Guideway Transit and Intermodalism: Function and Effectiveness: Interim Task 8 Report, Assessment of Guideway Transit System Impacts

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Guideway Transit and Intermodalism: Function and Effectiveness

Draft Interim Task 8 Report

Assessment of Guideway Transit System Impacts

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Preface

Over the past few decades more than a dozen U.S. cities have implemented new guideway public transit systems and virtually every major urban area has or is considering increasing public transportation infrastructure investments, frequently including the consideration of guideway transit investments. The country's dramatic suburbanization and socioeconomic changes have placed new challenges on public transportation. Various guideway investments are among the solutions that local communities have considered meeting the changing transportation needs of their communities. The result has been growing guideway transit ridership and an increase in the importance of guideway in the overall transportation system. Guideway transit investments are perceived as the public transit investment that provides an excellent opportunity to compete with auto travel, influence land use, motivate public and business financial support and address air quality and environmental goals. This report does not advocate guideway solutions or discourage careful consideration of non-guideway transportation investments, but provides a knowledge base to support those involved in guideway planning and implementation.

With the development of numerous systems over the past few years, a great deal of experience and knowledge has been gained about all aspects of using guideway investments to meet transportation and other local goals. Much of this knowledge resides with local planning agency staffs and is of great value to other urban areas if the most relevant information can be captured and communicated to the ever growing and changing group of professionals that are involved in guideway project planning and decisionmaking.

This report is one of several that are being produced as part of a study funded by the Federal Transit Administration on intermodalism and guideway effectiveness. This multi-year effort is being conducted by the Lehman Center for Transportation Research at Florida International University and the Center for Urban Transportation Research at the University of South Florida. The broadly-defined research project, a response to a U.S. congressional authorization, focuses on the examination of factors that influence the effectiveness and efficiency of guideway transit systems and passenger intermodal transportation. The work program is driven by eight primary research tasks, each of which is being addressed through a variety of research methodologies. The overall objective is to assemble existing and new information and interpret and communicate that information in a manner that supports the planning and decisionmaking efforts of public transportation planners. Knowledge gained in this project will provide useful information for the many communities and transportation professionals that are planning or considering guideway transit as a key component in their
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transportation system. In addition, many of the issues and much of the information will have application for all public transportation planning.

The products of this research effort in 1995 include technical reports, case studies, and data books.
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Guideway Transit and Intermodalism: Function and Effectiveness

Foreword

This report is one in a series of eight technical reports being prepared as part of an overall study titled Guideway Transit and Intermodalism: Function and Effectiveness. Each technical report addresses one of the major theme areas of research being investigated in the overall research project. The Center for Urban Transportation Research has the primary responsibility for addressing the four subject areas shown in bold in the task list below. This report is indicated by the pointer.

Task 1 Evaluation of Complementary Policies to Support Intermodal Guideway Investments
Task 2 Evolving Technology Options
Task 3 Preserving Guideway System Competitiveness
Task 4 Integrated Planning and Design of Intermodal Guideway Transit Systems
Task 5 Multimodal Transportation Center Design
Task 6 Determining Organizational and Operating Strategies
Task 7 Application of New Technologies in Developing Intermodal Transit Systems
→ Task 8 Assessment of Guideway Transit System Impacts

These interim task reports are one component in a broadly defined research project that examines factors that influence the success of guideway systems and intermodal transportation. Each task address one or more of the critical considerations. These interim reports are intended to communicate findings regarding the research that has been carried out thus far. These reports are not final reports nor are they the only output documents for the research effort to date. The Interim Task Reports are complemented by a series of case study reports for selected cities with guideway transit systems and with a three-part series of data books that compile information from guideway sites.

The reports are presented in two major sections. The first described the objectives of the task, the research methodology and activities underway and planned. The second section reports the findings to date from research in the given subject area. As work continues the remainder of this year and next year, the full work program will be accomplished and a report prepared that communicates the findings from the research activities.
INTERIM TASK 8 REPORT
Assessment of Guideway Transit System Impacts

SECTION I

Task Objectives

Over the past three decades as numerous U.S. cities have contemplated major investments in guideway transit systems, extensive discussion, research, investigation, debate and speculation has occurred regarding the impact that these systems have had and will have on the urban areas. This concern and interest are appropriate given the magnitude of the investments. Assessments of guideway transit impacts can serve many purposes:

- An integrated part of the planning and implementing process for guideway transit is monitoring how well guideway transit systems are performing relative to their design goals and objectives. Such monitoring may provide the valuable knowledge base that enables us to better understand and ultimately improve the performance of our investments. An important part of monitoring is to assess the impacts of guideway transit.

- Impacts of guideway transit are assessed to provide a check for the accuracy of predicted impacts before construction. As required by the alternatives analysis process, new starts need to be evaluated for their potential impacts in a number of impact areas, including transportation, economic development, land use, social, and environmental impacts. It is known that these predictions can be off substantially from what actually happens. For example, during the sixties and early seventies several guideway systems were planned and implemented partially based on some incorrect information fundamental to attaining hoped for impacts from guideway systems. Guideway planners expected that the availability of gasoline would be very limited and that real fuel costs would be several times their current levels. In numerous other areas, guideway planners misperceived the extent and pace of suburbanization to the pace of growth in female participation in the labor force, to the magnitude of inflation in the seventies.
• Impacts of guideway transit, particularly property values, may be assessed to help justify charges to benefiting properties. Facing resistance to local tax increases, diminishing federal assistance, and increasing demand for guideway transit assistance, local governments have developed a host of innovative financing techniques. One of these is to use charges on benefiting properties (Hoel, 1986). A critical element of this technique is to be able to estimate the impacts of guideway transit on property values. The City of Los Angeles created two benefit assessment districts to finance a portion of the Metro Rail subway project (Wilson, 1986).

• Impacts of guideway transit may be assessed to examine whether a guideway system has lived up to the expectations of a wide range of interests. Guideway transit has been perceived to be able to help cure many of the urban ills in the United States: poverty, congestion, air pollution, equity, deteriorating downtown, etc. These perceptions have made guideway transit a program with extremely wide ideological appeal, able to attract support from such disparate interests as the central city poor, downtown businessmen, environmentalists, construction workers, and others (Altchuler, 1979). Maintaining this appeal often requires not only assessing guideway impacts but also assessing a range of types of impacts.

• Impacts of guideway transit may be assessed to provide an opportunity to determine whether supportive policies are needed. In an era of automobiles, human decisions play a far greater role in the impacts of guideway transit than in the pre-automobile era when natural determinants were the key (Pisarski, 1990). Public policy becomes critical. The forces involved need to be better understood in order to influence impacts of public policies.

Some have argued that the ultimate test of guideway impact is a measure of the willingness of a given or additional urban areas to invest or continue to invest in the systems. From this perspective there appear to be strong evidence suggesting a positive impact. Few cities have publicly abandon projects or proposed slowing or stopping future investments even in cases where cost was higher ridership lower and implementation slower than had been planned for an existing system. In fact, the most common response to disappointments with current investments is a plea for subsequent investments with the hope that the system size will reach some threshold level where it will successfully serve enough of the population to become attractive. The queue of cities seeking federal funds for guideway implementation remains substantial with a strong contingency of the public transit industry and the urban planning community remaining more committed than ever to additional guideway...
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implementation. While this may be the ultimate relevant criteria for determining public
ingress to continue guideway investments, it does not serve any of the purposes
discussed above.

Assessment of guideway transit system impacts, however, faces many difficulties. One of
such difficulty is the tendency to look at all transportation investments and particularly
guideway investments from an increasingly broad perspective. As we have learned more
about the complex nature of the social, political, economic, physical, environmental, and
institutional relationships, we have increasingly broadened the list of goals and range of
considerations that go into making decisions as fundamental as how to best meet our
transportation needs. Accordingly, we have had ever longer goal lists and ever more
complicated sets of criteria with which we evaluate decisions and subsequently actions that
are taken. While this trend has been motivated by a desire to have more informed decision
making, it has resulted in ever greater uncertainty and ever greater difficulty in establishing
a shared perception of the impacts. The uncertainty and difficulty of fully understanding
these complex relationships and in measuring them has resulted in a great deal of
controversy as to the nature and magnitude of the impacts. The nature of the impacts
addressed when guideway impacts are considered have varied significantly from the obvious
transportation impacts on congestion, roadway needs, safety, mode split, etc. to areas as
far ranging as urban area image or stature and social fabric and harmony resulting from the
transit system serving as a mechanism for bringing people out of their steel cocoons
(automobiles) and enabling an environment that supports development of interpersonal and
community relationships. The ability to quantify these impacts and to attribute them directly
or indirectly to a transportation investment varies widely.

Another difficulty in assessing guideway impacts is in assessing the distributional
consequences and secondary impacts of investments. Many of the new goals and
objectives are related to distributional and secondary impacts of guideway transit systems.
For example, the economic impacts of various guideway investments have been debated.
The obvious benefits of attracting discretionary dollars to a region have been enumerated
but uncertainty regarding such factors as multiplier effects are much more controversial.
While measuring the stimulus of discretionary dollars is one thing, the ability to fully evaluate
the economic impacts of flexible funding dollars being invested in guideways versus roadway
expansion or the impact of more transit spending at the expense of higher local sales taxes
to support guideway are more difficult to assess.
Determining an appropriate time frame for measuring impacts is also difficult. Some planners argue that the fundamental significance of a guideway investment on an urban area will or can have impacts that will be influencing development for decades and even centuries into the future. Needless to say, attributing or measuring impacts in these time frames is beyond the scope of anything that has or can practically be carried out. On the other hand, the appropriate time frame varies with the particular type of impacts being assessed. Those impacts that result from changes in relatively short term decisions on individuals and institutions may require a shorter time frame than those that result from changes in relatively long term decisions.

The credibility and validity of evaluations assessing the impacts of guideway transit have been influenced by the objectivity and perceptions of objectivity of the parties involved in the planning and analysis. The public transit industry is, not surprisingly, populated with persons who, by virtue of a combination of personal values and beliefs and professional necessity, are generally strong advocates of public transit and additional investments in infrastructure and services. Accordingly, their perspective in assessing impacts is influenced by their value sets. Alternatively, other actors representing interests as diverse as libertarians who feel that the public has little business in transportation to "no new taxes" advocates to economists who take a strict quantifiable cost/benefit perspective have also been weight in on the issue of the impact of guideway investments. Thus, this variation of perspective and motivation combined with the range of factors influencing impact assessment previously discussed results in a sometimes vigorous debate about the impacts of guideway transit.

Another difficulty in discussing the impacts of various guideway investments relates to addressing the subtleties of determining the inherent impacts of the investment versus those impacts from other factors. One of these factors is the subsequent operation. The performance and ultimately the impact of a guideway operation will be very much affected by the actual operation of the system. Safety, equipment reliability, natural disasters, accidents, service and fare level as impacted by subsidy commitments, accidents, and a host of other possible actions partially or wholly independent of the decision to invest in a guideway system can strongly influence the subsequent impacts.

Another one of those external factors that may influence guideway transit is the complementary policy by local areas. For example, while the evidence suggests that the ability of a guideway project to directly influence land use patterns may be limited, more frequently, the commitment to a guideway investment may motivate complimentary commitments to land use policies, parking policies or decisions to avoid competing roadway
investments. As planners and decision makers begin to fully appreciate the range of considerations and complimentary policies that make guideway investments successful, we are challenged to attribute impacts to the various elements of a comprehensive transportation and urban planning strategy. Increasingly, the commitment to invest in guideway transit has associated with it a commitment to both revenue sources and supportive policies (i.e., the locals may be willing to raise the sales tax for a guideway proposal but not willing to raise it for an HOV investment). Thus, the same investment in different policy contexts could result in substantially different impacts.

Some of these difficulties are more challenging than others. The increasingly broad goals and objectives for guideway transit require sophisticated impact studies covering a wide range of impact types. The difficulty of assessing the distributional and secondary impacts is more an issue of measurement than an issue of assessing the impacts (see the discussion on the four elements of impact studies). In addition, the difficulty of determining an appropriate time frame may be reduced by letting the scope of impact studies depend on how long the guideway system under study has been in existence.

More challenging are those difficulties that may only be reduced through appropriate techniques of impact assessment. The objectivity and perceptions of objectivity of the parties involved in impact assessment may be reduced by using sound techniques. The difficulty of separating the inherent impacts of guideway transit from impacts of external factors may also be reduced through appropriate techniques.

As mentioned earlier, one important use of impact studies is to provide the knowledge base for future planning and operation of guideway transit. This purpose can be fulfilled only if conclusions of impact studies can be generalized to other cases. The extent to which an impact study's conclusions can be generalized is called external validity (Campbell and Stanley, 1966). Typically, previous impact studies tend to lack external validity. This lack of external validity in previous studies largely resulted from their failure to control factors besides guideway transit that may have influenced guideway impacts. The extent of this lack of external validity to a large degree depends on what technique is used in isolating the impacts of guideway transit from those of other factors. Thus, technique selection becomes critical to ensure external validity.

One objective of this task is to identify a set of techniques that can be used to assess guideway impacts. Another objective is to assemble cases of impact studies that use these techniques. The third objective is to review the set of types of impacts that are commonly
covered in impact studies of guideway transit. These sets of techniques, types of impacts, and cases of impact studies, once carefully documented, can become useful tool boxes for transportation planners.

Varying degrees of knowledge and different perspectives on the success of the investments in guideway transit over the past, several decades have resulted in several perspectives. For instance, they range from those who see the inevitable decline in the automobile with guideway transit assuming its rightful place as the cornerstone of urban transportation to those who perceive guideway transit as a nostalgic relic of the pre-auto era whose value is limited to continued operation only in the densest urban areas and as a historic or entertainment artifact adding character to selected urban locations. While all these issues and debates are not likely to be resolved soon, the remainder of this report presents a structured look at the state and extent of impacts assessment that has taken place for guideway transit. The reader will develop a better understanding of what has and can be done to assess impacts and be in a better position to understand the impacts that have been documented.

**Research Methodology**

A variety of impact studies have been conducted in the past three decades. Both the type of impact investigated and the type of technique used vary among these studies. It is believed that there is a common set of impact types and a common set of techniques that can be identified from these studies. Therefore, a major effort of this study has been devoted to identifying whether or not this common sets of impact types and techniques exist and if they do, what they are.

Conceptually, guideway impacts may be defined as an array of interactions between the guideway system and other components of an urban area (Stopher, 1976). An urban area may be seen as a system that consists of a set of subsystems, such as a human subsystem, a transportation subsystem, an economic subsystem, a real estate subsystem, and an environmental subsystem. A guideway system is just one component of this interactive transportation subsystem. Moreover, the guideway transit system interacts with each of the subsystems in various ways. A study of guideway impacts is, therefore, a study of the interactions between the guideway transit system, other subsystems and other components of the transportation subsystem.
There are four basic elements involved in an assessment of guideway transit system impacts. The first element is to determine the type of impact to be assessed. Land use and air quality are two examples of impact types. The second element is to measure the variables under investigation. For example, how is land use to be measured? How is air quality to be measured? How is noise to be measured? The third element is to select the appropriate technique to isolate the impacts of guideway transit from those of factors besides guideway transit. The last element is to apply the selected technique to the chosen type of impact assessment. This report examines all of these elements of impact assessment except that of measurement. Measurement is specific to the type of impacts being assessed. Methodologically, determining the level of air quality is unrelated to determining the pattern of land use in a given area and at a given time. In other words, there is no common set of measurement techniques for different types of impacts.

There are two types of impact assessment: before-construction and after-construction. A before-construction assessment is part of the alternatives analysis process, while an after-construction assessment is part of the monitoring process. These two types of impact assessment differ in two ways. In this study, an impact study is one that assesses after-construction impacts of guideway transit systems. First, a before-construction assessment, estimates what the future condition would be if a guideway system were constructed. An after-construction assessment, estimates what the current condition would be if the system had not been built in years past. Second, impact assessments are often criticized for failing to answer the proper question (Lee, 1981). The conventional question that impact studies try to answer is whether a given investment expenditure in guideway transit generates more benefits than an expenditure of zero dollars. The proper question, however would be whether the given expenditure generates more benefits than another equal expenditure used alternatively. This criticism is valid mainly for before-construction assessments because of the principal focus on net benefits in selecting projects. On the other hand, this criticism does not always apply to after-construction assessments. If the purpose of after-construction assessments is to reassess the net benefits of a system, it applies. Otherwise, it is not revealment.

**Activities Underway**

Activities underway include continued efforts to collect information on assessment techniques and cases of impact studies that use these techniques for various types of impacts. As case studies are completed information about impact assessment in the various study areas is added to the knowledge base on impact assessment.
Activities Planned

Future work in this task area includes expanding the report to include newly collected information on assessment techniques and cases of assessments. We anticipate organizing this collective body of knowledge into chapters of the year 3 research books.

SECTION II

Technical Findings

This section reports the findings to date on the three elements of assessing guideway transit system impacts: determining impact types, assessment techniques, and cases of impact studies.

Impact Types

Four categories of impacts are used: transportation impacts, economic impacts, social impacts, and environmental impacts. Individual impact studies may focus on only some of these categories, depending on the performance criteria chosen for guideway transit. The following briefly describes each of these impact types, the impact process involved, and how the addition of a guideway transit system may affect them.

Transportation Impacts

Transportation impacts are those factors that affect the urban transportation system in an urban area. The urban transportation system includes the physical infrastructure (e.g., roads, rails), the services provided, travel demand, and the interactions among these components. The services provided include the costs, travel time, availability, etc. Travel demand includes mode choice for line haul, mode choice for access and egress, route choice, origin and destination, time of day, etc. The services provided depend on the physical infrastructure and travelers’ choices, which of course depend on the services provided. The characteristics of the urban transportation system are determined by the interactions among the providers, users, and the physical infrastructure. These characteristics include travel time, speed, congestion, safety and overall modal shares, to name a few.
The presence of guideway transit changes the existing physical infrastructure. This change disturbs the established characteristics of the transportation system. Both providers and users may react to this change. Travelers may change any of their transportation choices before the guideway was built: their mode choice for the line haul, mode choice for access and egress, route choice, origin and destination, time of day, etc. The providers of transit services may change the network configuration, frequency, etc. A new set of equilibrium characteristics will be established after these reactions are adjusted in the urban transportation system. Impacts on highway traffic include changes in highway travel time, speed, congestion, safety, miles traveled, etc. The impacts of the guideway system on travel behavior are the differences in the users' transportation choices between the old and new equilibria. The impacts on the overall transportation system are the differences in the equilibrium characteristics of the transportation system, including safety, modal shares, etc. The extent of these impacts depends on how large the role of the guideway system is in the urban transportation system. The extent of these impacts may also depend on the existence of supportive conditions, such as a strong economy and a limited number of parking spaces in downtown. These impacts may be assessed at the regional level or for submarkets of the region.

Economic Impacts

Economic impacts include those that affect the regional economy, including employment, population, income, investment, retail sales, and others in private market activities. A regional economy has many sectors. Transportation is one of them and a guideway system is one of the components that interacts with the transportation sector. When there is no disturbance, the economy is in an equilibrium state and may be characterized by the equilibrium levels of employment, population, income, etc. When a guideway system is constructed, the existing equilibrium state is disturbed. Each of the sectors readjust and a new equilibrium state is obtained. Therefore, the impacts of the guideway system are the differences in these equilibrium characteristics of the economy.

Land Use Impacts

The interaction of transportation and land use is described first in the context of economic theories of residential location and business location, respectively. These theories provide a conceptual basis for examining this interaction. These theories usually focus on either residential location decisions or business-location decisions, but seldom consider both jointly. They are theoretical in that they may predict the direction of changes but not the magnitude.
of changes. This description is based on Meyer, et al. (1981). The interaction is then described in terms of three types of impacts. The second part is based on Stopher (1976).

Residential-location decisions. The traditional model of residential-location decisions assumes that every worker is employed at a central location of an urban area (the CBD) and that the number of workers is predetermined. The residential-location decision then is determined by a worker decision on how far from the CBD to live. Generally, it is assumed that the farther one lives from the CBD, the higher the costs of commuting (both in time and out-of-pocket) and the lower the cost of housing. Thus, the total cost of choosing a particular residential location is the sum of the commuting costs and the rent for housing at that location. It is hypothesized that workers live at locations that minimize the total cost of commuting and housing.

Within such a model, the impact of any reduction in commuting costs will have a decentralizing effect on residential-location decisions. A reduction in commuting costs effectively increases the real income of workers. Moreover, if the reduction in commuting costs is bigger for workers living farther from the CBD, then workers have an additional incentive to move farther out, all else being equal. A reduction in commuting costs thus encourages workers to move away from the CBD because of its indirect effect on real incomes as well as its direct effect on costs. This shift in residential location in turn decreases residential density near the metropolitan center, and in the metropolitan area as a whole.

Changes in commuting costs not only influence residential location decisions but also influence land prices. The exact extent of such impacts depends on the elasticities of the supply and demand curves for land use. Thus, at least part of any change in transportation costs is likely to be absorbed by landowners in the form of altered rents. The model outlined above would predict that when commuting costs decrease, all else being equal, the price of residential land close to the CBD will decrease, relative to the price of land farther out because of the shifts in demand indicated above.

Business-location decisions. The standard business-location model assumes that the number and location of jobs are not predetermined and that the firms located in the CBD compete for sales and profits with firms located elsewhere. A change in commuting costs to the CBD may affect the competitive advantage of firms located there and the number of workers they employ. Specifically, a change in commuting costs may affect the competitive advantage of firms in the CBD in two ways. First, by altering the amount of time or money
workers must spend commuting, a transportation change should affect the real incomes of those working in the CBD, and thus the wages that their employers must pay in order to attract a given number of workers. A decrease in commuting costs, for example, should allow employers to reduce wages, thereby improving their firms' position relative to competitors located outside the CBD. The second way in which commuting costs may affect the competitive position of firms in the CBD is through changes in residential and land rents. As noted, a decrease in commuting costs is likely to reduce rents for residential land adjoining the CBD and thus make workplace location or expansion there less expensive. A change in commuting costs then, should influence not only the residential choices of workers working in the CBD but also the number of workers working there. Lower commuting costs will increase employment in the CBD relative to other areas. Thus, in theory, a decrease in commuting costs tends to decentralize residences while it centralizes job locations.

How the construction of a guideway transit system may change commuting costs to the CBD, depends on its travel time and out-of-pocket costs relative to those of other modes. The additional factor of how individual travelers value their time must also be considered. In particular, if higher-income groups place more value on their time, then the introduction of faster forms of urban transportation could lower their total commuting costs, even if the faster transportation had greater out-of-pocket costs. For lower-income groups, however, the same transportation may increase their total commuting costs.

Types of land use impacts. Four major types of land use impacts may be identified: changes in property values; changes in the type of land use; changes in the intensity of development; and relocation of existing land uses. The first type is related to the effects on property and land values of changes in accessibility to the guideway system. The provision of guideway transit will have two impacts in the opposite directions on properties or land near stations. Properties near stations will benefit from increased accessibility on one hand and will suffer from increased congestion and other nuisances on the other hand. For locations between stations, however, accessibility will generally be reduced because of barriers created by the right-of-way. In addition, locations between stations may also suffer because of increases in noise and other nuisances.

The second type of land use impact is related to changes in land use as a result of changed accessibility. Changes in land use can occur in a number of ways. For example, a new guideway system might isolate a small parcel of vacant land between itself and a developed area. Because of the isolation and the proximity to the guideway, this land may be
developed for commercial, industrial, or residential uses. Changes in land use also occur to developed land. Decreases in accessibility and increased isolation of existing development may result in a gradual deterioration of the property and eventual abandonment. Also, properties near stations are likely to become commercially attractive. If commercial uses are not currently a major land use, pressures may arise for conversion to commercial uses, or even a total rebuilding of the area.

The third type of land use impacts is changes in density of development. High rises of both commercial and residential uses may be attracted to station areas both because of increased accessibility of these areas and increased cost of land.

The final major type of land use impact is that of relocation. Relocation normally results from the alignment of the right-of-way where the purchase and demolition of all property within that right-of-way is required.

The extent of land use impacts of guideway transit can be significantly influenced by factors besides guideway transit. These factors have been well documented in the literature (Knight and Trygg, 1977).

Social Impacts

Social impacts are those that affect the habits and lifestyles of individuals and groups and also those that affect the organization of various public institutions, such as schools, government, planning agencies, etc. Stopher (1976) describes how social impacts may result from changes in the urban transportation system, based on Thomas and Schofer (1967). The rest of this subsection is adopted from Stopher (1976).

Four phrases are introduced in Thomas and Schofer (1967) to describe social impacts of transportation: "activities," "activity set," "activity sites," and "activity linkages." Activities are interactions between individuals and the physical subsystem. An example of activities is shopping. The activity set of an individual include those activities undertaken by this individual. Activity sites are those physical locations where these activities occur. Activity linkages are those transportation facilities that link individuals to their activity sites. The social impacts of guideway transit are changes in activity sets or in activity sites as a result of changes in activity linkages.
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One source of changes in activity sets and sites is changes in activity linkages because of the introduction of a guideway transit system. For some individuals or groups, the guideway transit system increases their activity linkages and hence accessibility to new activity sites. For others, the guideway transit system could mean decreased activity linkages and decreased accessibility. Such reductions may occur, for example, when a coherent community is disrupted by the right-of-way placed through it with little or no cross-access provided. Such changes in activity linkages and accessibility may result in changes in activity sets and sites.

Another source of changes in activity sets and sites is changes in land use. Changes in land use can directly result in changes in activity sites because new opportunities for certain activities are now presented, or because old opportunities have been lost. The loss of activity sites that were important and nonsubstitutable can have serious effects on the community. Similarly the opening up of new activity sites would usually be a beneficial effect. New activity sites might come about by the location of a new shopping plaza or the opening up of park land for recreational purposes.

The third source of changes in activity sets and sites is relocation of land use. The relocation of residences is either forcible or voluntary. Forcible relocation of residences takes place because of property acquisition for the construction of a right-of-way. Forcible relocation may result in undesired disruption of existing activity sets and the rebuilding of new linkages and activity sites. This effect can be particularly serious where a part of a once coherent community is uprooted and relocated physically away from the remainder of the community. Many of the original activity linkages are destroyed because of the physical separation of the parts of the community, although these linkages may be an essential part of the social structure of the community. Such relocation is disruptive and may be expected to have some detrimental effects on the entire community involved.

Voluntary relocation of residences may occur possibly from the generation of new housing developments, which in turn have evolved because of the building of the guideway system that has made particular locations more attractive as potential housing developments. Those families that relocate in such developments have made a conscious decision to change the sites of their activity sets and possibly the activity sets themselves. The changes have also presumably occurred because of a net improvement in the quality of family life. Such relocation largely benefits those who are affected.
The relocation of non-residences will largely affect the activity sets of those who utilize the sites before relocation and of those who may be able to use them after relocation. Two major types of non-residential uses can be identified. The relocation of services, e.g., doctors, dentists, general commercial activities, etc., will usually generate changes in the activity linkages such that those who were originally served by such establishments will have to seek other establishments within an acceptable journey length. On the other hand, insofar as the establishments do relocate, others may be offered a greater choice of establishments from which to obtain their required services. The relocation of commerce or industry will affect the work trips of those involved. It will also affect potential labor markets for the activities. These changes will again affect the activity sets of the individuals concerned. More or less time may be involved in traveling to and from work, with a consequent effect on the amount of time available for travel to and from work, and for the participation in other activities. Similarly, competition for jobs may affect job stability and anticipation of job advancement.

These different forms of social impacts of guideway transit may be influenced by factors besides guideway transit. These factors, however, have not been well documented.

Environmental Impacts

Environmental impacts are those that affect the physical subsystems, rather than travel behavior, land uses, social, and economic aspects in the urban system. The two principal forms of environmental impacts are air and noise pollution. The introduction of a guideway system creates a set of emissions, such as sound and movement of vehicles. These emissions lead to direct impacts on the urban system, such as changes in noise levels in the corridor areas. On the other hand, the introduction of the guideway system may change travel behavior, such as modal shifts from automobiles to the guideway system. This behavioral change may result in changes in the emissions from automobiles, which would lead to indirect impacts on the urban system. However, the environmental impacts of guideway transit may be magnified or mitigated by factors besides guideway transit.

Assessment Techniques

A major difficulty of impact studies is controlling for the many factors besides the presence of guideway transit that can influence guideway impacts. Failure to control for these factors not only results in biases in impact estimates but also reduces external validity of the results. Three broad types of techniques have been identified in this study for assessing the impacts
of guideway transit: quasi-experimental approaches, econometric approaches, and computer simulations. The extent to which these techniques control these factors varies.

Quasi-experimental Approaches

Under quasi-experimental approaches, the analyst can introduce something like experimental design into his data collection procedures, e.g., when and from whom data will be collected. The analyst, however, lacks the full control over the scheduling of experimental stimuli, e.g., who will be exposed to the guideway system and when the exposure occurs. Two forms of quasi-experimental approaches are identified in this study: temporal and cross-sectional.

Temporal. Under the temporal form of quasi-experimental approaches, the impacts of guideway transit on a particular variable, such as property values, are assessed by examining how the variable has changed over time. This temporal change in the variable may be examined in several ways.

Trend: One way is simply to examine the trend in the variable and see if there is any noticeable change in the trend that may be attributed to guideway transit.

Before-and-After: Another way is to compare the values of the variable collected before and after the guideway system was constructed and simply attribute any differences in the values to guideway transit.

No-System Alternative (NSA): A third way is to compare the actual value of the variable after the guideway system was constructed and the value that is likely to be obtained if the system had not been built.

To the extent that the NSA scenario can be reasonably defined, the NSA technique has a better control than the Trend and Before-and-After techniques over the effects of factors besides guideway transit. One advantage of the Trend and Before-and-After techniques is their relative simplicity. One disadvantage of the NSA technique is its difficulty in defining the scenario that is likely to occur if the guideway system had not been built.

Cross-sectional. Under the cross-sectional form of quasi-experimental approaches, the value of the variable of interest collected in areas served by guideway transit is compared with that collected from "control" areas. These control areas are selected to be as comparable as possible to the study areas, the only difference being that the control areas
are not served by guideway transit. To the extent that the study areas and control areas are nearly identical, observed differences in the variable of interest may be partly attributed to the presence of guideway transit. An advantage of this technique is its greater external validity over the Trend and Before-and-After techniques. A major disadvantage is its difficulty to define and find those control areas.

Two types of this technique are identified: (1) intercity comparisons, which contrast, for example, land use patterns in metropolitan areas with guideway transit systems with patterns in areas without guideway transit systems; and (2) intracity comparisons, which compare, for example, land use patterns near a new guideway transit facility with patterns in control areas in the same metropolitan area.

Econometric Approaches

In the terminology of Damm, et al. (1980), quasi-experimental approaches rely on "controls in the data." Controls in the data are likely to result in "serious methodological problems" because the assumed control conditions tend to be violated in the real world. An alternative is to rely on "controls in the model," which can be achieved with a variety of econometric models. These models allow the analyst to isolate the effect of the independent variable of interest on the dependent variable of interest while holding constant a number of other independent variables. These other variables measure factors besides guideway transit that may influence the dependent variable.

What specific econometric model should be used depends on how the dependent variable is measured. Three examples are given here.

- If the dependent variable is continuous, such as one measuring property values, multivariate regression models may be used. The simplest of these models has the following linear form:

  \[
  y_i = \alpha_0 + \alpha_1 x_{i1} + \alpha_2 x_{i2} + \ldots + \alpha_n x_{in} + \epsilon_i
  \]

  where \( y_i \) is the dependent variable, \( X_{ik} \) (\( k=1,\ldots,n \)) are the independent variables (one of them measures the presence of guideway transit and the others are control variables), \( \epsilon_i \) is the error term, and \( \alpha_k \) (\( k=0,1,\ldots,n \)) are the parameters measuring the marginal effects of each independent variable on the dependent variable. Depending
on assumptions made on the data and the error term, such a model can be easily estimated using standard econometric or statistical software.

• If the dependent variable is discrete, such as whether a parcel of land has changed from one use to another, discrete choice models may be used. The simplest of these models is the following binary logit model:

\[
P_i = \frac{1}{1 + e^{-U_i}}
\]

\[
U_i = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \ldots + \alpha_n X_{ni}
\]

Where \(P_i\) is, for example, it is probable that a change in land use has occurred. This model can be easily estimated in a variety of statistical and econometric software. Once estimated, the sign and magnitudes of coefficients tell what factors encourage changes in land use and what discourage such changes.

• An important assumption in the above single-equation model is that changes in the dependent variable do not affect any of the independent variables. Violation of this assumption will result in biases in estimates of the parameters. An example of this violation is shown below. In assessing the impacts of guideway transit on population densities, one uses employment densities as one of the control variables. There is evidence that population and employment densities may be jointly determined. Where violation occurs, simultaneous-equations models should be used. They take the following form if linear models are used:

\[
y_{1i} = \alpha_0 + \alpha_1 x_{1i} + \alpha_2 x_{2i} + \ldots + \alpha_n x_{ni} + \beta y_{2i} + \epsilon_{1i}
\]

\[
y_{2i} = \beta_0 + \beta_1 z_{1i} + \beta_2 z_{2i} + \ldots + \beta_m z_{mi} + \alpha y_{1i} + \epsilon_{2i}
\]

where \(y_{1i}\) is the dependent variable of interest, \(y_{2i}\) is one of the control variables that is affected by \(y_{1i}\). These two variables are called endogenous variables, while the other variables are called exogenous variables. In this framework, the parameters of the exogenous variable do not directly measure their marginal effects on the endogenous variables.

Computer simulations

Computer simulations are based on structural models of how an urban system and its subsystems work. Some simulation models are limited to the working of a single subsystem,
while others include the interactions of two or more subsystems. In a given simulation model, the players in the subsystems included are modeled by mathematical relationships. These mathematical relationships are calibrated with empirical data. An advantage of simulation models over theoretical models is their ability to make specific predictions about the direction, magnitude, and rate of changes in the variables of interest.

Computer simulations can be used to estimate impacts of guideway transit on a particular subsystem by using a model that includes both that subsystem and the transportation subsystem, with and without the guideway system as a component of the transportation subsystem. The extent of its ability to isolate the impacts of guideway transit from those of other factors depends on the reliability of the underlying theory of the model and empirical estimates of parameters in the model.

Applications of Assessment Techniques

The following briefly reviews previous impact studies of guideway transit that have used the three types of assessment techniques. These studies are identified by the name of study areas.

Quasi-experimental Approaches

- **Calgary.** Walmsley (1992) reviewed the land use impacts of the light rail in Calgary. Calgary located in the Canadian Province of Alberta, experienced a boom in development in the late 1970s. The plans for numerous developments demanded that the city planning department conduct studies and begin to develop policies for channeling the new development. Along the south line of the light rail, careful consideration was given to the creation of planning districts around each station with conditions to channel development. However, a downturn in 1981 in the economy and a collapse in oil prices in 1986 had a dramatic effect. Housing prices fell by as much as 30 percent and still had not fully recovered by 1992. Further, the population of the city dropped radically and much of the planned development never materialized.

- **Edmonton.** Walmsley (1992) also reviewed the land use impacts of the light rail in Edmonton, also located in the Canadian Province of Alberta. When making the decision to build the light rail line, the city council also decided not to support development around suburban stations except for plans for massive development
at the suburban end of the line. The city council zoned out the capability of development at other stations by land use bylaws. However, following the economic crash in 1981, the plans for the suburban end of the line were also withdrawn. While there are signs of new development in downtown Edmonton, it would be difficult to attribute these to the light rail.

- **Portland, Oregon.** Diddleton (1990) described development activities near stations of the light rail in Portland. From the time when the decision to build the light rail line in Portland was made to 1990, development totaled nearly six million square feet, representing an investment of nearly $700 million. The most significant of this development was a regional mall planned for the outer end of the line at Gresham. It is a $100 million, 900,000 square-foot mall built directly over and incorporated into the light rail line. The Transit Station Area Planning Program of the Oregon Department of Transportation and local governments contributed to the land use impacts of the light rail transit. Even before construction started, every station location had been rezoned to encourage transit-related development and higher density zoning was put in place at suburban station locations.

Field observations carried out by CUTR for the Portland case study indicate a shift from single to multi-family housing development along a 3-mile stretch of Burnside on the eastern segment of the light rail line. These observations are supported by Bernick and Hall (1992). Bernick and Hall (1992) examined residential development around the stations of the Portland line. There had been two multi-story apartment complexes by 1992, totaling 271 units. One complex has 195 units and is four blocks away from the station at Rockwood and 188th Street in Gresham. The other complex has 76 units and is four blocks away from the station at 162nd Avenue.

The Portland case study carried out by CUTR indicates that the Downtown redevelopment and rehabilitation of the Lloyd District located east of the Willamette River have been coordinated with light rail construction. Also, plans for the west side line, currently under construction for 1997 completion, incorporate the concept of transit-oriented residential clusters with small scale commercial and service activities.

- **Sacramento.** Cervera (1992) surveyed transit-based joint-development projects in the U.S. There had been three major joint-development projects along the light rail line in Sacramento by 1992. One of these projects is a 700,000 square foot office
development linked directly to a suburban station (Swanston). It is a joint
development between USAA/WATT Properties and the Sacramento Regional Transit
District (SRTD). Another project is a 350,000 square-foot office and commercial
joint-development at the St. Rose of Lima Station. The third project is a 400,000
square-foot office and commercial joint-development at the 16th Street Station. The
latter two projects are located in downtown and were carried out by the Joseph and
Richard Benvenuti Company and SRTD.

Bernick and Hall (1992) studied residential development around stations of the light
rail line in Sacramento. A total of 354 residential housing units, all of them multi­
family, had been built within one-quarter mile of rail stations by 1992. Among these
units, 130 may not be directly attributable to the stations.

Glick (1992) reviewed transit-oriented development planning in Sacramento. In
1987, the Sacramento Regional Transit District produced a brochure identifying
some practical suggestions for a transit-supportive environment and community. In
1990, the same agency developed "Transit-Oriented Development Design
Guidelines." Glick (1992), however, identified no implementation measures by local
governments for transit-oriented development.

- **San Diego.** Cervera (1992) described two major joint-development office and
commercial projects around the San Diego Trolley by 1992. They are the
MTS/James R. Mills Building and Greater American Plaza. The MTS/James R. Mills
Building is a co-development project between the Starboard Development
Corporation and the San Diego Regional Building Authority. The Regional Building
Authority is a joint-powers agency that involves the county of San Diego and the
MTDB (Metropolitan Transit Development Board). It serves as a regional
transportation transfer center for the East Line, South Line, and the Bayside Line as
well as several major transit bus lines. It is on a 3.3-acre site immediately north of
the maintenance and storage facilities of the San Diego Trolley. The $43.6 million
project comprises 180,000 square feet in a ten-story building straddling the trolley
tracks and platform. The ground floor consists of commercial uses, including a
restaurant and mini-market, serving 55,000 people who passed through the site daily
in 1990. The upper nine stories house governmental departments, San Diego
Trolley, and MTDB. A six-story, 1011-space parking garage is located immediately
west of the building, serving both building tenants and automobile users who want
to access the downtown via the trolley.
The American Plaza is a joint development between Starboard Development Corporation and MTDB. It is $200 million, 912,000-square-foot mixed-use development. The project includes the 34-story Great American Plaza Tower, a 15-story, 272-room hotel, a restaurant, a museum, and 31,000 square feet of retail space. The project is integrated with the new Broadway and Kettner Transfer Station, linking the East and South lines with the new Bayside extension; the rail line and station are located in a street-level passage way bridged over by the Plaza Tower. This structure is adjacent to the Amtrak rail passenger shelter and provides a connection between local transit and intercity rail and, since March 1995, Coaster commuter rail from Oceanside.

Bernick and Hall (1992) and Graham (1992) examined residential development within one-third of a mile of eight suburban stations of the South and East lines. Three of these stations are on the South Line and the other five are on the East Line. A total of 1,052 units had been developed near the five East Line stations. Of these units, 141 units are in a joint-development project and 702 may be attributable to the light rail. A total of 466 units had been developed around the three South Line stations; none of which may be attributed to the presence of the light rail.

Graham (1992) examined planning efforts by cities in the San Diego area served by the light rail line. He concluded that an important factor in the lack of land use impacts around suburban stations is the virtual lack of supportive planning. Until the approval of the Transit-Oriented Development Guidelines in 1989, there was no citywide planning effort for promoting intensified land use around stations. Even in the few cases where the goal of promoting denser development around stations was stated in community planning documents, there was an absence of any implementation measures. Furthermore, with the exception of the 141-unit joint development project, the planning files for the individual projects had no indication of their proximity to light rail stations.

- San Jose. Bernick and Hall (1992) surveyed multi-family housing developments of over 50 units in size and over 15 units per acre within a quarter-mile radius of a light rail station in San Jose in 1992. They showed a total of 1,214 units built near the River Oaks Station and a total of 1,561 units that were being constructed near the Vista Montana Station. No information was provided on local government
planning and policy in promoting transit-based development around stations of the light rail.

- **Vancouver, British Columbia.** Bernick and Hall (1992) examined the development around stations of the SkyTrain in Vancouver. There have been three major projects within a quarter-mile radius of a SkyTrain station that are completed, currently under construction or in the planning stage. One of these is Pacific Place, a massive 204 acre, $2.5 billion project adjacent to the Stadium Station. This project is to be developed over the next 10 to 12 years. About two-thirds of the site is designated as residential use and will include 7,600 dwelling units and three million square feet of commercial space. Another project is the Lido built in 1988. It is a $215 million (Canadian dollars) 1,400-unit housing development on a 23 acre site in the city of New Westminster. The third major project is a joint development on a 21 acres in Surrey with 1.2 million square feet of commercial space and 1.4 million square feet of residential space. There are many other smaller transit-based projects within a one-quarter mile radius of a SkyTrain station. They include 314 residential units completed at the Columbia Station, 2,859 units under construction at the Station Square, Edmonds Town Center, and Westminster Pier, and 2,800 units that are being proposed or are in advanced planning in Coal Harbor.

Cities along the SkyTrain corridor offer various incentives for development near a station. These include density bonuses and rezoning from industrial to residential and commercial uses.

**Econometric Approaches**

The examples below all use the hedonic price approach to investigate the effect of proximity to stations on property values.

- **Atlanta.** Nelson (1986) studied the impacts of the heavy rail in Atlanta on the prices of single-family houses. The study area is approximately 2.7 miles east to west by 1.7 miles north to south along a rail segment of the East Line. The north side is predominantly higher income neighborhoods. The south side is predominantly lower income neighborhoods. Sale prices of houses for the year 1986 were used. Proximity to rail stations had a positive effect on sale prices in lower income neighborhoods, but a negative effect on sale prices in higher income neighborhoods.
Alterkawi (1991) studied assessment values per square foot of nine parcels of land within 3,000 feet of the Brookhaven station of the northeast line for 1980 and 1988, respectively. It was not explained how these parcels of land were selected for the study. Land value per square foot was regressed against a constant and distance from the station for each of the two years. Land attributes other than distance to the station were not included. The regressions indicate that distance has a significantly negative effect on land values in both years but that the absolute impact effect of distance in 1988 is five times the impact in 1980.

Miami. Gatzlaff and Smith (1993) studied the Miami Metrorail's and its impact on the prices of single-family houses. The houses were located within a one-square mile section of each of eight stations selected. Sale prices between 1971 and 1990 were used. A weak effect on home prices is observed from the announcement of Metrorail. In addition, proximity to Metrorail stations did not appear to affect sale prices.

Philadelphia, Oregon. Voith (1993) studied the impact of SEPTA's commuter rail stations on house values using both 1980 census data and sales prices of single-family houses during 1970-1988. Census tracts were designated as having service or not having service as follows. In densely populated suburban areas where tracts are geographically small, the census tracts where the station is located and immediately adjacent tracts are all designated as having service. In less densely populated areas where census tracts cover much larger areas, only the tract with the station is deemed to have service, except where stations lie on the border of two tracts.

The first regression was based on census tracts in four Pennsylvania counties and one New Jersey county that had radial commuter rail service to the CBD in 1980. There were a total of 678 tracts. Tract data from the 1980 Housing Census and the Journey to Work Census were combined with highway travel time data and commuter rail service data. Commuter rail stations were located on census tract maps, and a list of tracts with stations in or near the track was compiled. Controlling for household size, percent of black population, percent of single family housing, and median age of tract housing, the regression indicates that tracts with commuter rail service enjoy house value premiums of $7,279, which is 7.5 percent of the 1980 median housing value of $87,455 in the area considered. The second regression was based on 59,000 sales of single-family houses taken from the Montgomery Center for Urban Transportation Research.
County tax assessment file. For each transaction, information was collected on the actual sale price, date of sale, housing attributes, and location by census tract. Instead of distance from a station, a dummy variable for being near a station was used. The regression indicates that houses in tracts with commuter rail service enjoyed house value premiums of $9,605, which is 8.1 percent of the average sale price of $119,065.

- **Portland, Oregon.** Al-Mosaind, et al. (1988) studied the impacts of the light rail in Portland on the prices of single-family houses. The houses were located within 1,000 meters of actual walking distance to a light rail station along the segment in the E. Burnside corridor. Sale prices of houses during 1988, two years after the line opened, were used. Proximity to light rail stations had a positive effect on sale prices, indicating that the positive impacts of close proximity are stronger than the negative impacts.

- **Toronto.** Dewees (1976) studied the effects of a streetcar and subway on residential property values in Toronto, Canada. The study area was along the Bloor-Danforth subway corridor. Five areas were chosen scattered along the subway line. A total of 690 sales in 1961 and 1,174 sales in 1971 were used from an area extended up to one mile from Bloor Street. In 1961, streetcars provided local service along Bloor Street and Danforth Avenue at a speed of 10-12 miles per hour. The subway started service in 1966 and provided higher travel speeds than the streetcars. Separate regressions were done for 1961 and 1971. When the shortest walking distance to Bloor Street was used, proximity to the streetcar in 1961 had a significant negative effect on property values; but proximity to the subway in 1971 had no effect on property values. When proximity was measured with travel time, however, proximity had a significant negative effect on property values in both years, with the subway having a larger effect. It should be noted that this study is over 20 years old and considerable growth has taken place in Toronto accompanied by additional investments in rail transit.

- **Vancouver, British Columbia.** Ferguson, et al. (1988) studied the pre-service impacts of the SkyTrain in Vancouver on single-family house values. They used 13,064 sales of single-family properties during 1971-1983 within 500 meters of the alignment. They concluded that proximity to the line did not influence housing prices and that only in the last year of study period (1983) does a property's location relative to a station affect the price of that property, with house values decreasing...
with distance from a station. Their results seem to indicate that pre-service impacts may become significant only when it is a few years before service starts. The SkyTrain was opened in early 1986.

* Washington, D.C. * Damm et al. (1980) studied the response of single- and multi-family real estate values in anticipation of the Washington Metro. There were 286 transactions for single-family houses and 771 transactions for multi-family buildings during 1969-1976. The independent variable of interest is the straight line distance to the nearest Metro station in miles. A significant inverse relationship between real estate values and distance to the nearest station was found for both types of housing.

Alterkawi (1991) studied assessment values of land within 3,000 feet of four stations in northern Virginia: Ballston, Virginia Square, Clarendon, and Court House. For each station, the assessment values per square foot were collected for 1975, 1980, 1985, and 1990. It was not explained how these parcels of land were selected for the study. Land value per square foot was regressed against a constant and distance from the station for a given station and year. Land attributes other than distance to the station were not included. The regressions indicate that land values around a station decline at a statistically significant level with distance from the station for any given year. Interesting, when the regressions are compared across the years, the rate of decline in land value with distance from a station increases much more significantly for later years. For example, the rate of decline at the Ballston Station in 1990 was 32 times that of the rate in 1975.

Econometric techniques have also been used to investigate the other types of guideway impacts. These include changes from one use to another use in land around stations, employment and population densities, office vacancy rates, office absorption rates, new housing construction, new office construction, and others. For example, Cervera and Landis (1995) investigate, as part of the BART at 20, factors that influenced whether land changed one use to another use around BART stations. They estimate a binary logit model that predicts the probability of each hectare grid cell of land around stations changing dominant land uses from 1965 to 1990 as a function of distance to the nearest BART station and a set of other control variables.
Computer simulations

- **New York.** Anas and Armstrong (1993) use computer simulations to assess the impacts of guideway transit on land values in the New York Metropolitan area to support policy recommendations on value-capture financing for public transit. The model developed includes two subsystems: transportation and real state. An easy way to understand the model is to view it as an extension of the Urban Transportation Planning System (UTPS). The UTPS models households' travel decisions in a number of sequential steps: trip generation, trip distribution, modal split, and traffic assignment. The sequential nature of the UTPS has been long criticized because of the well understood feedbacks among the different steps. Also, the UTPS does not consider the importance of using economic relationships in the steps. Finally, the UTPS does not include the working of the real estate markets, and therefore, is not suitable to predicting how real estate values will change in response to changes in transportation. The model Anas and Armstrong (1992) developed is a response to these concerns. On the one hand, the sequential steps are unified into a simultaneous process by means of an economic model. On the other hand, travel decisions are unified with housing related decisions so that the feedbacks between the two decisions can be captured.

- **Philadelphia.** Urban Institute and Cambridge Systematics (1992) evaluated the impacts of rehabilitating versus closing the Southeastern Pennsylvania Transportation Authority (SEPTA) public transportation system. Four types of impacts are assessed using four interacting computer simulation models. A regional transportation model is used to estimate the impacts on travelers, in terms of changes in operating costs, travel time, safety, and out-of-pocket costs incurred. A regional economy model is used to estimate the impacts of changes in travel cost and time on the economy, in terms of business sales, employment, income, and population. A fiscal model is used to estimate the impacts of changes in business sales, employment, income, and population on government revenues and expenditures. An energy and air pollution model is used to estimate the impacts of changes in vehicle-miles of travel on consumption of gasoline and emissions of air pollutants.
Cases of major impact studies

The UMTA and FTA have sponsored a number of major impact studies for guideway transit since the early 1970s. These include two impact studies for BART, three impact studies for MARTA, WMATA, and the San Diego Trolley, as part of the Transit Impact Studies Program in the late 1970s to early 1980s, and the new MARTA Impact Study underway since 1994. Each of these studies is briefly described, including what impacts are assessed and what evaluation techniques are used. There seems to be a tendency that later studies are more likely to use more rigorous techniques than quasi-experimental approaches.

BART Impact Program

The BART Impact Program from 1972-1978 covered all five types of guideway impacts: transportation, economic, land use, social, and environmental impacts. The main method of analysis is the NSA approach. This approach was used because it was believed that "a simple comparison of conditions in the Bay Area before and after BART was built would have been misleading" (MTC, 1979, p. 14). The reason was that "the transportation network in the area would not have remained unchanged if the voters in the area had not approved BART." The definition of the NSA scenario was based on an analysis of the political and financial environment in the area at the time of the decision to build BART, and in the following years. On the basis of this analysis, it was decided that the Bay Area's transportation system in 1976 would have been essentially as it was in 1973, the year prior to the beginning of BART's transbay service. The system consisted chiefly of local and express buses, and it would have provided less service and less capacity than with the BART system in 1976. It would also have attracted fewer patrons. The year 1976 was selected for comparisons of BART's impacts with those estimated for the NSA scenario because it was a period within the Program's research framework when all of BART's lines had been in operation for at least one year. It was believed that the assumptions in defining the NSA scenario had a considerable influence on the impacts.

BART at 20

The work to date for BART at 20 years of operation focuses on land uses, property values, and rent (Landis and Cervero, 1995; Cervero and Landis, 1995). Land uses focus on changes in density and changes in the type of land use. Changes in employment and population densities are assessed using trends. Changes in building spaces are assessed using both trends and control areas. Changes in land use type are assessed using a binary
logit model. The dependent variable in the binary logit model is whether a particular piece of land around stations changed type of use. Changes in property values are assessed using multivariate regression techniques. Overall, BART at 20 uses econometric techniques more extensively than the BART Impact Program described above.

MARTA's TIMP

The Transit Impact Monitoring Program at MARTA took four years to complete in 1982. The TIMP was divided into two sections: transportation and land use. Work within each of these sections was further divided into work tasks. The transportation section had the following six tasks (Donnelly, 1982):

1. Travel time survey: Collect observed data from travel time runs and measures of O-D data for selected trips before and after major transit line openings.

2. On-board survey: Distribute questionnaires on buses and in rail stations.

3. Work place survey: Distribute questionnaires to employees in major employment areas in proximity to the Phase A rail system.

4. Telephone survey: Interview people throughout the MARTA service area about mode selection for a variety of trip purposes.

5. Traffic counts: Place automatic counters on arterials and freeways to obtain screenline counts as observers measure average automobile occupancy. These counts were taken during phases with major system opening milestones.

6. Station area surveys: These include observations of the access mode of rail patrons, use of on-street parking, park-and-ride lot parking, and pedestrian conflicts with traffic.

The land use section had four major tasks (Donnelly, 1982):

1. Residential attitude survey: Two surveys were conducted, one along the East line and a second along the West line, to ascertain attitudes of residents about MARTA construction and operation in their neighborhoods.
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2. MARTA relocation analysis: The number and types of businesses (and employees) and households (and individuals) displaced as a result of MARTA construction.

3. Residential land activity analysis: Secondary data sources were examined to compare housing prices, rental prices, and housing supply changes near transit stations and in control areas.

4. Commercial land activity analysis: Secondary data sources were examined to obtain information on major leasing and sales of commercial property, employment, and building and rezoning applications.

Quasi-experimental approaches were used for these analyses.

MARTA's MIS

The MARTA Impact Study underway expands the scope of assessment by covering not only transportation and land use impacts but also social impacts (Atlanta Regional Council, 1994). The MIS uses econometric techniques more extensively than the TIMP. The study design was to be used as a model for future impact studies of guideway transit throughout the country. The transportation part focuses on the impact of MARTA on five travel markets in the Atlanta Region: the regional travel market, the North Area Corridor market, the special events market, the reverse commute market, and the Lenox Square market. The assessment of the regional market will examine the regional propensity for using the guideway system. The method of analysis is econometric modeling with the logit model. Quasi-experimental approaches are used for the other four markets. The land use part will focus on the effects on station area housing and commercial real estate markets and on neighborhood population and employment densities. Hedonic models are used for the prices of single family homes, apartments, and offices. Simple multivariate regression models are used for vacancy rates, absorption rates, census tract shares of regional single family, multi-family, and office space construction. Simultaneous equations models are used for population and employment densities.

A number of social impacts are assessed: 1) the statutory and regulatory framework within which MARTA has been implemented; 2) how MARTA has led to legislative actions at the local, state, and federal levels; 3) the effect of MARTA on the formulation of public policy to promote station area development plans and to evaluate the success of various public policies; and 4) the impact on crime and the perception of crime in rail service areas.
compared to non-service areas. Quasi-experimental approaches are used for impacts on crime. Some qualitative approaches are used for the other types of impacts, however these qualitative techniques are not examined in this study.

WMATA

The Washington Metrorail Before and After Study completed in 1982 was designed to examine primarily transportation impacts (Donnelly, 1982). Impacts covered include changes in transit travel in selected submarkets of the region and changes in automobile travel at the regional level. Quasi-experimental approaches were used to compare information collected in before and after surveys.

San Diego Trolley

The Guideway Implementation Monitoring Study completed in 1983 concentrated on changes in travel characteristics, land use, and socioeconomic characteristics. The study was divided into three phases:

Phase I: Study Area Inventory (1980-1981)

The first phase was to describe the study area prior to implementation of the San Diego Trolley. Land use data, travel data, socioeconomic data, as well as data on system construction, were collected.


This was to monitor land use and travel changes in the study area during the first year of operation.


The final phase collected data for the same factors in Phase I, followed by an evaluation of the impacts of the light rail construction and operation.

The evaluation was done primarily with different forms of quasi-experimental approaches.
Summary

This study report has tried to identify and document a common set of types of impacts, and a common set of types of assessment techniques from previous impact studies of guideway transit. The intention is to provide transportation professionals tool boxes in assessing guideway transit system impacts. The following summarizes the report.

• An assessment of guideway transit system impacts may serve many purposes such as providing information for future planning and implementation, checking the accuracy of estimates of before-construction impacts, justifying value-capture policies, satisfying the expectations of a wide range of interest groups, and others.

• Impact studies may need to be conducted for individual systems because of their generally low level of external validity.

• Four elements in assessing the after-construction impacts of guideway transit systems are identified: determining the types of impacts and understanding impact processes, measuring the variables of interest (such as air quality), selecting assessment techniques, and applying selected techniques. The measurement element is specific to the type of impacts assessed and is not examined in this report.

• Five types of impacts are examined: transportation impacts, economic impacts, land use impacts, social impacts, and environmental impacts.

• Three types of assessment techniques are identified: quasi-experimental approaches, econometric approaches, and computer simulations.

• Quasi-experimental approaches use controls in the data and lack external validity. The advantage is their simplicity.

• Econometric approaches use controls in the model and can achieve high levels of external validity. They can be used in assessing a variety of impacts, including land-use and environmental impacts.

• Computer simulations are more complex and used less frequently than the other two types. They can achieve high levels of external validity as well.
• Since the early 1970s, the federal government has sponsored seven major after-construction impact studies of guideway transit. Both the types of impacts assessed and techniques used vary significantly across these studies. Transportation and land use impacts are the most frequently assessed among the five types examined in the report.

• It seems that econometric approaches are being used more extensively in the more recent impact studies than in the earlier ones.
Bibliography

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Social Impacts


Environmental Impacts


