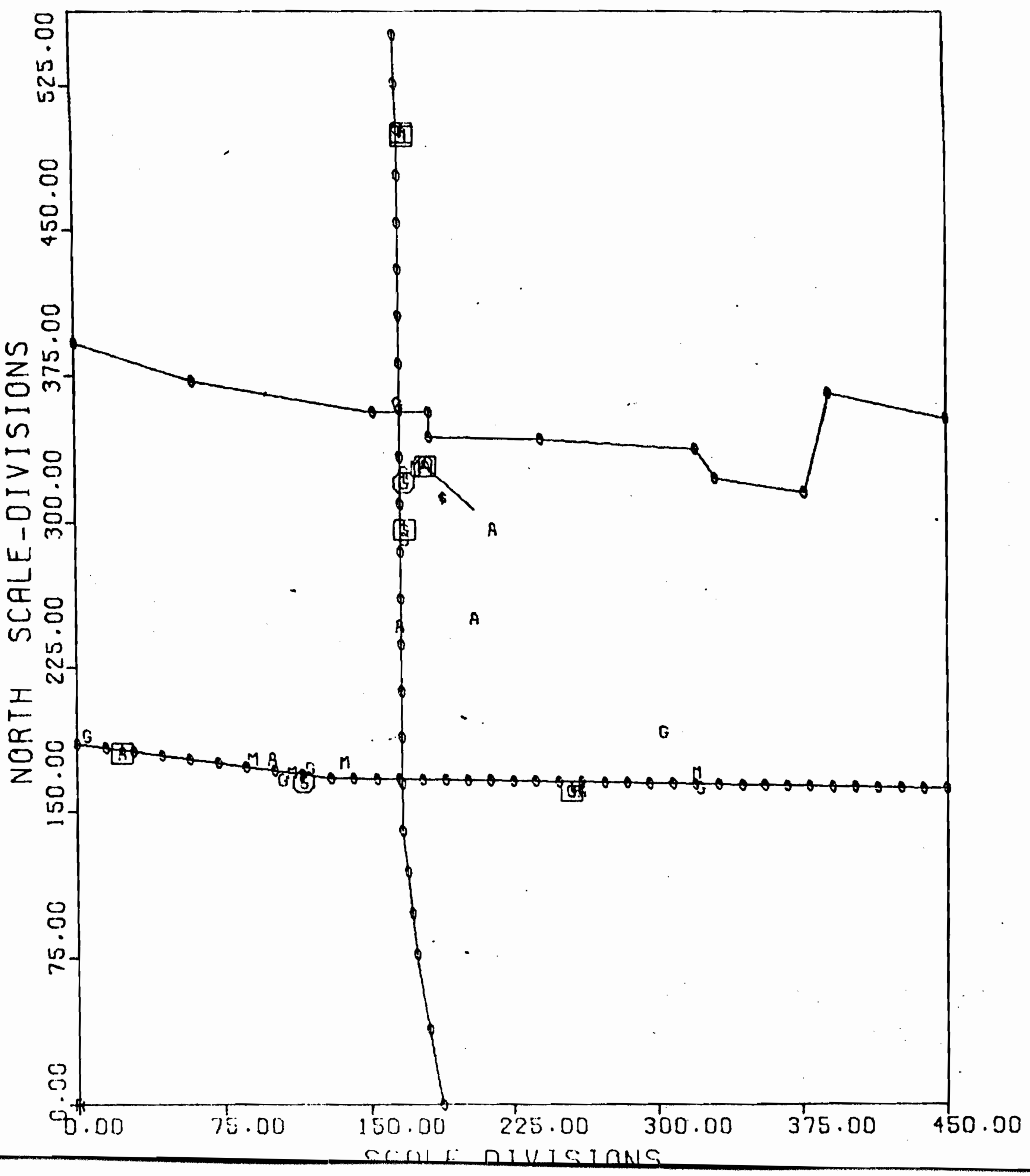
6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 65

⊡	ACTIVITY STARTED	A CODE 7538
⊙	ACTIVITY ENDED	
G	CODE 5541	
R	CODE 5813 5812	
M	CODE 7011	
$	CODE 6022	

THE MARK 0 ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



HIGHWAY SER STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 169, 320. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

HENDERSONS TXACO OPENED AT THE COORDINATES , 169, 296. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

VICTORIA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 116, 165. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

GENES TEXACO OPENED AT THE COORDINATES , 255, 160. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

RAINBOW INN OPENED AT THE COORDINATES , 170, 500. THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

TOMS TAVERN OPENED AT THE COORDINATES , 170, 498. THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

CITY AUTO MOVED DURING THE YEAR FROM ITS OLD LOCATION 205, 306 TO A NEW LOCATION AT 180, 328. ITS S.I.C. CODE IS 7538 AND IS REPRESENTED BY SYMBOL17.

CITY AUTO OPENED AT THE COORDINATES , 180, 328. THE S.I.C. CODE IS , 7538 AND IS REPRESENTED BY THE SYMBOL 17

OTTS GARAGE OPENED AT THE COORDINATES , 23, 180. THE S.I.C. CODE IS , 7538 AND IS REPRESENTED BY THE SYMBOL 17

DURING THE YEAR 1965:

6 ACTIVITIES STARTED.

2 ACTIVITIES CLOSED.

1 ACTIVITIES MOVED TO NEW LOCATIONS.

13 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

4 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 66

□ ACTIVITY STARTED   A   CODE 7538
⊙ ACTIVITY ENDED

G   CODE 5541

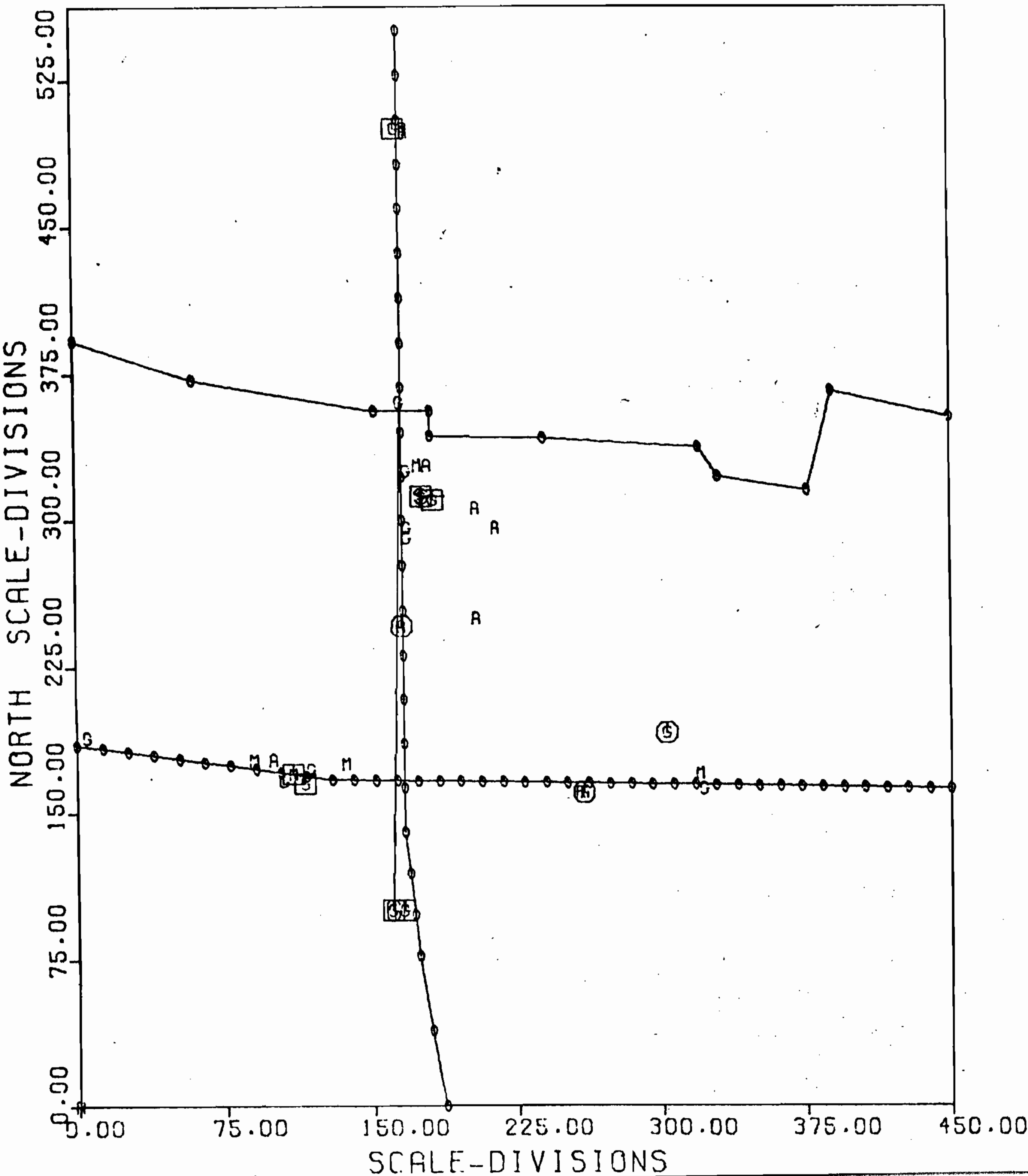
R   CODE 5813 5812

M   CODE 7011

$ CODE 6022

THE MARK ⊘ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



RIVRSIDE SER STA MOVED DURING THE YEAR FROM ITS OLD LOCATION
166, 360 TO A NEW LOCATION AT 160, 100.
ITS S.I.C. CODE IS 5541 AND IS REPRESENTED BY SYMBOL23.

RIVRSIDE SER STA OPENED AT THE COORDINATES , 160, 100.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL

WRIGHTS SER STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 303, 191. ITS SIC CODE WAS
5541 AND WAS REPRESENTED BY THE SYMBOL 23.

SEALY SERVICE OPENED AT THE COORDINATES , 116, 165.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

T BONES OPENED AT THE COORDINATES , 165, 500.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

ZAPALACS TEXACO OPENED AT THE COORDINATES , 183, 310.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

QUINTON ENCO SER OPENED AT THE COORDINATES , 166, 100.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

WESERN TWN OPENED AT THE COORDINATES , 110, 170.
THE S.I.C. CODE IS , 7011 AND IS REPRESENTED BY THE SYMBOL 29.

CITIZENS BANK MOVED DURING THE YEAR FROM ITS OLD LOCATION
189, 312 TO A NEW LOCATION AT 177, 312.
ITS S.I.C. CODE IS 6022 AND IS REPRESENTED BY SYMBOL59.

CITIZENS BANK OPENED AT THE COORDINATES , 177, 312.
THE S.I.C. CODE IS , 6022 AND IS REPRESENTED BY THE SYMBOL 5

CHESTERS GARAGE CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 166, 246. ITS SIC CODE WAS
7538 AND WAS REPRESENTED BY THE SYMBOL 17.

HENRYS GARAGE CLOSED THIS YEAR. IT HAD BEEN LOCATED AT
THE COORDINATES , 260, 160. ITS SIC CODE WAS
7538 AND WAS REPRESENTED BY THE SYMBOL 17.

DURING THE YEAR 1966:

7 ACTIVITIES STARTED,

3 ACTIVITIES CLOSED,

2 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

4 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

6 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

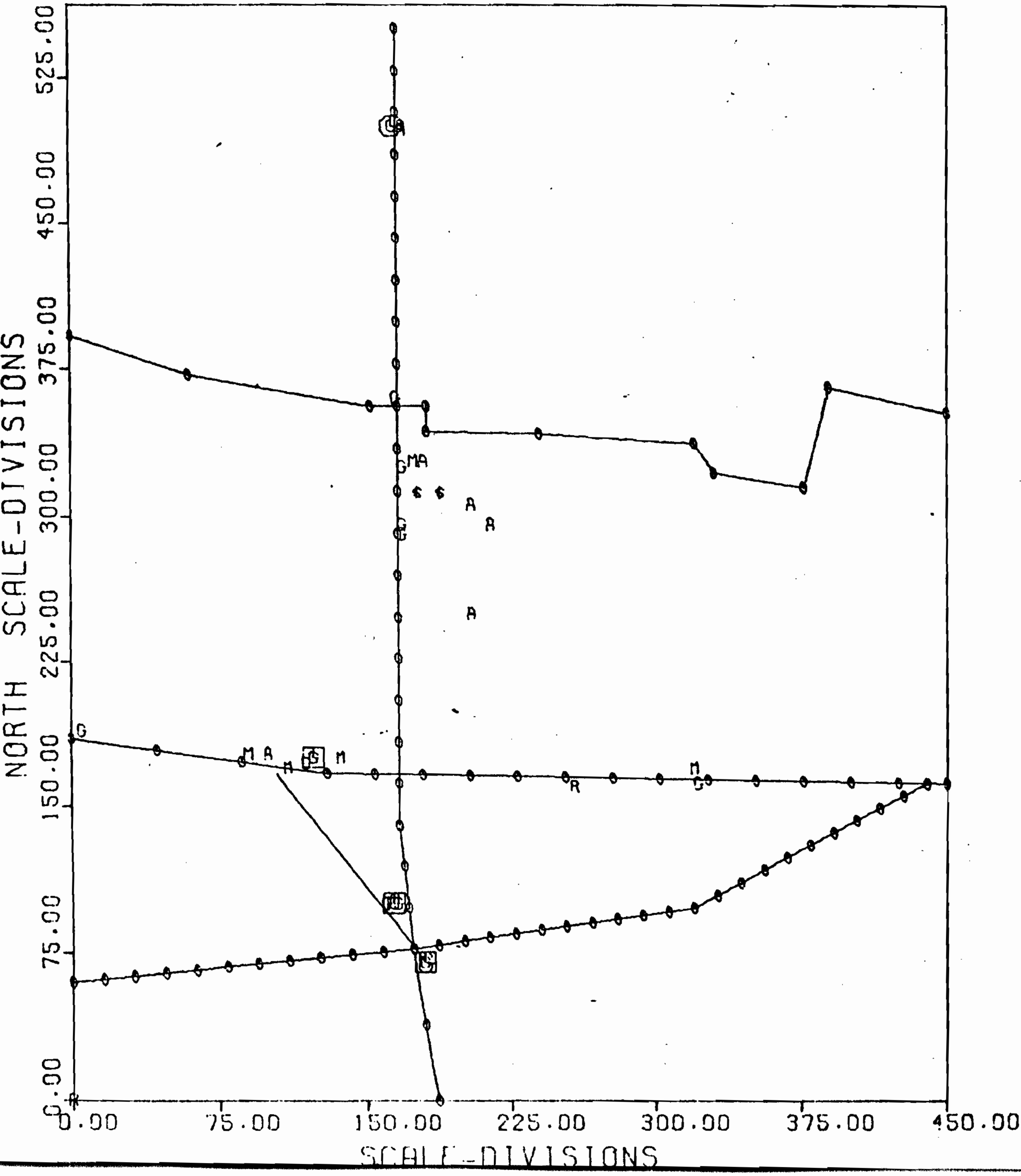
1 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

SEALY LEGEND YEAR 67

- ⊡ ACTIVITY STARTED
- ⊙ ACTIVITY ENDED
- A CODE 7538
- G CODE 5541
- R CODE 5813 5812
- M CODE 7011
- $ CODE 6022

THE MARK ⊙ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



REMMERTS GULF MOVED DURING THE YEAR FROM ITS OLD LOCATION 105, 166 TO A NEW LOCATION AT 180, 70. ITS S.I.C. CODE IS 5541 AND IS REPRESENTED BY SYMBOL23.

REMMERTS GULF OPENED AT THE COORDINATES , 180, 70. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

HENDERSONS TXACO OPENED AT THE COORDINATES , 164, 100. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

T BONES CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 165, 500. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

BAGLEYS SHELL OPENED AT THE COORDINATES , 123, 175. THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

QUINTON ENCO SER CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 166, 100. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

DURING THE YEAR 1967:

3 ACTIVITIES STARTED,

2 ACTIVITIES CLOSED,

1 ACTIVITIES MOVED TO NEW LOCATIONS.

14 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

4 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

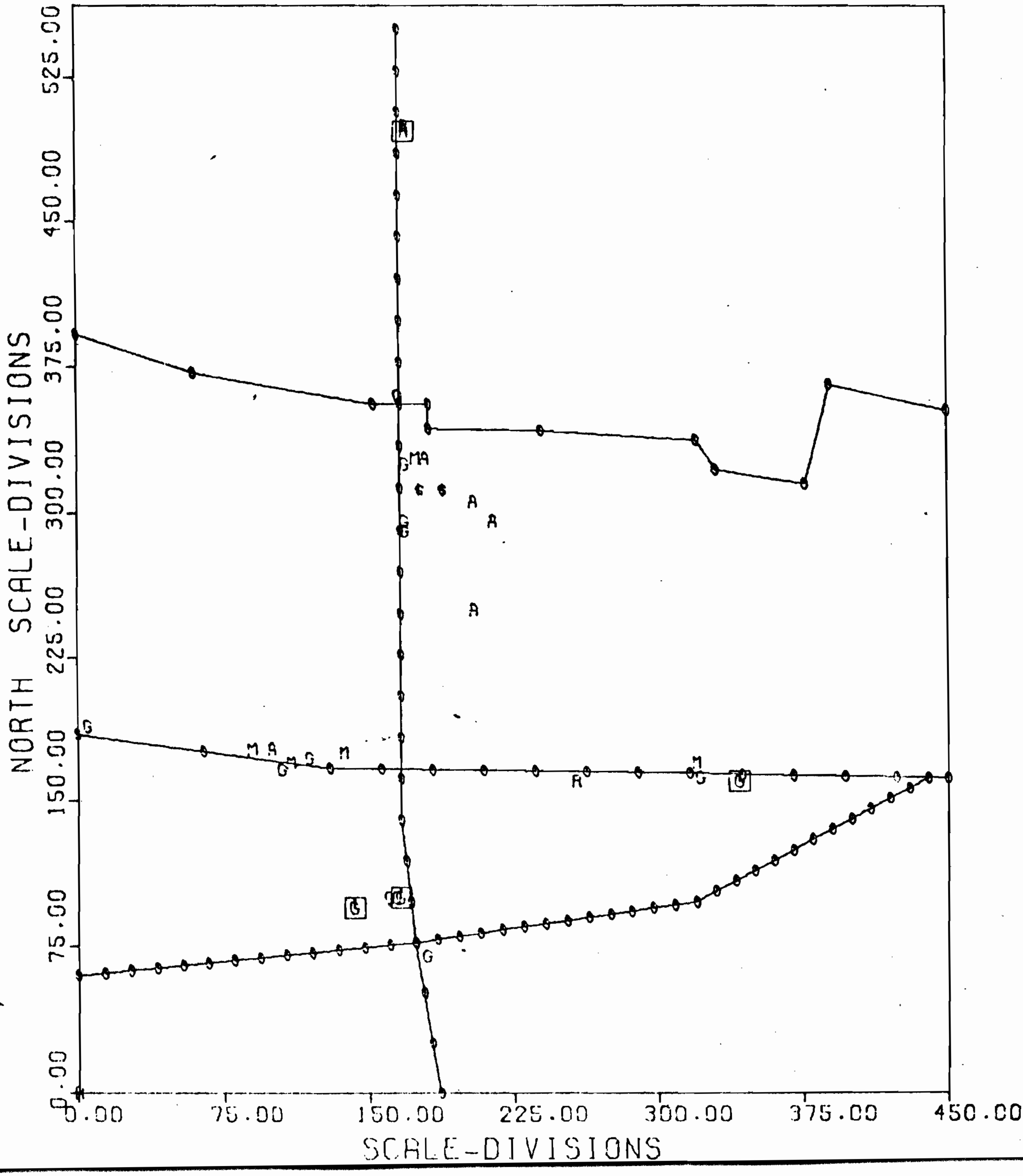
5 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 68

⊡ ACTIVITY STARTED
⊙ ACTIVITY ENDED
G CODE 5541
R CODE 5813 5812
M CODE 7011
$ CODE 6022
A CODE 7538

THE MARK ⊘ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



SEALY   YEAR 1968

JOES FINA   OPENED AT THE COORDINATES , 342, 160.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

MORRIS ENCO SER STA   OPENED AT THE COORDINATES , 166, 100.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

KEY TRUCK STOP   OPENED AT THE COORDINATES , 142, 95.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

GRANNYS TAVERN   OPENED AT THE COORDINATES , 170, 497.
THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

DURING THE YEAR 1968:

4 ACTIVITIES STARTED,

0 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

15 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY

LEGEND

YEAR 69

ACTIVITY STARTED

ACTIVITY ENDED

A CODE 7538

G CODE 5541

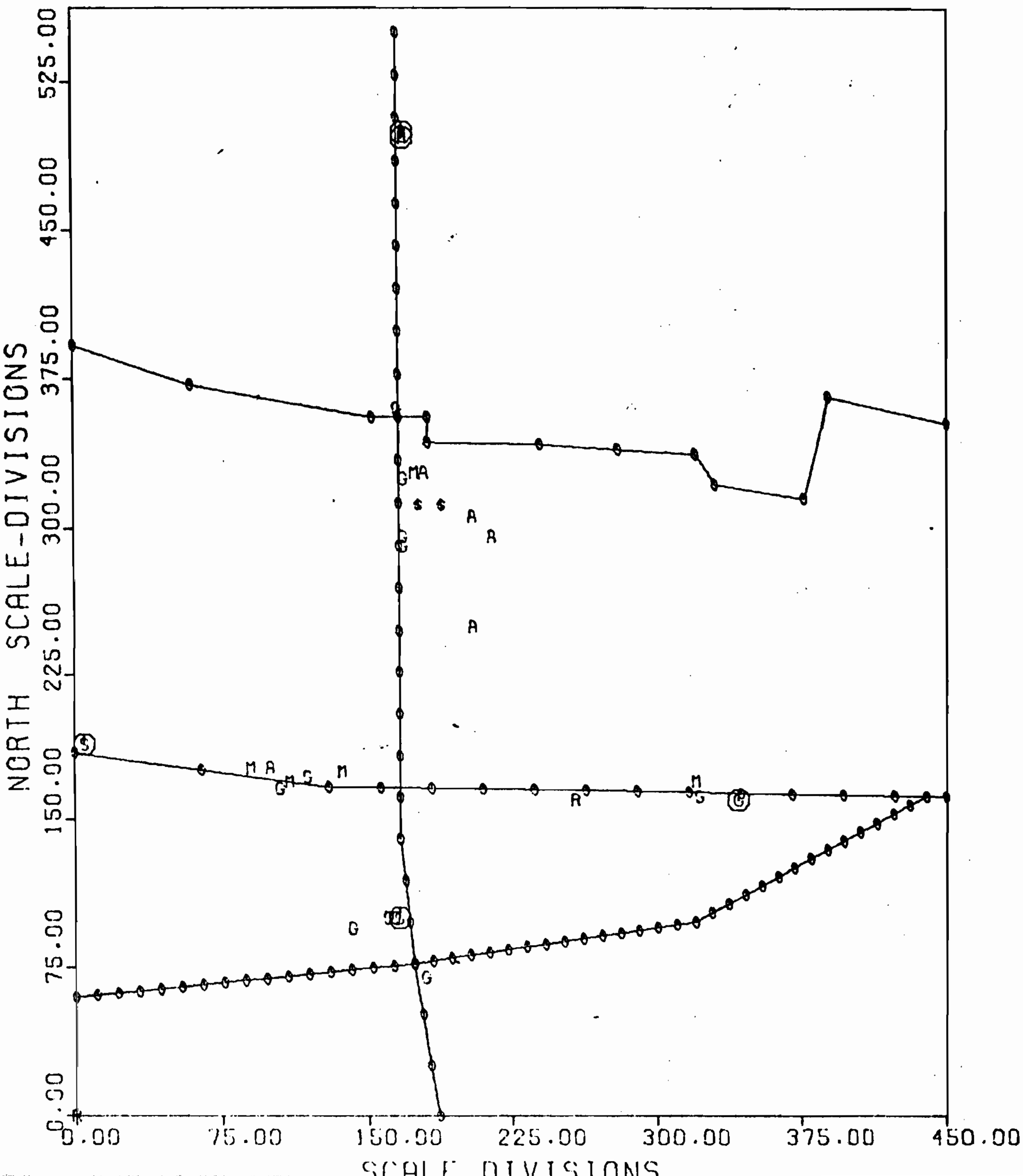
R CODE 5813 5812

M CODE 7011

$ CODE 6022

THE MARK ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



SEALY YEAR 1969

JOES FINA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 342, 160. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

T L TRUCK STOP CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 5, 189. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

MORRIS ENCO SER STA CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 166, 100. ITS SIC CODE WAS 5541 AND WAS REPRESENTED BY THE SYMBOL 23.

RAINBOW INN CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 170, 500. ITS SIC CODE WAS 5813 AND WAS REPRESENTED BY THE SYMBOL 34.

GRANNYS TAVERN CLOSED THIS YEAR. IT HAD BEEN LOCATED AT THE COORDINATES , 170, 497. ITS SIC CODE WAS 5813 AND WAS REPRESENTED BY THE SYMBOL 34.

DURING THE YEAR 1969:

0 ACTIVITIES STARTED,

5 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

15 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

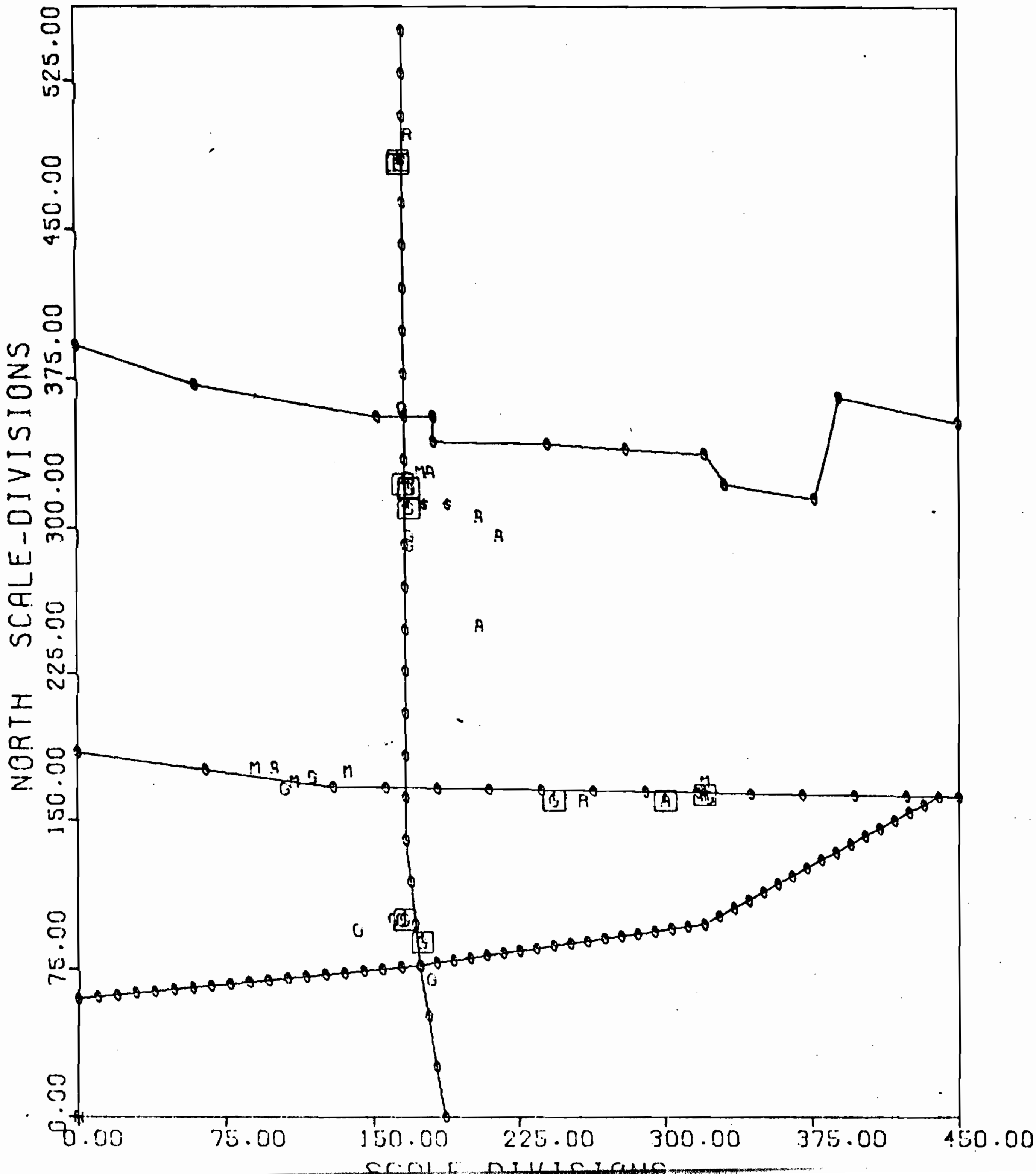
5 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

SEALY LEGEND YEAR 70

- ☐ ACTIVITY STARTED
- ⊖ ACTIVITY ENDED
- A CODE 7538
- G CODE 5541
- R CODE 5813 5812
- M CODE 7011
- $ CODE 6022

THE MARK ⊖ ON THE ROAD LINES INDICATE RELATIVE TRAFFIC COUNTS.

SCALE : 1 IN. = 2000 FT.



SEALY YEAR 1970

KRUPALA ENCO SER OPENED AT THE COORDINATES , 166, 100.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

CHARLIES CONOCO OPENED AT THE COORDINATES , 243, 160.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

ZAPALACS ARCO OPENED AT THE COORDINATES , 169, 310.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

FISHERS SHELL OPENED AT THE COORDINATES , 175, 89.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

MIDWAY BAR SERV OPENED AT THE COORDINATES , 165, 483.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

SEALY SHAMROCK OPENED AT THE COORDINATES , 169, 320.
THE S.I.C. CODE IS , 5541 AND IS REPRESENTED BY THE SYMBOL 23.

MIDWAY BAR SERV OPENED AT THE COORDINATES , 165, 483.
THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

HIGHWAY INN OPENED AT THE COORDINATES , 320, 163.
THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

LONGHORN LOUNGE OPENED AT THE COORDINATES , 166, 322.
THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

STARLITE INN OPENED AT THE COORDINATES , 165, 485.
THE S.I.C. CODE IS , 5813 AND IS REPRESENTED BY THE SYMBOL 34.

EINKAUFS REPAIR OPENED AT THE COORDINATES , 300, 160.
THE S.I.C. CODE IS , 7538 AND IS REPRESENTED BY THE SYMBOL 17.

DURING THE YEAR 1970:

11 ACTIVITIES STARTED,

0 ACTIVITIES CLOSED,

0 ACTIVITIES MOVED TO NEW LOCATIONS.

18 ACTIVITIES CORRESPONDING TO SYMBOL 23 APPEAR THIS YEAR.

7 ACTIVITIES CORRESPONDING TO SYMBOL 34 APPEAR THIS YEAR.

5 ACTIVITIES CORRESPONDING TO SYMBOL 29 APPEAR THIS YEAR.

2 ACTIVITIES CORRESPONDING TO SYMBOL 59 APPEAR THIS YEAR.

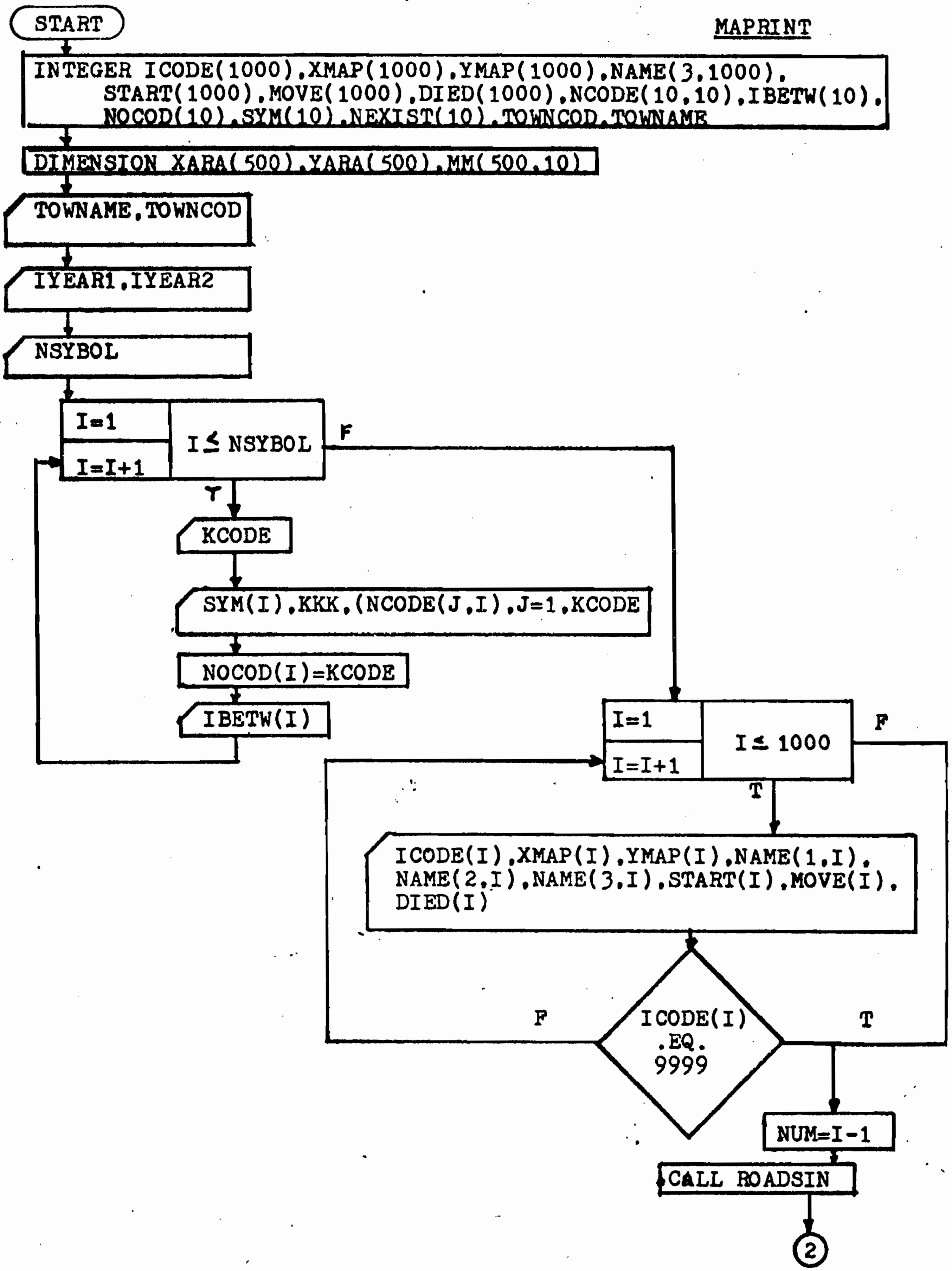
6 ACTIVITIES CORRESPONDING TO SYMBOL 17 APPEAR THIS YEAR.

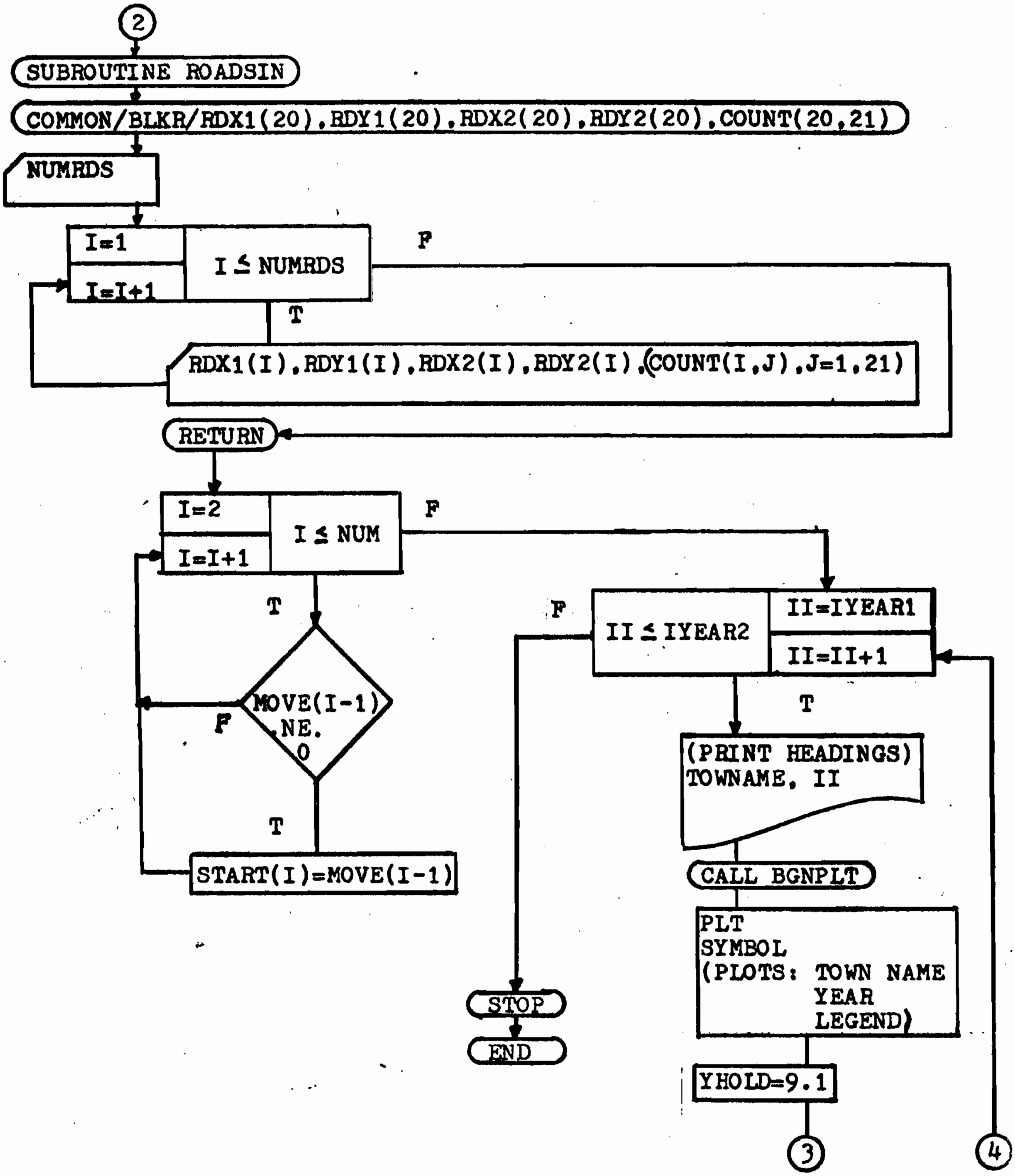
APPENDIX B

FLOWCHART AND PROGRAM

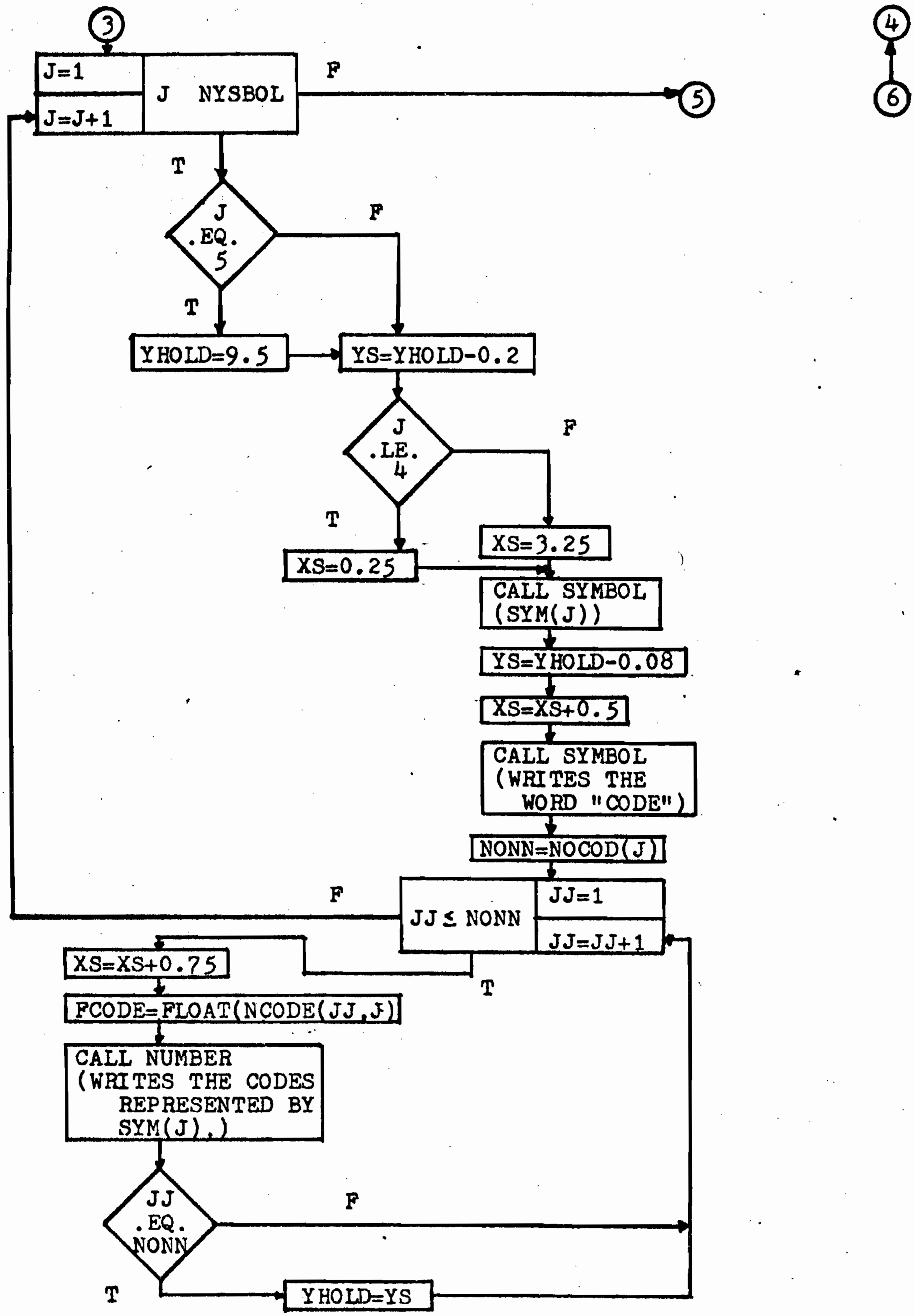
FLOWCHART -

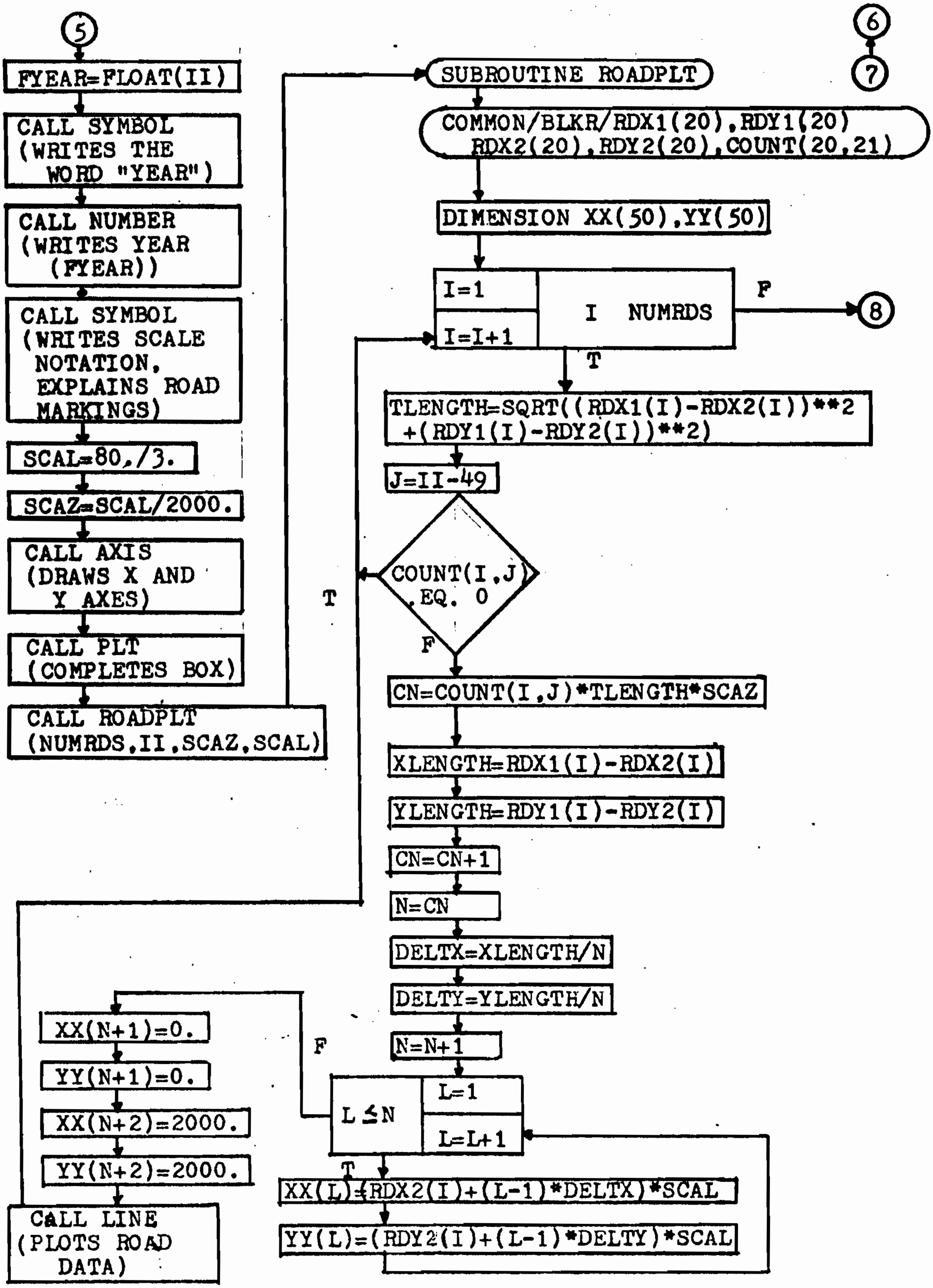
MAPRINT



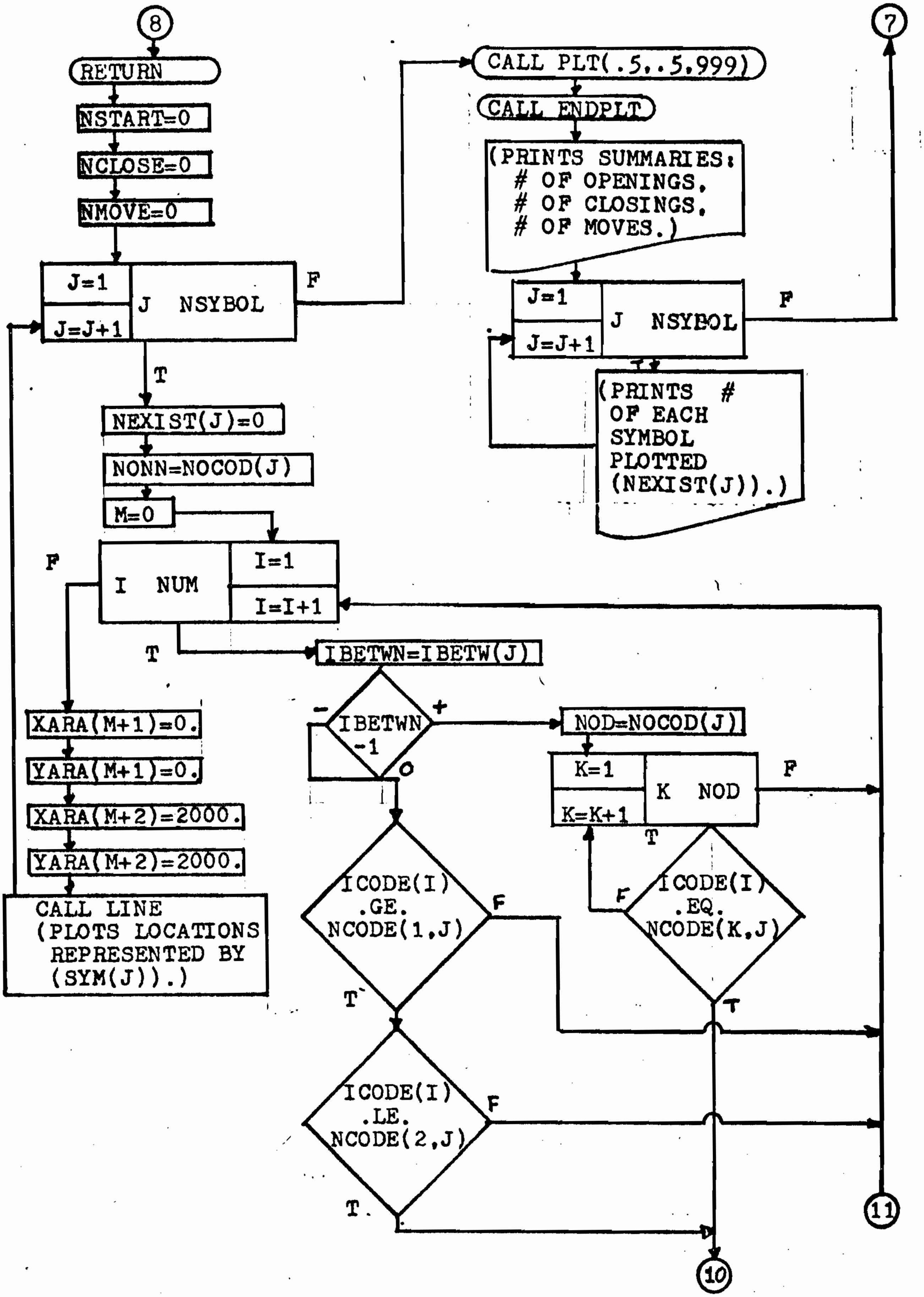


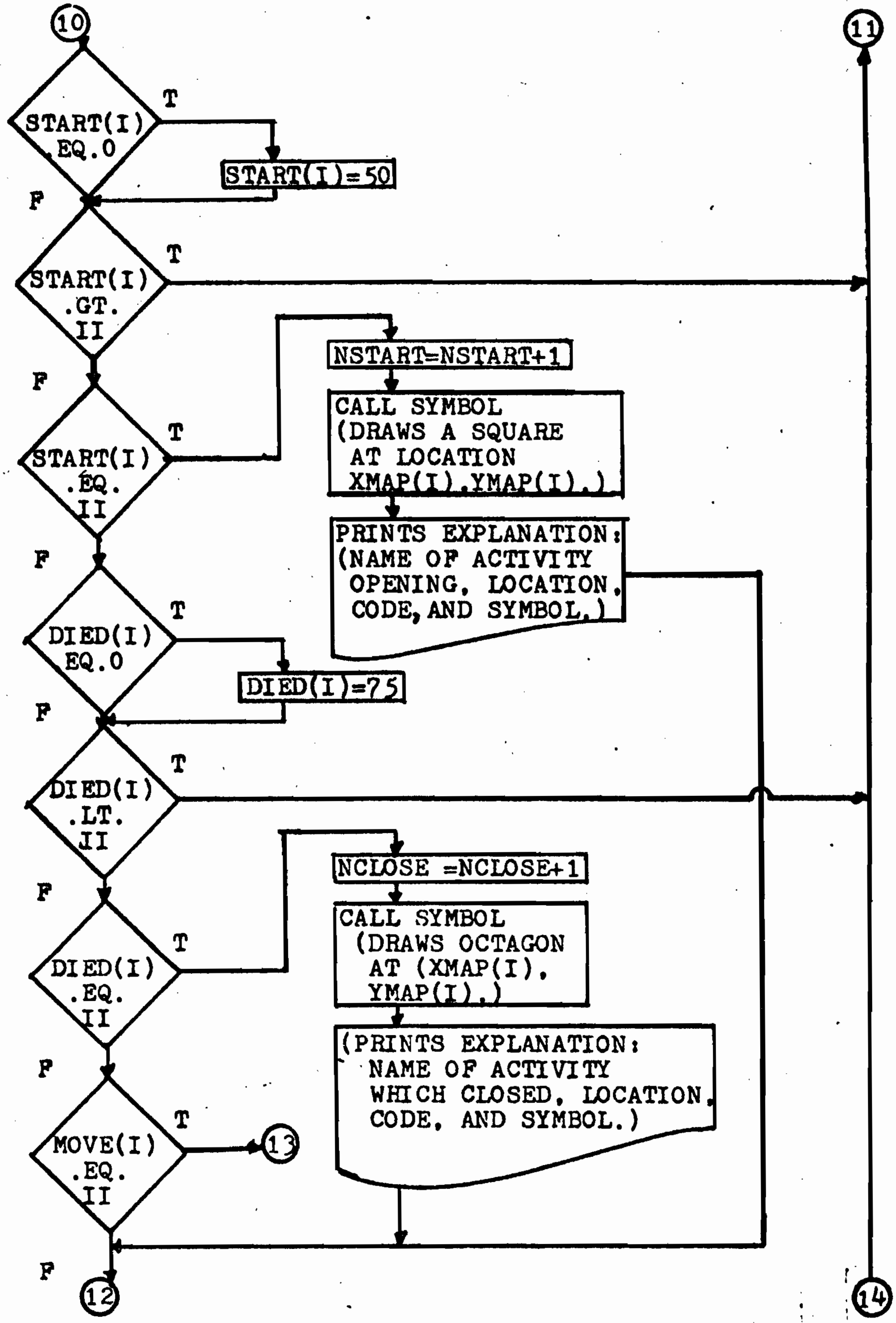
2
SUBROUTINE ROADSIN
COMMON/BLKR/RDX1(20),RDY1(20),RDX2(20),RDY2(20),COUNT(20,21)
NUMRDS
I=1
I=I+1
I ≤ NUMRDS
F
T
RDX1(I),RDY1(I),RDX2(I),RDY2(I),(COUNT(I,J),J=1,21)
RETURN
I=2
I=I+1
I ≤ NUM
F
T
MOVE(I-1) .NE. 0
F
T
START(I)=MOVE(I-1)
II ≤ IYEAR2
II=IYEAR1
II=II+1
F
T
(PRINT HEADINGS) TOWNAME, II
CALL BGNPLT
PLT
SYMBOL
(PLOTS: TOWN NAME
YEAR
LEGEND)
YHOLD=9.1
STOP
END
3
4

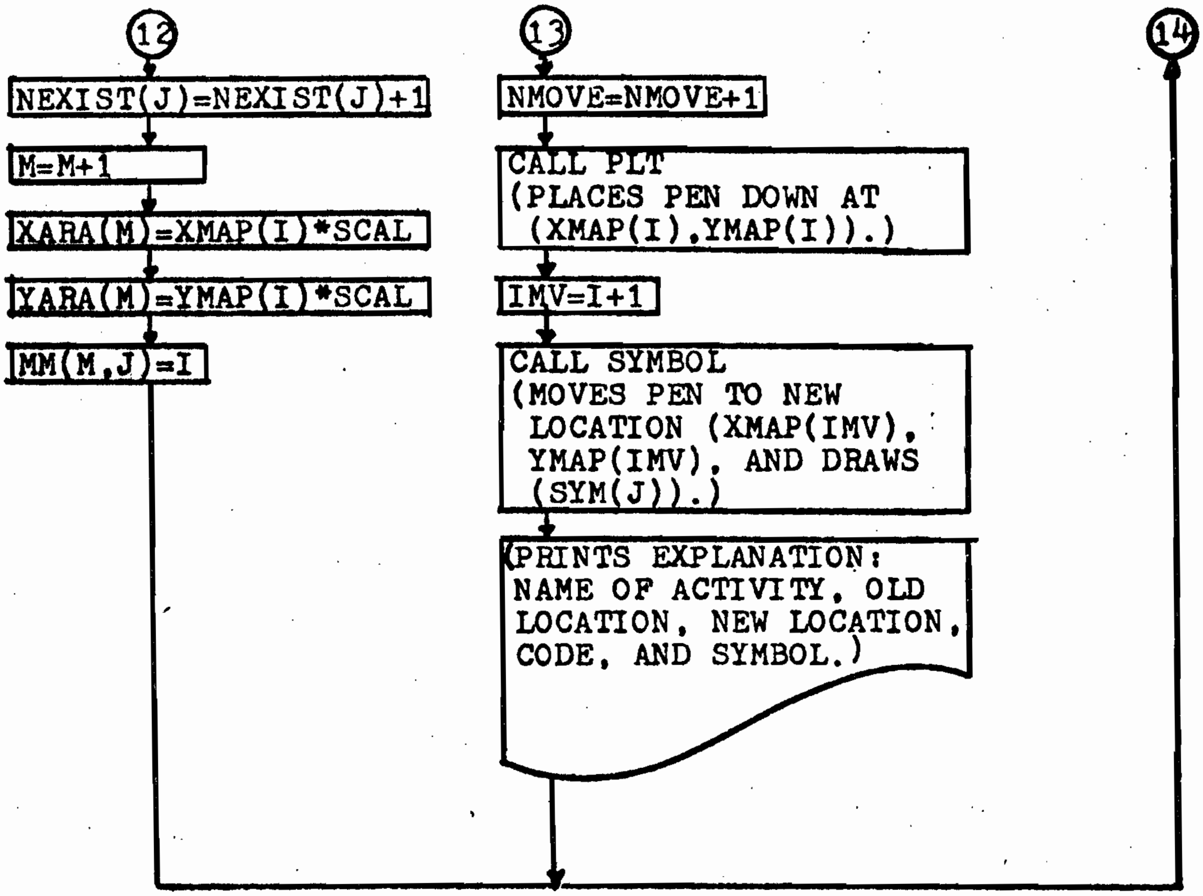

3
J=1
J=J+1
J NYSBOL
F
5
4
6
T
J .EQ. 5
F
T
YHOLD=9.5
YS=YHOLD-0.2
J .LE. 4
F
T
XS=0.25
XS=3.25
CALL SYMBOL (SYM(J))
YS=YHOLD-0.08
XS=XS+0.5
CALL SYMBOL (WRITES THE WORD "CODE")
NONN=NOCOD(J)
F
JJ≤ NONN
JJ=1
JJ=JJ+1
T
XS=XS+0.75
FCODE=FLOAT(NCODE(JJ,J))
CALL NUMBER (WRITES THE CODES REPRESENTED BY SYM(J).)
JJ .EQ. NONN
F
T
YHOLD=YS



5
FYEAR=FLOAT(II)
CALL SYMBOL (WRITES THE WORD "YEAR")
CALL NUMBER (WRITES YEAR (FYEAR))
CALL SYMBOL (WRITES SCALE NOTATION, EXPLAINS ROAD MARKINGS)
SCAL=80./3.
SCAZ=SCAL/2000.
CALL AXIS (DRAWS X AND Y AXES)
CALL PLT (COMPLETES BOX)
CALL ROADPLT (NUMRDS,II,SCAZ,SCAL)
6
7
SUBROUTINE ROADPLT
COMMON/BLKR/RDX1(20),RDY1(20) RDX2(20),RDY2(20),COUNT(20,21)
DIMENSION XX(50),YY(50)
I=1
I=I+1
I NUMRDS
F
8
T
TLENGTH=SQRT((RDX1(I)-RDX2(I))**2 +(RDY1(I)-RDY2(I))**2)
J=II-49
COUNT(I,J) .EQ. 0
T
F
CN=COUNT(I,J)*TLENGTH*SCAZ
XLENGTH=RDX1(I)-RDX2(I)
YLENGTH=RDY1(I)-RDY2(I)
CN=CN+1
N=CN
DELTX=XLENGTH/N
DELTY=YLENGTH/N
N=N+1
L≤N
L=1
L=L+1
F
T
XX(L)=(RDX2(I)+(L-1)*DELTX)*SCAL
YY(L)=(RDY2(I)+(L-1)*DELTY)*SCAL
XX(N+1)=0.
YY(N+1)=0.
XX(N+2)=2000.
YY(N+2)=2000.
CALL LINE (PLOTS ROAD DATA)


8
RETURN
NSTART=0
NCLOSE=0
NMOVE=0
J=1
J=J+1
J NSYBOL
F
T
NEXIST(J)=0
NONN=NOCOD(J)
M=0
I NUM
I=1
I=I+1
F
T
XARA(M+1)=0.
YARA(M+1)=0.
XARA(M+2)=2000.
YARA(M+2)=2000.
CALL LINE (PLOTS LOCATIONS REPRESENTED BY (SYM(J)).)
IBETWN=IBETW(J)
IBETWN -1
-
+
O
NOD=NOCOD(J)
K=1
K=K+1
K NOD
F
T
ICODE(I) .GE. NCODE(1,J)
F
T
ICODE(I) .EQ. NCODE(K,J)
F
T
ICODE(I) .LE. NCODE(2,J)
F
T
10
11
CALL PLT(.5,.5,999)
CALL ENDPLT
(PRINTS SUMMARIES: # OF OPENINGS, # OF CLOSINGS, # OF MOVES.)
J=1
J=J+1
J NSYBOL
F
T
(PRINTS # OF EACH SYMBOL PLOTTED (NEXIST(J)).)
7


10
11
START(I) .EQ.0
T
F
START(I)=50
START(I) .GT. II
NSTART=NSTART+1
CALL SYMBOL (DRAWS A SQUARE AT LOCATION XMAP(I),YMAP(I).)
START(I) .EQ. II
PRINTS EXPLANATION: (NAME OF ACTIVITY OPENING, LOCATION, CODE, AND SYMBOL.)
DIED(I) EQ.0
DIED(I)=75
DIED(I) .LT. II
NCLOSE =NCLOSE+1
CALL SYMBOL (DRAWS OCTAGON AT (XMAP(I), YMAP(I).)
DIED(I) .EQ. II
(PRINTS EXPLANATION: NAME OF ACTIVITY WHICH CLOSED, LOCATION, CODE, AND SYMBOL.)
MOVE(I) .EQ. II
13
12
14


12
NEXIST(J)=NEXIST(J)+1
M=M+1
XARA(M)=XMAP(I)*SCAL
YARA(M)=YMAP(I)*SCAL
MM(M,J)=I
13
NMOVE=NMOVE+1
CALL PLT
(PLACES PEN DOWN AT
(XMAP(I),YMAP(I)).)
IMV=I+1
CALL SYMBOL
(MOVES PEN TO NEW
LOCATION (XMAP(IMV),
YMAP(IMV), AND DRAWS
(SYM(J)).)
(PRINTS EXPLANATION:
NAME OF ACTIVITY, OLD
LOCATION, NEW LOCATION,
CODE, AND SYMBOL.)
14

```
      PROGRAM MAPRINT(INPUT,OUTPUT)
      INTEGER ICODE(1000),XMAP(1000),YMAP(1000),NAME(3,1000),START(100
      INTEGER MOVE(1000),DIED(1000)               ,NCODE(10,10),IBETW(10)
      INTEGER NOCOD(10),SYM(10),NEXIST(10),TOWNCOD,TOWNAME
      DIMENSION XARA(500),YARA(500),MM(500,10)
      READ 190,TOWNAME,TOWNCOD
190   FORMAT(A10,I3)
      READ 110,IYEAR1,IYEAR2
      READ 104,NSYBOL
      DO 7 I=1,NSYBOL
       READ 104, KCODE
      READ 106,SYM(I),KKK      ,(NCODE(J,I),J=1,KCODE)
      NOCOD(I)=KCODE
      READ 108,IBETW(I)
7     CONTINUE
       DO 5 I=1, 1000
      READ 102,ICODE(I),XMAP(I),YMAP(I), NAME(1,I),NAME(2,I),NAME(3,I)
     1,START(I),MOVE(I)     ,DIED(I)
      IF (ICODE(I).EQ.9999) GO TO 150
5     CONTINUE
  150 NUM=I-1
      CALL ROADSIN(NUMRDS)
      DO 85 I=2,NUM
      IF(MOVE(I-1).NE.0) START(I)=MOVE(I-1)
85    CONTINUE
      DO 10 II=IYEAR1,IYEAR2
      PRINT 86,TOWNAME,II
86    FORMAT(1H1,10X,A10,20X,*YEAR*,*  19*,I2,/)
      CALL BGNPLT
      CALL PLT(.5,.50,-3)
      CALL SYMBOL(2.7,9.5,.14,6HLEGEND,0.,6)
      CALL SYMBOL(0.,9.50,.21,TOWNAME,0.,10)
      CALL SYMBOL(.25,9.4,.14,2,0.,-1)
      CALL SYMBOL(.75,9.3,.14,16HACTIVITY STARTED,0.,16)
      CALL SYMBOL(.25,9.2,.14,1,0.,-1)
      CALL SYMBOL(.75,9.1,.14,14HACTIVITY ENDED,0.,14)
      YHOLD=9.1
      DO 8 J=1, NSYBOL
      IF(J.EQ.5)YHOLD=9.5
      YS=YHOLD-.2
      IF(J.LE.4)XS=.25
      IF(J.GT.4)XS=3.25
      CALL SYMBOL(XS,YS,.14,SYM(J),0.,-1)
      YS=YS-.08
      XS=XS+.5
      CALL SYMBOL(XS,YS,.14,4HCODE,0.,4)
      NONN=NOCOD(J)
      DO 9 JJ=1,NONN
      XS=XS+.75
      FCODE=FLOAT(NCODE(JJ,J))
      CALL NUMBER(XS,YS,.14,FCODE,0.,-1)
      IF(JJ.EQ.NONN)YHOLD=YS
9     CONTINUE
8     CONTINUE
      FYEAR=FLOAT(II)
      CALL SYMBOL(4.2,9.5,.21,4HYEAR,0.,4)
      CALL NUMBER(5.5,9.5,.21,FYEAR,0.,-1)
      CALL SYMBOL(1.2,7.6,.14,25HSCALE :  1 IN. = 2000 FT.,0.,25)
```

```
      CALL SYMBOL(3.5,8.2,.14,8HTHE MARK,0.,8)
      CALL SYMBOL(4.7,8.3,.14,0,0.,-1)
      CALL SYMBOL(4.9,8.2,.14,11HON THE ROAD,0.,11)
      CALL SYMBOL(3.5,8.0,.14,23HLINES INDICATE RELATIVE,0.,23)
      CALL SYMBOL(3.5,7.8,.14,15HTRAFFIC COUNTS.,0.,15)
      SCAL=80./3.
      SCAZ=SCAL/2000.
      CALL AXIS(0.,0.,15HSCALE-DIVISIONS,-15,6.0,0.,0.,75.)
      CALL AXIS(0.,0.,22HNORTH  SCALE-DIVISIONS,22,7.5,90.,0.,75.)
      CALL PLT(0.,7.5,3)
      CALL PLT(6.,7.5,2)
      CALL PLT(6.,0.,2)
      CALL ROADPLT(NUMRDS,II,SCAZ,SCAL)
      NSTART=0
      NCLOSE=0
      NMOVE=0
      DO 41 J=1,NSYBOL
      NEXIST(J)=0
      NONN=NOCOD(J)
      M=0
      DO 40 I=1,NUM
      IBETWN=IBETW(J)
      IF(IBETWN-1)12,12,14
12    IF((ICODE(I).GE.NCODE(1,J)).AND.(ICODE(I).LE.NCODE(2,J)))GO TO 18
      GO TO 40
14    CONTINUE
      NOD=NOCOD(J)
      DO 16 K=1,NOD
      IF (ICODE(I).EQ.NCODE(K,J))GO TO 18
      GO TO 40
16    CONTINUE
18    IF(START(I).EQ.0)START(I)=50
      IF(START(I).GT.II) GO TO 40
      IF(START(I).EQ.II) GO TO 20
      IF(DIED(I).EQ.0) DIED(I)=75
      IF(DIED(I).LT.II)GO TO 40
      IF(DIED(I).EQ.II)GO TO      22
      IF(MOVE(I).EQ.II) GO TO 24
      GO TO 26
20    CONTINUE
      NSTART=NSTART+1
      CALL SYMBOL((XMAP(I)*SCAZ),(YMAP(I)*SCAZ),.14,2,0.,-1)
      PRINT 21,NAME(1,I),NAME(2,I),NAME(3,I),XMAP(I),YMAP(I),ICODE(I),
     1SYM(J)
21    FORMAT(12X,2A10,A1,*  OPENED AT THE COORDINATES ,*,I5,*,*,I5,*.*,
     1,15X,*THE S.I.C.  CODE IS ,*,I5,* AND IS REPRESENTED BY THE SYMB
     2  *,I2, *.*,/)
      GO TO 26
22    CONTINUE
      NCLOSE=NCLOSE+1
      CALL SYMBOL((XMAP(I)*SCAZ),(YMAP(I)*SCAZ),.14,1,0.,-1)
      PRINT 23 ,NAME(1,I),NAME(2,I),NAME(3,I),XMAP(I),YMAP(I),ICODE(I),
     1SYM(J)
23    FORMAT(12X,2A10,A1,*  CLOSED THIS YEAR.  IT HAD BEEN LOCATED AT
     1*,/,15X ,*THE COORDINATES ,*,I5,*,*,I5,*.  ITS SIC CODE WAS  *,
     2/,15X,I5,* AND WAS REPRESENTED BY THE SYMBOL *,I2,*.*,/)
      GO TO 26
24    CONTINUE
```

```
      NMOVE=NMOVE+1
      CALL PLT((XMAP(I)*SCAZ),(YMAP(I)*SCAZ),3)
      IMV=I+1
      CALL SYMBOL((XMAP(IMV)*SCAZ),(YMAP(IMV)*SCAZ),.14,SYM(J),0.,-2)
      PRINT 25,NAME(1,I),NAME(2,I),NAME(3,I),XMAP(I),YMAP(I),XMAP(IMV),
     1YMAP(IMV),ICODE(I),SYM(J)
25    FORMAT(12X,2A10,A1,* MOVED DURING THE YEAR FROM ITS OLD LOCATION
     1AT*,/,15X,I5,*,*,I5,* TO A NEW LOCATION AT*,I5,*,*,I5,*.*,/,
     215X,* ITS S.I.C. CODE IS *,I5,* AND IS REPRESENTED BY SYMBOL*,
     3I2,*.*,/)
      GO TO 40
26    CONTINUE
      NEXIST(J)=NEXIST(J)+1
      M=M+1
      XARA(M)=XMAP(I)*SCAL  $  YARA(M)=YMAP(I)*SCAL
      MM(M,J)=I
40    CONTINUE
      XARA(M+1)=0.  $  XARA(M+2)=2000.
      YARA(M+1)=0.  $  YARA(M+2)=2000.
      CALL LINE(XARA(1),YARA(1),M,1,-1,SYM(J))
41    CONTINUE
      CALL PLT(.5,.5,999)
      CALL ENDPLT
      PRINT 27,II,NSTART,NCLOSE,NMOVE
27    FORMAT(////,12X,*DURING THE YEAR 19*,I2,*:*,//,20X,I2,*  ACTIVITI
     1S STARTED,*,//,20X,I2,*  ACTIVITIES CLOSED,*,//,20X,I2,* ACTIVITI
     2S MOVED TO NEW LOCATIONS.*,///)
      DO 28 J=1,NSYBOL
      PRINT 29,NEXIST(J),SYM(J)
29    FORMAT(15X,I2,*  ACTIVITIES CORRESPONDING TO SYMBOL *,I2,* APPEAF
     1THIS YEAR.*,//)
28    CONTINUE
10    CONTINUE
100   FORMAT(I5)
102   FORMAT(3I4,2A10,1A1,2I3,21X,I3)
104   FORMAT(I5)
106   FORMAT(I5,I5, 14I5)
108   FORMAT(I5)
110   FORMAT(2I2)
      STOP
      END
```

```
      SUBROUTINE ROADPLT(NUMRDS,II,SCAZ,SCAL)
      COMMON/BLKR/RDX1(20),RDY1(20),RDX2(20),RDY2(20),COUNT(20,21)
      DIMENSION XX(50),YY(50)
      DO 1 I=1,NUMRDS
10    TLENGTH=SQRT((RDX1(I)-RDX2(I))**2+(RDY1(I)-RDY2(I))**2)
      J=II-49
      IF(COUNT(I,J).EQ.0.)GO TO 3
      CN=COUNT(I,J)*TLENGTH*SCAZ
      XLENGTH=RDX1(I)-RDX2(I)
      YLENGTH=RDY1(I)-RDY2(I)
      CN=CN+1
      GO TO 4
4     N=CN
      DELTX=XLENGTH/N
      DELTY=YLENGTH/N
      N=N+1
      DO 2 L=1,N
      XX(L)=(RDX2(I)+(L-1)*DELTX)*SCAL
    2 YY(L)=(RDY2(I)+(L-1)*DELTY)*SCAL
      XX(N+1)=0.
      YY(N+1)=0.
      XX(N+2)=2000.
      YY(N+2)=2000.
      CALL LINE(XX,YY,N,1,+1,0)
3     CONTINUE
1      CONTINUE
      RETURN
      END
```

```
      SUBROUTINE ROADSIN(NUMRDS)
      COMMON/BLKR/RDX1(20),RDY1(20),RDX2(20),RDY2(20),COUNT(20,21)
      READ 101,NUMRDS
  101 FORMAT(I5)
      READ 102,(RDX1(I),RDY1(I),RDX2(I),RDY2(I),(COUNT(I,J),J=1,21),
     1                                                  I=1,NUMRDS)
  102 FORMAT(5X,4F3.0,21F3.1)
      DO 1 I=2,NUMRDS
      DO 1 J=1,21
      IF(COUNT(I,J).EQ.0.) COUNT(I,J)=COUNT(I-1,J)
    1 CONTINUE
      RETURN
      END
```

APPENDIX C

ORGANIZING THE DATA DECK FOR RUNNING MAPRINT

The data deck is divided into three parts.

Part 1: Output Control Cards: years of investigation, codes to be analyzed and symbols to be used in output.

Part 2: Town Data: SIC code; X, Y; name; years started, moved and/or closed for each activity.

Part 3: Road Data: name of road, X's and Y's, ADT from 1950 - 1970.

Part 1: Output Control Cards.

Card no. 1: TOWNAM and TOWNCOD

Town Name (TOWNAM) is used in the output.

Town Code (TOWNCOD) is not utilized at present.

Card no. 2: IYEARI, IYEAR2

IYEARI is the first year to be looked at.

IYEAR2 is the last year to be looked at.

MAPRINT will look at the range of years from IYEARI to IYEAR2.

Card no. 3: NSYBOL

NSYBOL is the number of system symbols to appear in the output.

Subsequent Output Control Cards: These are cards read in during a do-loop which is controlled by the variable NSYBOL (output control card no. 3). If NSYBOL = 1, three cards follow; if NSYBOL = 5, 15 cards follow. Cards 4...n describe the specific SIC codes in which the researcher is interested and the way they are to be represented. For each graphic symbol that will appear in the output three separate cards are required. The information on any card whose rank order in the output card portion is equal to 3(I) +1(from I=1 to I=NSYBOL) is the equivalent of the description of card number 4. Those which equal 3(I) + 2 correspond to card number 5, and those which equal 3(I) + 3 correspond to card number 6. Thus card number n, the last card in the output control card portion is equal, in rank order, to 3 X NSYBOL + 3.

Card no. 4: KCODE

KCODE is the number of SIC codes which will appear on the next card.

Card no. 5: SYM (I), KKK, NCODE (1 through KCODE)

SYM is the call number for the system symbol used to represent the SIC codes under study.

KKK is a dummy.

KCODE (1 through KCODE) are SIC codes to be looked at, which will be represented by system symbol SYM (I).

Card no. 6. IBETW(I)

IBETW(I) determines whether a series of specific SIC codes (e.g., 5812 and 5850 and 6324) or a range (e.g., 5812 through 6324) is to be represented.

The following chart diagrams the format for the output cards.

DATA CARD FORMAT: OUTPUT CONTROL CARDS

	Variable Name	Variable Format	Spaces
Card no. 1	TOWNAME	A10	1-10
	TOWNCOD	I3	11-13
Card no. 2	IYEARI	I2	1-2
	IYEAR2	I2	3-4
Card no. 3	NSYBOL	I5	1-5
Card no. 4	KCODE	I5	1-5
Card no. 5	SYM (I)	I5	1-5
	KKK	I5	6-10
	NCODE(I)	I5	11-15
	⋮		
	NCODE (KCODE)		
Card no. 6	IBETW(I)	I5	1-5

Part 2: Town Data. Town data is entered on a series of individual cards. The computer reads the information into seven arrays, ICODE, XMAP, YMAP, NAME, START, MOVE, and DIED.

ICODE is the SIC code for the activity.

XMAP and YMAP are the "X" and "Y" coordinates.

NAME is the listing in the phone book.

START is the year it first appeared.

MOVE is the year it changed location.

DIED is the last year it appeared in the phone book.

There are only two major points to remember when setting up the town data deck.

First: if an activity moves, MAPRINT assumes that the new location is listed on the next card. Thus it is extremely important that the new location card for any moving activity follows immediately the old location card.

Second: a card with 9999 as the value for ICODE (there is no activity with SIC code 9999) is used to terminate the town data reading do-loop. This card separates the town data part from the road data part.

DATA CARD FORMAT: TOWN DATA

All cards

Variable Name	Variable Form	Spaces
ICODE	I4	1-4
XMAP	I4	5-8
YMAP	I4	9-12
NAME	2A10,A1	13-33
START	I3	34-36
MOVE	I3	37-39
DIED	I3	61-63

Part 3: Road Data. Road data is read in using the subroutine ROADSIN.

Card no. 1: NUMRDS

NUMRDS is the number of seqments of road for which data is available.

All subsequent cards are read in a do-loop controlled by NUMRDS and are the equivalent of card no. 2.

Card no. 2: RDXI(I), RDYI(I), RDX2(I),RDYZ(I),COUNT (I,J(J=1,21))

RDXI(I), RDY1(I) are the "X" and "Y" coordinates of one end of a segment of road.

RDX2(I), RDYZ(I) are the "X" and "Y" coordinates of the other end of the same segment.

COUNT (I,J(J=1,21)) is the yearly average daily traffic on that segment of road. In the study we used data from 1950 to 1970, twenty one years in all, which accounts for the twenty one COUNT's for each road segment.

DATA CARD FORMAT: ROAD DATA

	Variable Name	Variable Format	Spaces
Card no. 1	NUMRDS	I5	1-5
Card no. 2	RDX1(I)	F3.0	6-8
	RDY1	F3.0	9-11
	RDX2	F3.0	12-14
	RDYZ	F3.0	15-17
	COUNT(I,J,(J1,21))	21F3.1	18-20 ⋮ 68-80

SYSTEM 2000 - DATA MANAGEMENT FOR TRANSPORTATION IMPACT STUDIES

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SYSTEM 2000 - DATA MANAGEMENT FOR TRANSPORTATION IMPACT STUDIES

INTRODUCTION

During the first year of work conducted by the Council for Advanced Transportation Studies (CATS) on Topic II, "The Environmental Impact of Interurban Transportation Systems on Rural Communities," it became apparent that large quantities of data would be collected. Part of the research required measuring and evaluating the transportation impact on an entire community, Sealy, Texas, for a 20-year period, from 1950 to 1970. The major task was to create descriptive models of changes during that period within the community and the transportation system, a task which has involved collecting and managing an extensive data base. Specifically, two large data sets were compiled. The first contained economic data, the second, an inventory of land sales compiled from title policies written for individual sales. This latter set contains over 20,000 pieces of data, including information covering 600 sales of parcels with 35 variables for each.

The first problems encountered entailed the storing and updating of these large data sets and the manipulation of the completed data sets at a reasonable cost in manpower and computer time. The information had to be accessible for multiple regression analysis and various other statistical analyses. A system was needed that was simple enough that persons with little experience could use the system and acquire results with a minimum outlay of effort. Thus the system had to be convenient and yet remain flexible enough to meet the requirements of different kinds of data.

STUDY ENVIRONMENT

The Computation Center at The University of Texas at Austin campus provides computing services for both students and researchers. The Computation Center is equipped with a Control Data Corporation (CDC) Model 6600 computer system, which was purchased and installed in 1966, and a CDC model 6400 computer, which was purchased and installed in 1971.[1] The system (UT2D) is one of the most extensive academic computing systems in the United States. UT2D runs 24 hours a day, 7 days a week. High-speed card readers and paper printers are situated at 16 strategic locations on campus, three of which are in the engineering building complex. A timesharing system is provided through the Bell telephone system, allowing 128 users simultaneous connection to the central computer via keyboard terminals, teletypewriters, or similar apparatus. At the keyboard terminal, the user can write programs and run them in a conversational or interactive mode. The UT2D system includes permanent files which allow the user to reference data, programs, and binary decks without reconstructing a file each time he references it in successive jobs.

Not only does UT Austin have execptional computer hardware, but it has an equally exceptional set of software programs easily accessible, including SPSS (Statistical Package for the Social Sciences); AID (Automatic Interaction Detection), an interactive, one-way AOV routine; and STEP01, a stepwise multiple regression analysis package. Most file editing is handled by EDIT, an interactive program for use from remote terminals. SYSTEM 2000 (S2K), which is the system ultimately chosen for this study, is the on-line, in-house data management system marketed by MRI Systems Corporation. Also available is OMNITAB, an interpretive computing system developed and maintained by the National Bureau of Standards.

IMPACT RESEARCH AND INDICATORS

Transportation impact studies are undertaken to measure the environmental effects caused by changes in transportation systems. Impact studies have evolved through various forms to their present state. The earliest and simplest form of impact study is the before-and-after study. Measurements of economic activity, land value, land use, etc., are taken, usually covering a period of 2 to 5 years before the project construction begins. Then another set of measures is taken 2 to 5 years after the project's completion and the two periods are compared. The difference is attributed to the transportation change.

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[1]University of Texas Computation Center. "User's Manual," Computation Center, The University of Texas at Austin, September 1972.

The major problem with this technique is that the total difference is probably not attributable to the change in transportation alone. For example, a factory in town may have closed for reasons unrelated to the transportation system. The backwash of this event would affect the whole community.

To separate the highway impact and nonhighway impact effects on a community, a survey-control area study method was developed. In this method, an area, designated the survey area, is chosen such that all of the area affected by the transportation change can be monitored. Then, a control area is designated outside of the area where the change in transportation took place. The control area's physical, social, and economic characteristics in the period before must be as simliar as possible to those of the survey area. The difference in the survey area minus the difference in the control area is considered the effect of the transportation change. The problem with this method is that an adequate "control" area is almost impossible to find.

Another approach, the case study method, may employ the above techniques or other modes of analysis applied to a single set of indicators, such as the change in number of employees and business volume, etc., in a manufacturing concern. However, again it is difficult to isolate the influence of the change in transportation facilities. For example, the local, regional, and even national economies, as well as the policy decisions of an industry's executives, can have an effect on employment.

There are other forms of highway impact research, usually involving projected trends which are then compared with the actual situation after the change. These depend upon strongly subjective assumptions.

One tool used in several of these impact study techniques is that of multiple regression analysis. The data must be in quantitative form in order to be processed through a computer analysis to derive a best-fit equation. This tool enables the researcher to perceive the relative magnitude of various indicators in relation to other indicators. Multiple regression analysis is especially helpful in modeling the complex situations which impacts usually create.

The methodology chosen was to study a single community, Sealy, Texas, continuously over a long term period. An attempt was made to assess all forms of impact, both direct and indireot. The broad areas included both economic and social pattern changes. The bias which is apparent in most impact research is eliminated in this study due to the longitudinal time base involved and the detail of the analysis.

Aside from methodology, problems have arisen because the available data sources are different in every location where an impact study has been undertaken. Therefore, in this project, an attempt was made to use data sources which would be readily available in most areas. In the detailed investigation of Sealy, Texas, the following indicators have been studied:

(1) number of businesses opening, number of businesses closing (by category),

(2) changes in bank deposits (by category),

(3) changes in employment,

(4) land use and value changes,

(5) changes in travel patterns,

(6) community social structure change, and

(7) cognitive perception of transportation change.

Data management problems were encountered primarily in connection with the first four indicators. Changes in the community social structure were to be studied qualitatively. Data on travel patterns and on people's perception of change were to be used in developing a cognitive model which required special arraying of data, but posed no data management problems. The first four indicators were all easily quantifiable, but the study required that large data sets be created which could be frequently updated and could be output in a variety of forms.

ALTERNATIVES

An effective and efficient system had to be found to handle the data sets which the study required. The only three alternatives found that came near meeting the project's needs were a manual card file system, SYSTEM 2000, or the development of other computer programs.

A manual card file system would entail large amounts of bookkeeping. The information would be kept in ledger books, and when a data set might be needed, the appropriate pieces of data would have to be transferred to code sheets and from these punched onto data cards. Only then could the completed deck be analyzed with a statistical package or could other operations with the data be performed.

The second alternative, the use of SYSTEM 2000 (S2K), would involve an initial loading of all data into the system, but then any data modifications could be made with S2K's wide range of update capabilities. The completed file set that S2K would create would be stored on permanent files so that after loading there would be no need for punching cards. Output format could be greatly varied.

The third alternative for data management would require the project to write its own program on the UT2D system. This program would be set up to handle the data and to give output in a variety of forms. Again all data would be on card image records on a permanent file in the UT2D system.

CHOICE

All three proposals were studied. The manual system was soon rejected. The project lacked the personnel to carry out all of the necessary bookkeeping. At the same time, this system would create greater chance of error because of overlooked or miscopied data. The final reason for rejecting the manual system was that, given the available computer capabilities, we could save time and manpower by choosing one of the other alternatives.

A project-developed program had its advantages in that it would take less time to get results than the manual system; such a program could handle large data sets, output could be varied, and EDIT could be used for data update. However, this approach would have its own disadvantages. Time is needed to write and debug such a program, time which the project did not have. A second disadvantage was that whenever the data specifications changed, the program would need to be rewritten and debugged.

SYSTEM 2000 (S2K) was chosen. It is on-line in-house and can be accessed either by punched card input or remote terminal input. S2K is quick and powerful. The maximum data size is limited only by the available file storage size. The decision was made that all data management work for the study would be handled by S2K in a remote terminal mode. This would provide convenience, since the data base could be called up and data extracted, edited, analyzed, and transferred to a hardprinter, all from a remote terminal. All of this could be accomplished in less than an hour. The system thus would allow near instant turnaround from idea to output.

In addition to convenience, S2K offers versatility and ease of access. S2K data bases consist of three separate but highly integrated parts: the definition, the logical entries, and the two sets of pointers. One set of pointers describes the interrelationships of the data values, and the other, the inverted index, indicates locations of data values. The reason for S2K's economic feasibility is that the major part of data base qualification takes place within these two sets of pointers before any data values are accessed. Time is not required for a search of each piece of data. Since S2K uses pointer-directed, data set-qualification techniques, complex access criteria can be stated and processed very quickly.

The data base is defined using S2K's "Define Module." The user names the elements of the data base in language appropriate for the application and defines each element's relationship to that of other elements. Different types of data may be stored in an S2K-maintained data base. Name data are any alpha-numeric data with all extraneous blanks edited out. Text data are data with all blanks retained. The last four data types are self-explanatory: Integer, Decimal, Date and Money.

Loading values into the data base is a simple process. After a data structure has been defined, the values are laid out in a value string, with element numbers associated with each value. No special coding is required, nor is it necessary to perform a preliminary sorting of the data before loading. S2K scores the data, performs error checking, and creates the data and tree structure tables. Data manipulation may begin immediately.

The permanent file system of UT2D was used to complement SYSTEM 2000. Magnetic tape permanent files were brought on line to retrieve the stored data base or to save a new data base. Punching of data cards was therefore unnecessary, saving the cost of cards and punchers. These permanent files were also used in other areas of the project for storage of programs and data.

CONSTRUCTING AND EDITING OF THE DATA BASE

ECON was the first data set created. It was built for a sub-topic of the project's research.

This study has a three-fold purpose:

(1) identify the available sources of economic data in small communities,

(2) determine whether the initial set of available data is suitable for the study of transportation impact, and

(3) develop an appropriate methodology for modeling of economic impact in rural areas.

S2K's flexibility was highly valuable for handling such a broad study. A data base definition was used which would allow the storage of many types of data. The name of each economic activity in Sealy was stored along with a corresponding unique number. All appropriate Standard Industrial Classification codes were input for each business. Coordinates for each business location and years of operation were added. Employee and monetary data for each year were stored. The monetary data might be sales, assessed tax valuation, or other relevant information. The data base definition is shown in Figure A, p. 8.

The features of the data base definition in S2K allow for efficient use of storage. The KEY/NON-KEY designation allows the user to determine how one data element will be related to other data elements. The NON-KEY designation is used with elements which will not be specified as access criteria. Since these elements will not have inverted files created for them, storage space is reduced. The other feature which saves on storage is the use of repeating groups (RG's). Repeating groups allow for multiple occurrences of data set information. A repeating group acts like an inverted tree where all lower levels are accessible from all upper levels. There may be any number of branches to the tree, and where no branches are needed, none are created. For example, an element in a data base might be "Names of Children"; one man has five children, three men have one child each, and eight ment have no children. In most programs, the definition would have to account for the case of the largest number of children. For the 12 men, 60 spaces would be made available, though only 8 would be used. The repeating group designation eliminates wasted storage because spaces are not set aside unless data are input. Repeating groups are most helpful when there is great variability in the amount of data to be stored for each data point.

A data set had been built for use in MAPRINT.[2] Business name, location, and years of operation for each business had been taken from the past telephone books of Sealy. These data, using EDIT, were written into a format appropriate

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[2]Graham C. Hunter, Richard Dodge, and C. Michael Walton, "MAPRINT: Computer Program for Analyzing Changing Locations of Non-Residential Activities." Research Memo 11, Council for Advanced Transportation Studies, University of Texas at Austin, March 1974.

Figure A

ECON DATA BASE DEFINITION

1 * UNIQUE NUMBER

2 * NAME (NK)

3 * PRODUCT OR ACTIVITY CODE (RG):

  31 * PRIMARY SIC

  32 * OTHER SIC

4 * ORGANIZATION TYPE

5 * YEARS OF OPERATION (RG):

  51 * BEGINNING YEAR

  52 * LAST YEAR

6 * LOCATION DATA (RG):

  61 * LAST ADDRESS (NK)

  62 * X-COORDINATE

  63 * Y-COORDINATE

  64 * NUMBER OF LOCATIONS SINCE 1950

  65 * PREVIOUS LOCATIONS (RG IN 6):

    650 * YEAR BEGIN FIRST LOCATION

    651 * FIRST X-COORDINATE

    652 * FIRST Y-COORDINATE

7 * EMPLOYMENT DATA (RG):

  75 * NUMBER OF EMPLOYEES IN YEAR

8 * SALES DATA (RG):

  85 * SALES AMOUNT IN YEAR

for building of the ECON data base. After ECON was created it was found that a new coordinate system was needed due to the inadequacies of the MAPRINT system. The MAPRINT coordinate system covered only the areas within the city, yet some businesses and transactions were outside the city limits. The necessary adjustments were in the form

$$X_{new} = C_1 X_{old} + C_2$$

$$Y_{new} = C_3 Y_{old} + C_4$$

The constants (C_1, C_2, C_3, C_4) were found by choosing points under the old system and finding the points in the new system. An algebraic equation was solved finding the constants. All of the X coordinates were changed using the command

CHANGE C62 = (C_1) * C62 + (C_2) WHERE C62 EXISTS:

Y coordinates were similarly changed using C63 rather than C62.

Employment information was available from primary sources. As each piece of employment data was collected, it was added to the data base. Over 600 update operations were carried out on ECON with no trouble.

Output from S2K for ECON is in two forms. Employment data is output in lists of business activities by unique number and number of employees. These lists contain each year's data, further broken down by the activity of the business as defined by the SIC code at the second digit level. For the study of the spatial distribution of the business activity, the businesses are mapped using lists of coordinates from S2K. These lists are input into MAPRINT and the information plotted for study.

LANDSALE

LANDSALE data base was used for the study "Land Value Modeling in Rural Communities," by Lidvard Skorpa, Michael Walton, and Richard Dodge. The ultimate goal of this study was to evaluate a descriptive model for land values in a given community with specific characteristics and served by a specific transportation system. The land value model from this case study can possibly be refined and expanded to a general descriptive model. The descriptive model in this case study phase was given the form of a function. The dependent variable was the land sale price, and the independent variables were the different community and transportation related factors which might influence land value: use, location, access, and so on. Data for ten different variables were collected for each of over 600 land sales in Sealy in the period from 1950 to 1970. These included

(1) parcel sale date,
(2) size of the parcel,
(3) improved or unimproved parcel,
(4) parcel land use before the sale,
(5) parcel land use after the sale,
(6) site quality,
(7) CBD accessibility,
(8) bus and train accessibility
(9) highway accessibility, and
(10) neighborhood quality.

Four more variables were created and stored using combinations of the above. Variables dependent on time, including population, transportation system quality, connectivity to highway, and traffic volumes, were input by half years. (Transgenerated variables were formed by combining the original variables.) The original data base was created before the problem had been completely defined. Since these new variables did not have a storage slot, a new definition was written taking into account all anticipated data needs. The data were unloaded from the original definition using the UNLOAD command and immediately reloaded into another data base definition which better matched the necessary qualifications.

The output from LANDSALE was in the form of list output. Data for a particular transaction were placed in a card image upon a file which was then stored. The files were later transferred to the local file for statistical analysis by STEP01 and AID. The major advantage of this system was that the data file could be created using any set of qualifications. Files were created based on whether the lot was improved or unimproved at the time of the sale. Descriptive models were then created for each data set. Later data files were created using "Land Use Before" as the qualifying variable. Using the X and Y coordinates as qualifiers, specific geographical regions could be isolated and analyzed. These data files were also used in our locational analysis by serving as input for mapping.

S2K USE[3,4]

All of the data management for CATS Topic II using SYSTEM 2000 (S2K) was accomplished in an interactive mode from remote terminals. Use of the constructed data base is very simple. Only 3 control cards are needed to access the data base. For a data base Z stored on permanent file 1234 under the file name Y the following control cards are needed:

READPF, 1234, Y

S2KRS, DR, Y

S2K, CMR = TTY, D = TTY

The user is now S2K. All commands in S2K are followed by a colon (:). If S2K accepts the line input, it will answer by 3 dashes (_ _ _). If data base Z has a password of X, then data base Z can be brought up with the commands

U S E R, X:

DATA BASE NAME IS Z:

If the Data Base is brought up, S2K will return with "ASSIGNED Z" followed by the definition version number, data version number, date created, and time created. Following this, work with S2K on Z may be accomplished. To leave S2K requires only the command, "EXIT:".

To get a listing of the data base definition requires the command, "DESCRIBE:". An example of this is the definition of the data base named LANDSALE in Figure B, p. 12.

A complex data management system is of little utility without adequate output capabilities. There are three basic output commands in S2K, PRINT, LIST, and TALLY. The first two are general output commands. TALLY provides a means of obtaining statistical information about the unique values of elements stored in the data base. A TALLY for C7, ZONE, is shown in Figure C, p. 13. The purpose of the PRINT command is to retrieve data from the data base as specified in the "WHERE" clause and to output the data in a simple sequential list.

---

[3]MRI Corporation, "SYSTEM 2000, Reference Manual," MRI Corporation, Austin, Texas, 1973.

[4]UT Computation Center, "A Supplemental Guide to SYSTEM 2000 at UT Austin," TPB 143 UT Computation Center, Austin, Texas, July 1973.

```
 ---
DESCRIBE
 ---
:
  SYSTEM RELEASE NUMBER        2.22B8
  DATA BASE NAME IS SEALYSALE
  DEFINITION NUMBER        1
  DATA BASE CYCLE        99
     1*   TIMEONE (INTEGER NUMBER 999)
     2*   TIMETWO (INTEGER NUMBER 999)
     3*   UNIQUE NUMBER (INTEGER NUMBER 999)
     4*   X-COORDINATE (INTEGER NUMBER 9999)
     5*   Y-COORDINATE (INTEGER NUMBER 9999)
     6*   FRONT STREET (NAME X(122))
     7*   ZONE (INTEGER NUMBER 9)
     8*   UNIT MARKET VALUE (INTEGER NUMBER 9(6))
     9*   TIME (DECIMAL NUMBER 99.9)
    10*   SIZE (DECIMAL NUMBER 999.99)
    11*   IMPROVEMENT (INTEGER NUMBER 9)
    12*   PREVIOUS LAND USE (INTEGER NUMBER 9)
    13*   POST SALE LAND (INTEGER NUMBER 9)
    14*   SITE QUALITY (INTEGER NUMBER 9)
    15*   DISTANCE TO CBD (DECIMAL NUMBER 99.99)
    16*   STREET ADJUSTMENT FACTOR (NON-KEY DECIMAL NUMBER 9.9)
    17*   BUS DEPOT DISTANCE (NON-KEY DECIMAL NUMBER 99.99)
    18*   RAILWAY STATION DISTANCE (NON-KEY DECIMAL NUMBER 99.99)
    19*   CBD ACCESS (DECIMAL NUMBER 99.99)
    20*   PT ACCESS (DECIMAL NUMBER 99.99)
    21*   DIST TO HWY (DECIMAL NUMBER 99.99)
    22*   INTERCHANGE TYPE (NON-KEY INTEGER NUMBER 9)
    23*   PARCEL LOCATION FACTOR (INTEGER NUMBER 9)
    24*   HIGHWAY ACCESS (DECIMAL NUMBER 99.99)
    25*   ONEDUM (NON-KEY DECIMAL NUMBER 99.99)
    26*   NEIGHBORHOOD QUALITY (DECIMAL NUMBER 99.99)
    27*   TIMETHREE (DECIMAL NUMBER 99.9)
    28*   TIMEFOUR (DECIMAL NUMBER 99.9)
    29*   QUALITY OF INTERURBAN HWY (NON-KEY INTEGER NUMBER 9999)
    30*   USE OF INTERURBAN HWY (NON-KEY INTEGER NUMBER 9(5))
    31*   RAIL SERVICE (NON-KEY INTEGER NUMBER 99)
    32*   LOCAL TRAFFIC COND (NON-KEY INTEGER NUMBER 99)
    33*   CONNECTION TO HWY (NON-KEY INTEGER NUMBER 99)
    34*   SMSA CONNECTION (NON-KEY INTEGER NUMBER 99)
    35*   POPULATION GROWTH RATE (NON-KEY INTEGER NUMBER 999)
    36*   TWODUM (NON-KEY DECIMAL NUMBER 99.9)
    37*   THREEDUM (NON-KEY DECIMAL NUMBER 99.9)
 ---
```

Figure B

LANDSALE "DESCRIBE" COMMAND

```
************************
 ELEMENT-       ZONE
************************
FREQUENCY    VALUE
------------------------
       78        1
      148        2
       50        3
       49        4
      113        5
       76        6
       57        7
       40        8
------------------------
        8   UNIQUE VALUES
------------------------
      611   OCCURRENCES
------------------------
---
```

Figure C

TALLY FOR C7 ZONE

The general format for a print statement is

PRINT (print clause) (ordering clause) WHERE (conditions exist),

(print clause) - what is to be printed,

(ordering clause) - order to be printed,

(conditions clause) - qualifications for data to be printed.

An example is shown in Figure D, p. 15. The purpose of the LIST command is to provide the user with a means of displaying output data in a columnar format with optional page headings and footings. The majority of the project's output was printed using this command.

The general format for the LIST command is

LIST/TITLE (title specifications) / (ordering clause) WHERE (conditions exist)

(list clause) - what is to be output,

(ordering clause) - the order of the data to be output,

(conditions exist) - qualifications to be met to be output.

Headings and column titles are inserted using the title specifications of the list format. Arithmetic statistics about the data values contained in the data base are obtainable from the system functions. Capabilities include minimums, maximums, sums, averages, and standard deviations.

All output commands are tempered by the qualification clause, the WHERE statement. The WHERE statement follows the format

WHERE (conditions exist):,

(conditions exist) any number of legal WHERE clause conditions

Legal conditions may be of four types

(1) unary operator

(2) binary operator

(3) ternary operator

(4) normalized

Combinations of these statements are made using the Boolean Operators AND, OR, NOT. Complex qualifications are avilable through judicious use of the WHERE clause.

Update in S2K may be performed from the remote terminal. The update commands are few in number, unique in purpose, and contain great power. The

```
PRINT C3,C7,C8,C9,DB C3 WHERE C3 LT 10:
 UNIQUE NUMBER•    1
 ZONE• 3
 UNIT MARKET VALUE•  31297
 TIME• 55.0
 UNIQUE NUMBER•    2
 ZONE• 1
 UNIT MARKET VALUE•   4323
 TIME• 56.5
 UNIQUE NUMBER•    3
 ZONE• 1
 UNIT MARKET VALUE•  24949
 TIME• 56.5
 UNIQUE NUMBER•    4
 ZONE• 2
 UNIT MARKET VALUE•  12107
 TIME• 59.0
 UNIQUE NUMBER•    5
 ZONE• 2
 UNIT MARKET VALUE•  10495
 TIME• 60.0
 UNIQUE NUMBER•    6
 ZONE• 3
 UNIT MARKET VALUE•  28956
 TIME• 60.5
 UNIQUE NUMBER•    7
 ZONE• 3
 UNIT MARKET VALUE•  37657
 TIME• 60.5
 UNIQUE NUMBER•    8
 ZONE• 3
 UNIT MARKET VALUE•  68467
 TIME• 60.5
 UNIQUE NUMBER•    9
 ZONE• 1
 UNIT MARKET VALUE•  10728
 TIME• 60.5
 ---
LIST/TITLE R10__(1),R(1),R(6),R(5)/ C3,C7,C8,C9,DB C3 WHERE C3 LT 10:

•••
   1   3    31297     55.0
   2   1     4323     56.5
   3   1    24949     56.5
   4   2    12107     59.0
   5   2    10495     60.0
   6   3    28956     60.5
   7   3    37657     60.5
   8   3    68467     60.5
   9   1    10728     60.5
 ---
LIST/TITLE NO,ZONE, PRICE ,TIME / C3,C7,C8,C9,DB C3 WHERE C3 LT 10:
   NO    ZONE    PRICE    TIME
•••
     1       3    31297   55.0
     2       1     4323   56.5
     3       1    24949   56.5
     4       2    12107   59.0
     5       2    10495   60.0
     6       3    28956   60.5
     7       3    37657   60.5
     8       3    68467   60.5
     9       1    10728   60.5
```

Figure D

EXAMPLES OF LIST AND PRINT OUTPUT

commands may be used for adding, modifying, or removing data in the data base. The ADD command adds data within existing data sets where no data sets currently exist. The CHANGE command changes data within existing data sets where data exists. To remove data takes the REMOVE command. The ASSIGN command assigns new data values whether data previously existed or not.

CONCLUSIONS

SYSTEM 2000 has been very beneficial in the accomplishment of topic tasks. It has been quick and easy to use yet thorough in its work. The interfacing of S2K with other programs was handled quickly and easily. Above all other features the flexibility of output has allowed project personnel to handle a wide assortment of data for its maximum usefulness.

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APPENDIX III
Exhibit 1

EVALUATION FORM

Name________________________________ Date____________________

Position____

Please provide the information requested below by checking (x) the appropriate item or by filling in the blank.

1. Number of years in your present position.

   1-2 years_____ 2-5 years_____ 5-10 years_____ 10 or more_____

2. Education Level Attained

   Please Specify: ______________________

3. Major area(s) of study ____

   ____

   ____

Please evaluate each of the elements of the manual indicated below by checking the appropriate number and by written commentary.

1. Did the Executive Summary give an adequate overview of the contents of the whole manual?

   value
   3 very adequate _____
   2 adequate _____
   1 inadequate _____

2. What changes would you suggest for the executive summary?

   Comment:____

   ____

   ____

VOLUME II, CHAPTER I: THE TRANSPORTATION PLANNING PROCESS

1. Did the manual add to your knowledge of the actors (agencies and organizations) involved in the national and regional planning process? (Sections 1.1-1.8)

value
3 very much ____
2 some ____
1 very little ____

Comment: ____________________

____

____

2. Did the manual add to your knowledge of the steps in the transportation planning process? (Sections 1.9-1.20)

value
3 very much ____
2 some ____
1 very little ____

Comment: ____________________

____

____

3. Was the evaluation form at the end of the chapter useful to you in assessing the status of the regional planning activity for your city and area?

value
3 very useful ____
2 useful ____
1 of little use ____

Comment: ____________________

____

____

4. What changes would you recommend in this chapter?

____

____

____

____

VOLUME II, CHAPTER II: TRANSPORTATION IMPACT

1. Did the chapter clarify your knowledge of the nature of transportation impact? (Sections 2.2-2.15)

   value
   3 very much ____
   2 somewhat ____
   1 very little ____

   Comment: ____________________

2. Did the material add to your understanding of the indirect effects which transportation changes might have on your community? (Sections 2.16 - 2.23)

   value
   3 very much ____
   2 somewhat ____
   1 very little ____

   Comments: ____________________

3. Did you find the section on Environmental Impact Statements (Appendix A) useful as a guide for evaluation?

   value
   3 very useful ____
   2 useful ____
   1 of little use ____

   Comment: ____________________

4. What changes would you recommend for this chapter?

   ____

VOLUME II, CHAPTER III: GOALS AND OBJECTIVES

1. Did the chapter provide an adequate discussion of the nature of goals and objectives? (Sections 3.1 - 3.4)

value

3 very adequate ______
2 adequate ______
1 inadequate ______

Comment: ____

____

____

2. Would the process of formulating goals (described in Sections 3.5 to 3.10) be helpful in your community's planning activity?

value

3 very helpful ______
2 helpful ______
1 of little help ______

Comment: ____

____

____

3. Would the section on formulating objectives (Section 3.11) be useful in your planning activity?

value

3 very useful ______
2 useful ______
1 of little use ______

Comment: ____

____

____

4. What changes would you suggest in this chapter?

Comment: ____

____

____

VOLUME II, CHAPTER IV: COMMUNITY INVENTORY

1. Could your community gather the data required for the community inventory described in this chapter?

value

3 very easily ____
2 fairly easily ____
1 with difficulty ____

Comment: ____

____

____

2. Given your experience, if you collected the information as recommended in this chapter, would you have an adequate information base for planning activity in your community?

Comment: ____

____

____

3. Are the worksheets in this chapter helpful?

value
3 very helpful ____
2 helpful ____
1 only somewhat helpful ____

Comment: ____

____

____

4. What changes would you suggest in this chapter?

Comment____

VOLUME II, CHAPTER V: DEVELOPMENT OF ALTERNATIVES AND PRELIMINARY ASSESSMENT

1. Do the steps for developing and making preliminary assessment of alternatives give you a useful framework for making planning decisions?

value
3 very useful _____
2 useful _____
1 of little use _____

Comment:____

2. Did the "scenario" (the description of the hypothetical community's activities) adequately illustrate the procedure described in the chapter.

value
3 very adequately _____
2 adequate _____
1 inadequate _____

3. Could you relate your own community's situation to the one described in the scenario?

value
3 very easily _____
2 reasonably well _____
1 only occassionally _____

Comment:____

4. What changes would you recommend in this chapter?

Comment____

VOLUME II, CHAPTER VI: EVALUATION

1. Would the evaluation procedure be useful to your community in selecting programs and determining priorities?

   value
   3 very useful ______
   2 useful ______
   1 of little use ______

   Comment: ______

2. Would the evaluation procedure be useful to you personally in making decisions related to planning?

   value
   3 very useful ______
   2 useful ______
   1 of little use ______

   Comment: ______

3. What changes would you recommend in this chapter?

   Comment ______

The manual as a whole:

1. Was the style of the manual

   value
   3 very clear ______
   2 usually clear ______
   1 unclear ______

   Comment: ______

2. Was the format of the manual:

value
3 very useful ____
2 useful ____
1 of little use ____

Comment: ______________________________

____

____

3. Did you find the manual relevant to the problems in your community?

value
3 very relevant ____
2 relevant ____
1 irrelevant ____

Comment: ______________________________

____

____

4. To whom would this manual be most useful?

City Manager ____
Planning Advisory Committee Member ____
Planning Commission Member ____
Mayor and City Council ____
City or Regional Planner ____
Interested Citizen ____
Other (specify) ____

5. To which of the above individuals would each of the chapters (listed below) be most useful? Please specify:

Executive Summary
Chapter 1 (Transportation Planning Process) ____________
Chapter 2 (Transportation Impact) ____________
Chapter 3 (Goals and Objectives) ____________
Chapter 4 (Community Inventory) ____________
Chapter 5 (Development of Alternatives) ____________
Chapter 6 (Evaluation) ____________

5. What overall changes would you recommend in the manual?

COMMENT:

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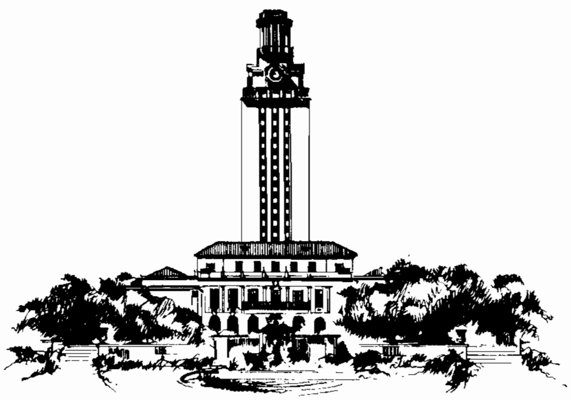

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