

A Strategic Plan for Researching Urban Form Impacts on Travel Behavior

Final Report

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Final Report

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**A STRATEGIC PLAN FOR RESEARCHING
URBAN FORM IMPACTS ON TRAVEL BEHAVIOR**

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INTRODUCTION

"Cities may have first been built for symbolic reasons and later defense, but it soon appeared that one of their special advantages was the improved access they afforded. Modern theorists have seen transportation and communication as the central asset of an urban area, and most theories of city genesis and function take this for granted." (1)

There is a growing consensus that we cannot sustain or improve access within urban regions if we continue to be dependent on driving alone as our primary means of mobility. Despite progress in congestion management, our present urban transportation system makes it difficult to maintain the pace of facility construction needed to maintain service levels, to achieve air and water quality standards, and to reduce our dependence on foreign oil.

The search for alternative means of transportation that can sustain access, improve the environment, and reduce our trade imbalance has led researchers to question the relationship between land use, urban design, and travel behavior. Researchers believe that the characteristic forms of our current cities and metropolitan areas, such as low density and separation of land uses, adversely affect changes in travel behavior.

Public policies in areas of land use have been developed independent of transportation planning, and the two often conflict with each other. The lack of coordination among these policies has caused our continued dependence on driving alone and, therefore, impeded effective growth management and transportation planning. In response, policy makers have begun to look at different means of coordinating land use and transportation policy. The Washington State Growth Management Act, as well as similar laws in Florida, Oregon, and Vermont, among other states, requires local jurisdictions to adopt comprehensive plans with consistent land use and transportation elements and to ensure that transportation facilities are concurrently available with new land development. In addition, the Washington State Transportation Policy Plan

establishes the goals of linking land-use planning to transportation planning and linking land-use development directly to transportation development. New concepts, such as concurrency, jobs-housing balance, transit-friendly urban design, and transit-oriented employment centers, have become integral elements of both city and transportation planning in guiding their new, joint endeavors.

Better coordination among land use, urban design, and transportation planning could reduce the necessity of initiating projects to increase road capacity. In fact, one study by the Southern California Association of Governments found that improved coordination between land use and transportation policy to improve the regional jobs-housing balance would help make up billions of dollars in projected transportation funding deficits. The indirect effect on economic development resulting from lower transportation costs and the environmental benefits to the private sector from less auto use have not yet been calculated but they may also be significant.

Planners are uncertain how to accomplish these new policies. Detailed knowledge on how land use, urban design, and transportation systems are related to one another is minimal, as is actual experience in implementing coordinated plans successfully. Past research has identified the major elements that characterize the relationships between land use, urban design, and transportation. Significant relationships have been found, for example, between population density and mode choice, between jobs-housing balance and trip distance, and between streetscape design and auto speed. These relationships are summarized in *Land Use-Transportation Linkage*, published by the Washington State Transportation Commission Innovations Unit. However, as that report states, many questions remain regarding the nature of these relationships and how to develop and implement plans that effectively reshape development patterns.

The question of how land use, urban design, and transportation systems are related has been recognized by state agencies like the Washington State Department of

Transportation (WSDOT) and the Federal Transit Administration (FTA), as well as others who plan to conduct research in this area. However, because research funds are limited, it is necessary to prepare a strategic research plan that identifies the most important areas in which to focus research activities. This report is designed to contribute to this effort. It is modeled after the Freeway and Arterial Management Effort (FAME) prepared by the Washington State Transportation Research Center (TRAC) for the WSDOT, which has been successful in directing over a million dollars in research funds in other critical research areas.

This report is the culmination of a project whose mission was (1) to collect and disseminate current knowledge about linkages between land use, urban design, and transportation; (2) to support and coordinate ongoing graduate thesis research in this area, funded by the WSDOT; (3) to identify critical gaps in our current knowledge about these issues; (4) to design a program capable of efficiently filling those gaps; and (5) to seek further funding from public and private sources for the program.

This report is organized into four parts:

- a discussion of how to focus a research plan in land use, urban design, and transportation,
- a review of the meaning of urban form and how it is related to transportation,
- an outline of a research program specifying various research projects to be done, and
- a discussion of how the research program should be implemented.

A related effort has been conducted during the course of this project — the Land Use-Transportation Linkage project of the Washington State Transportation Commission's Innovations Unit. That project produced a report reviewing literature on land use-transportation relationships, summarizing information on existing land-use practices associated with transportation in Washington state, and analyzing the resulting data to extract key land use attributes that deserve further policy studies. Members from both projects met twice-monthly during the project to share information and recognize

duplicate efforts. Several interrelated endeavors between this project and the Innovations Unit's work exist:

1. the bibliography prepared for this project includes materials collected for the literature review by the Innovations Unit. They, in turn, used several works cited in this project in their literature review;
2. the Innovations Unit's report contains several recommendations for further research that were considered by this report's researchers in developing the strategic research plan contained herein;
3. the Innovations Unit staff participated in brainstorming sessions, which developed research ideas for this project, and members of this project assisted the Innovations Unit in preparing a list of policy issues that should be considered by the Washington State Transportation Commission's land use subcommittee.

RESEARCH FOCUS

Research needs to focus on ways to *design and implement human settlement patterns* that encourage greater use of alternatives to the single-occupancy vehicle. The alternatives include reducing trip-making needs, taking shorter trips, and using other modes of travel. The objective is to devise ways to build and rebuild cities that are less dependent on travelers driving alone.

The legitimacy and importance of this aim is widely recognized. Most people who live in urban areas do so to enable access to many kinds of opportunities: jobs, cultural events, educational centers, social contacts, and other resources only available in urban areas. However, the reduction in mobility caused by increased traffic congestion has considerably diminished people's access to many of these opportunities.

As a result, solving the transportation problem now appears at the top of most surveys on urban issues. A recent national survey found that traffic congestion and housing affordability are the top two problems in urban areas with populations of more than 25,000. (3) The policy makers and specialists in transportation and urban planning we interviewed for this report agree that it is no longer possible to restore or maintain access to opportunities in metropolitan areas by increasing mobility of single-occupancy automobiles. (4) Their reasons include the following:

1. the current economic situation, which limits building new infrastructure;
2. high land values of urbanized regions, which makes new housing in less-congested areas in the periphery increasingly costly;
3. environmental laws that penalize the use of fossil-fueled vehicles that add to air and non-point water pollution;
4. public opposition to road and infrastructure development and the further urbanization of rural lands;
5. changing demographics, with an increasing proportion of the population consisting of small, elderly, or single-parent families that cannot drive or have limited travel time available; and

6. increasing political pressure to reduce the consumption of non-renewable forms of energy.

In response to these circumstances, transportation policy is focusing on alternatives to driving alone by encouraging other modes, fewer trips and shorter trips. However, most urban areas, particularly those in Washington state, developed to a large extent in an era when driving alone was the basic transportation strategy. The forms of urban development that resulted are not well suited to supporting alternative transportation approaches. Thus, a key research problem that has emerged out of this shift in transportation policy is that of finding out how urban forms influence the use and feasibility of alternatives to driving alone and which urban planning policies are most effective in creating these development patterns.

WHAT IS URBAN FORM, AND HOW IS IT RELATED TO TRAVEL BEHAVIOR?

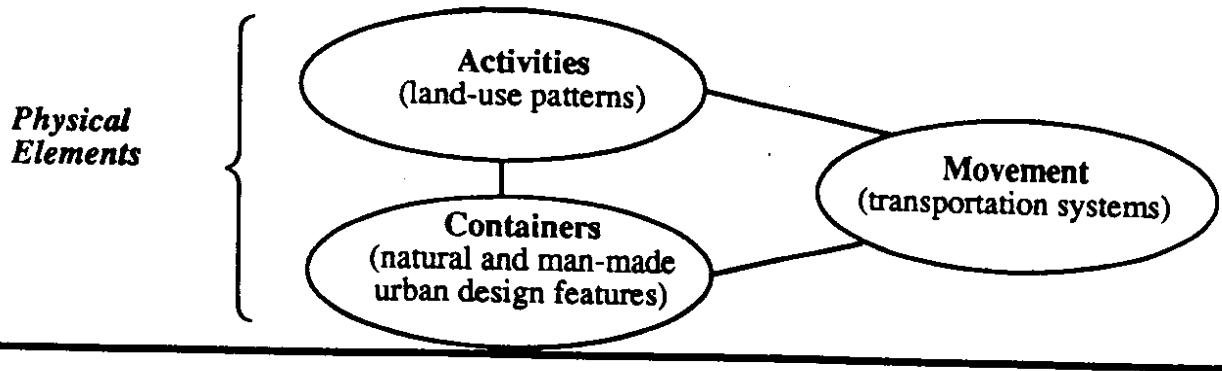
Research in land use, urban design, and transportation needs to bridge the methodologies of the different fields involved. This section reviews concepts used in urban form and transportation planning to establish measures that synthesize the relationships between urban form and transportation performance.

ELEMENTS OF URBAN FORM

The work of land use planners and urban designers focuses and has an impact on what we will call *urban form*. Methods of analysis rely on two basic components of urban form: one component includes a variety of *physical elements* encompassing land use patterns (e.g., sprawl), urban design features (e.g., streetscapes), and transportation networks (e.g., gridiron road patterns); the second component treats urban form as a *process*: the physical elements are in a constant state of change or transformation because of political, social, and economic forces.

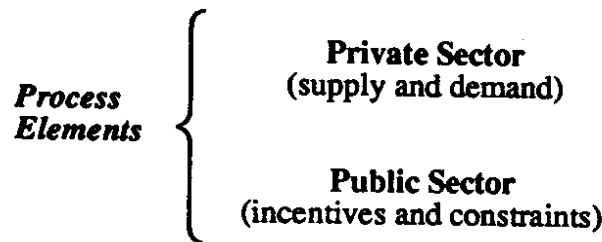
Physical Elements

A simple model of physical elements portrays land use patterns as "activities," urban design features as "containers," and transportation systems as "movement." In this model, containers are related to both activities and movement because they contain both land uses and transportation systems within physical structures (e.g., buildings, roads, etc.). Also, movement is related to both activities and containers, as land use patterns and urban design features are related.



Process Elements

A simple model of process elements of urban form includes the private sector, with its supply and demand patterns for urban services, and the public sector, with its incentives and constraints to supply and demand. Process elements constitute the time dimension of urban form, as they continuously modify existing physical elements or create new ones.



Interrelationships Between Physical and Process Elements

These simple models illustrate the complexity of urban form. Its physical and process elements form a system of interrelationships. Planners and policy makers have learned that modifying one or two elements of this system can change its entire nature and void the effectiveness of any attempt to change any one element. For instance, taking steps to consolidate multi-functional centers of development (e.g., mixed-use centers, urban villages, etc.) at appropriate distances from one another to support carpools, vanpools, and public transportation will force development onto cheaper land in the outskirts if development boundaries are not established at the same time. Alternatively, the consolidation of multi-functional centers may displace or even eliminate existing,

smaller commercial services catering to pedestrian movement unless the size of the centers is carefully calibrated to preserve the existing services.

The systemic characteristics of urban form require that both research and policy be integrated along several dimensions, which is often overlooked and is the cause of many of the transportation problems existing today. To be effective, research and policy must realize the following three relationships :

1. *Relationships between the elements of urban form and the process of city building.* Defining the physical characteristics of a region that supports effective transportation will not be useful unless this knowledge is integrated with policies and tools to implement these urban forms. The political, economic, and social processes of city building must be integrated with physical objectives if the integration of urban design, land use, and transportation is to be successful.
2. *Relationships between urban functions or activities.* It is relatively well understood that the various functions in urban areas (e.g., housing, employment, retail, education, recreation, and transportation) must be considered together. There are, however, many obstacles to achieving smooth relationships between these functions. They include the boundaries instituted by professional turfs (e.g., both within and among urban planning, transportation engineering and planning), the disjointed, functional responsibilities within institutions (e.g., the separation within agencies between zoning and code enforcement, public transit, public works, community development, parks and recreation, housing and renewal, etc.), and fragmented governance (e.g., the great number of cities, counties, special districts, and state and federal agencies whose decisions affect urban form and transportation outcomes).
3. *Relationships between the various scales of urban form.* Four scales are commonly used to define the urban structure: the urban region (generally over 50 square miles), the subregion or the city (from 2 to 100 or more square miles), the district (from 150 acres to 2 or more square miles), and the individual site (from one acre to one square mile or more). Although these scales are loosely defined and vary from case to case, they must be recognized because elements and processes are embedded, one within the other, at these different scales (e.g., the city groups several districts within one region). The regional dimension of policies and research in urban design, land use, and transportation planning is intimately related to the characteristics of the various sites involved. Regional bus service is supported by a pedestrian environment at the neighborhood level as, similarly, ample parking at people's front doors (at home or at work) helps increase regional freeway use. Political and jurisdictional disputes over local versus regional control have impeded the development of effective policies. The Washington State Growth Management Act addresses these problems by requiring coordination between regional, county, and local planning.

RELATING URBAN FORM TO TRANSPORTATION PERFORMANCE

Several years of research and applications in land use and transportation have led to the formation of a group of methods to analyze and measure the relationships between settlement patterns, transportation behavior, and the performance of transportation systems. Recently, it has become popular to define settlement patterns *in terms of* their effect on transportation behavior. It is common to contrast *auto-dependent* and *transit-dependent* patterns. Auto-dependent settlements infer landscapes with wide roads, numerous large parking lots, and generally dispersed, lower-density development. Transit-dependent (and HOV-oriented) settlements, on the other hand, suggest streets full of people and concentrated, higher-density development. It is widely recognized that most settlement patterns since the 1950s can be considered auto-dependent. The severe automobile traffic congestion problems of contemporary settlements have led to a renewed interest in transit-oriented forms. Now, however, the new term qualifying such urban forms is "*transit-friendly*," a notably less demanding or more optimistic way to define possible future modes of transportation.

This nomenclature is useful in defining extremes in patterns of settlements (e.g., San Francisco versus Los Angeles). But it fails to identify the exact characteristics of settlements that make them more or less auto- and transit-dependent. For example, in what category does downtown Seattle belong, or where does it belong between these two poles, and what is the effect of settlement patterns in the rest of the urban region? To respond to these questions, researchers have used a range of variables to measure the interaction between the characteristics of urban form and transportation performance. These variables will be the methodological foundation of our research.

MEASURING URBAN FORM AND RELATED TRANSPORTATION PERFORMANCE

Our literature survey has identified *density, land use mix or grain, nucleation, corridor*ing, *connectivity*, and *experiential complexity* as the variables that are

consistently used to measure aspects of urban form affecting transportation. Researchers and policy planners have used these variables to explore the relationships, or linkages, between urban form and transportation. Because this list constitutes an initial attempt to assemble research methodologies from sources representing a variety of disciplines, it may not be inclusive. The variables (and their scope) used to measure urban form in terms of its transportation dimension are more fully described below.

Density measures numbers of residents or jobs in a given area, indicating the size of a market for transportation systems. Density is important at all scales of the urban structure. It is generally related to the number of trips taken at given points in time. Density affects mode split, as the higher the concentration, the more feasible the transit- and HOV-like characteristics of the transportation system. A variable similar to density is *intensity*, which measures the density of buildings and facilities.

Land Use Mix and *Land Use Grain* are measures of access to different types of activities or land uses in a given area, usually related to density of people, jobs, businesses, and the distances separating them. Land Use Mix describes the number and proportions of different land uses in a given area. Land Use Grain describes the degree to which these different land uses are interspersed with one another. The two concepts are quite different. Two areas could have the same mix, with an equal number of different land uses, but also have very different grains by arranging the land uses differently. One area could be "coarse-grained," for example, locating each different land use in its own separate district, while the other could be "fine-grained," combining all of the land uses together on each block in the area. Mix and grain affect the length of trips taken, and influences mode split in that the shorter the distance between activities, the more feasible the use of non-motorized transportation modes.

Nucleation measures the distribution of densities, or concentration of people and jobs. It indicates the degree of centralization or decentralization of an area. Nucleation is important at the larger scales of the urban structure, particularly at the regional and city

scales. Regional patterns, hierarchies, functional structures, the size and intensity of centers and subcenters, and distances between centers are all important measures at the regional scale. Urban areas have at least one nucleus or center, but today's metropolitan areas have so many nuclei: they are multi-nucleated. As concentrations of relatively dense development within a city or a region, nuclei may or may not have an adequate mix of uses. Nucleation affects mode split in that a highly nucleated area will tend to support regional transit, depending on the number and density of the nuclei. Nuclei are also likely to support local transit, HOV, or non-motorized transport, especially if they are of mixed land uses.

*Corridor*ing measures the concentration of people and jobs (distribution of density) along major transportation routes. Like nucleation, corridoring is important at the regional and city scales because it describes the distribution of density, intensity and development. It may or may not be related to land use mix; for instance, a commercial strip rarely includes residential or office facilities. Corridoring affects mode split in that it can support regional transit and HOV use. But it is generally less effective than nucleation in supporting non-motorized transport because of increased distances between activities.

Connectivity is a measure of achieving short distances between activities without necessarily mixing land uses. Regional and city transportation systems typically provide a high level of connectivity. But a low level of connectivity is characteristic of transportation systems at the district and site scales (e.g., loop and cul-de-sac streets). Low connectivity is also characteristic of non-motorized transport in contemporary environments (e.g., discontinuous trails, sidewalks, etc.).

Experiential Complexity is a measure of sensory diversity found in the immediate environment. It affects one's perception of distance. High levels of complexity support non-motorized and slow transport: they help to distract the traveler and to reduce the perception of time spent on the road. On the other hand, low levels of experiential

complexity are desired to promote safety at high speeds. The typically low levels of complexity found in contemporary landscapes (blank walls, parking lots, and large asphalted surfaces) are not conducive to slow transport.

Establishing actual values for these variables, which relate to transportation performance, is one of the researchers' principal research goals. The following table illustrates in a simple way how urban form characteristics relate to transportation performance:

Urban Form/ Transportation Variables	Transportation Performance	
	Auto-dependent forms More auto use	More transit, HOV, and non- motorized-transport use
density	low	high
nucleation	some	high
corridoring	some	high
mix	low	high
connectivity	low	high
experiential complexity	low	high

Clearly, urban forms that decrease dependence on driving alone will exhibit high values in many of the variables selected. However, as other researchers have noted, transportation performance usually depends on not one but several variables. For example, we know that certain levels of density are essential to support transit. Yet density alone is not sufficient: a continuous street network (connectivity) and short distances between the different land uses (grain) must be carefully established to promote good access to transit. Klahanie, a development in King County, presents an example of how transportation performance is contingent on many factors. The community's gross residential densities of six to seven dwelling units per acre are quite conducive to good transit service, but the discontinuous street layout and lack of commercial services are not. Klahanie's present dead-end primary feeder loop road is not efficient for bus service. The loop will eventually join another arterial when the project is completed, but at this time residents have no alternative but to use their car. Also, pedestrian access to the main

arterial to which Klahanie is connected is impractical because of the excessive distance between the houses and the arterial. A complete loop road inside the development would support bus service as residents move into the community. Also, commercial facilities located along the arterial (or better still, inside the community) would provide an incentive for residents to use modes of transportation other than their cars.

The variables also have different significances when considered in the context of the various scales of the urban structure. For example, connectivity and experiential complexity usually apply only to the lower scales, while density and mix must be considered at all scales. At the regional scale, high densities and high levels of mixed uses will support transit, whether or not nucleation is pronounced. But low densities and low levels of mix will demand high nucleation or corridoring to support transit.

Finally, research needs to include several dependent variables that relate to traffic congestion and environmental degradation, including air, noise, water pollution (total, per passenger mile, per mode), and energy consumption (total, per passenger mile, per mode). The significance of these variables in auto-dependent urban forms must be recognized and included in all research.

PROPOSED RESEARCH SUBJECTS

To provide data on ways to design and develop settlement patterns that reduce dependence on single-occupancy vehicles, research must be conducted in three general areas. They are as follows:

- **Urban Form and Travel Behavior.** *What* are the characteristic elements of settlement patterns that will support means of transportation other than single-occupancy vehicles, reduce the number of trips and shorten trip length?
- **Policy and Implementation Studies.** *How* can public policy *effectively* encourage settlement patterns that would reduce dependence on single-occupancy vehicle use? This question addresses the necessity of retrofitting existing settlements, as well as shaping new settlements.
- **Market Studies.** *Why* do most settlement patterns created today encourage the use of single-occupancy vehicles? What are the primary forces shaping these patterns? To what extent are these forces changing, and, hence, changing settlement patterns? To what extent are these forces and patterns changeable? How can public policy be used to shift market preferences?

This section provides a brief summary of proposed research projects. The researchers' intent is to provide a guide for the Department of Transportation in programming their research efforts.

For each project a brief description, estimated costs, and possible funding sources are given. The cost estimates will be refined when specific research proposals are prepared, which would occur several months prior to beginning each study. The possible funding sources should be seen as suggested sources, as other sources could also be acquired.

URBAN FORM AND TRAVEL BEHAVIOR

The key question in this content area concerns which types of physical development patterns should be promoted to reduce dependence on the single-occupancy automobile. The researchers' goal is to determine those variables of urban form that are most effective in reducing the need to make trips, in promoting alternative modes, and in

reducing travel distance. In particular, we need to realize what thresholds must be exceeded in the most important variables to achieve specific transportation goals.

The researchers' general hypothesis is that urban form can have a significant effect on transportation behavior and its related environmental concerns, but a combination of urban form characteristics at the local and regional scales must occur together to make a significant difference. A comprehensive, multi-scale strategy is needed if policy makers want to use urban form to affect transportation outcomes.

One of the challenges will be to find valid, reliable, and efficient methods of operationalizing urban form concepts and the concept of access. Discovering indicators that are useful for modeling the relationship between urban form and travel behavior will be one benefit of this research.

Since the researchers believe that this research must be approached on more than one scale, we recommend studying this question at different scales of (1) the region, (2) the subregion (including the city and corridor), (3) the district or neighborhood, and (4) the site.

The researchers hope the results of research in this area will be an improved understanding of the urban form variables that are most important for various travel characteristics, an understanding of the significance of changes in urban form on travel behavior, and of the relative importance of regional and local urban forms for travel behavior. This will be directly applicable to local and regional growth management plans being prepared throughout the state of Washington and the U.S. Those growth management plans with the goal of reducing reliance on driving alone could incorporate the urban forms that encourage alternatives to the single-occupancy automobile in the land use elements of their plans. The research could also influence subdivision, zoning, and other land development standards. For example, local jurisdictions could be encouraged to require a greater mix of land uses within new neighborhoods through their

zoning codes and better pedestrian connections between residential subdivisions and neighborhood retail services through their subdivision codes.

Specific projects needed in this area include the following:

District/Neighborhood Urban Form Impacts on Travel Behavior

Description This study will examine the travel behavior and neighborhood urban form variables associated with households in the Puget Sound region. Both residential and work place neighborhoods will be studied. The Puget Sound Regional Council (PSRC) household travel survey and 1990 U.S. Census data will be used. Travel behavior variables will include mode, frequency, length, and vehicle occupancy. Urban form variables will include land use intensity, land use mix, level of transit service, and distance from the central business district. (See research proposal of June 15, 1992, prepared for the WSDOT Research Office by Gary Pivo and TRAC).

Approved Budget \$55,000

Funded by WSDOT

Regional Urban Form Impacts on Travel Behavior

Description This study will examine the relationship between urban form and indicators of travel behavior at the metropolitan scale. It will involve a comparative assessment of metropolitan areas across the U.S. The regional urban form variables will include density, area, nucleation, coridoring, jobs-housing balance, land use mix, containment, transportation facility mix, pattern, and intensity. The travel behavior variables will include mode split, travel length, congestion, number of trips, vehicle occupancy, and origin-destination patterns. The U.S. Census and other secondary sources will be used.

Estimated Cost \$70,000

Possible Funding WSDOT, FTA, Urban Land Institute, Lincoln Institute of Land Policy

Impacts of Site Design Elements on Non-motorized and HOV Travel Behavior

Description This study will examine the effects of connectivity and experiential complexity on travel behavior. The focus will be on the aspects of urban form that support and enhance non-motorized transport, HOV, and transit use. The study will include areas within the medium ranges of density and mix, including suburban and urban, employment and residential sites. Travel behavior variables will include number and length of non-auto trips and their share of total trips.

Estimated Cost \$60,000

Possible Funding WSDOT, National Endowment for the Arts

Urban Form Impacts on Suburb-to-Suburb Commuting Opportunities

Description One of the most important and least understood groups of commuters are cross-commuters who travel from suburb to suburb. This study will utilize the database developed for the first study mentioned above to examine the travel behavior of these commuters in greater depth. It also will examine linkages that may exist between their travel behavior and the land use pattern where they live and work.

Estimated Cost \$30,000

Possible Funding WSDOT, PSRC

Transit Ridership and Residential Density

Description Previous research has associated higher residential densities with a higher transit ridership share. Several major studies have related residential density to transit ridership for the Northeast region of the United States; however, this information is generally felt to be invalid for the newer cities in the west, which have developed after the advent of the automobile. A study recently done at the University of Washington showed a promising approach to developing a valid relationship for density and transit use. There is a need to quantify the relationship between residential density and transit use in the major metropolitan areas of Washington state.

The newly available 1990 census results will be used with Metro transit passenger counts available for each bus stop. These data will be analyzed to develop estimates of residential density and transit ridership in the Seattle area.

This information will be useful to local and regional transit and land use planners in working to create development patterns more amenable to quality transit service.

Estimated Cost \$40,000

Funded by Washington State Transportation Commission

Travel Patterns in Mixed Use Neighborhoods

Description Recent research by the Washington State Transportation Commission's Innovations Unit focused on the impact of land use policies on transportation systems. Land use/transportation linkage concepts such as encouraging pedestrian-friendly site design, providing attractive transit facilities and services, and developing appropriate mixes of nearby land uses, are intended to enhance the attractiveness of alternative transportation modes and reduce automobile trip making. However, the influence that attributes such as mixed land uses have on travel behavior needs to be quantified.

Surveys will be conducted in several Puget Sound and Spokane neighborhoods to gather data on travel behavior in neighborhoods with a good mix of housing, shopping, and other services that might reduce the need for auto trips. The survey data will be analyzed to determine whether any strong relationships exist between mixed land uses and travel behavior.

In mixed use areas, opportunities for non-motorized trips are expected to increase and auto trips to decrease. What is not known is how much reduction in auto trip making can be expected. This research will establish trip reduction rates for each of the land use types studied. These trip reduction rates will be useful to planners and developers in evaluating the tradeoffs between mixed-use and other types of development.

Estimated Cost \$130,000

Funded by Washington State Transportation Commission

Impacts of High-Capacity Transit Development on Urban Form

Description Growth management strategies have become the preferred means of controlling urban sprawl, promoting transportation alternatives to single-occupant automobiles, and subsequently reducing air pollution and energy consumption. The development of high-capacity transit (HCT) systems has long been hailed by land use planners as an effective way to control and focus new construction along densely developed corridors. Early studies of the land development and economic impacts of HCT systems have revealed mixed results. Thus, both the negative and positive impacts that are beginning to result from recently developed HCT systems need to be assessed.

This study will attempt to address the basic research issue of the effects high-capacity transit development has had on regional form, district/neighborhood form, and on type and density of site development. A comparative analysis of regional urban development patterns in cities with and without HCT systems will be undertaken. The study will also examine the extent to which HCT development has affected land use patterns in ways that reinforce use of the HCT system, and the extent to which the absence of HCT systems has promoted the use of single-occupant automobiles. The study will use 1990 U.S. Census data for specific HCT and non-HCT transportation corridors.

The analysis this research will provide will be valuable to planners and elected officials faced with making decisions about the transportation system improvements that should carry us into the next century. A clearer understanding of how HCT systems affect land development patterns and economic conditions within HCT corridors will help elected officials and the public make informed decisions about how best to invest public dollars to improve our transportation system.

Estimated Cost \$40,000

Possible Funding WSDOT, PSRC, Metro

Impacts of High-Speed Rail on Statewide Development Patterns

Description The 1991 state legislature sponsored a high-speed ground transportation feasibility study. Potential high-speed rail corridors were evaluated and analyzed for any possible fatal flaws that might preclude feasibility of such a system in Washington state. No fatal flaws were discovered, and a phase II study was recommended to examine specific corridor alignments. High-speed ground transportation, if implemented, has the potential to influence the type, density, and location of future development statewide.

A literature search of high-speed ground transportation case studies will be conducted. On the basis of information and data generated through the literature search and from supplemental interviews with high-speed rail professionals, the factors that influenced station development will be analyzed, as will the impacts on development nationwide. This analysis will then be used to project the likely impacts that implementing a high-speed rail system in Washington state will have on the type, density, and location of development statewide.

As a result of the information provided through this research, elected officials and the public might better understand how high-speed ground transportation will impact land development in Washington state, and how this transportation investment will or will not support the state's growth management goals.

Estimated Cost \$25,000

Possible Funding WSDOT, High Speed Rail Commission, Port of Seattle, Port of Tacoma, Cascadia Corridor Commission

POLICY AND IMPLEMENTATION STUDIES

The value of knowing the forms urban areas can take to become less auto-dependent is ultimately derived from using this knowledge effectively in the public planning and policy-making processes. The goal of this part of the research agenda is, therefore, to improve our ability to implement urban forms that successfully support a decrease in the number of people driving alone. Our general hypothesis is that public policy can have a significant influence on urban form.

We recommend that research be done in three areas: first, we must study the basic conditions for the successful and unsuccessful implementation of plans shaping and reshaping urban form. Second, we need to evaluate the effectiveness of existing policies

that either directly or indirectly affect urban form in relation to travel behavior. Third, we need to identify potential new tools and policies.

State and local officials need to implement policies that present the best probability of effectively shaping urban form to encourage alternatives to driving alone. State and local officials' goals can be achieved, and time and money can be spent developing plans that result in positive, influential changes.

Specific projects in this area include the following:

Factors that Influence the Implementation of Transit- and HOV-Supportive Urban Forms

Description This study will determine the factors that are associated with successful and unsuccessful implementation of urban developments that encourage transit and HOV use. The types of developments to be studied will be determined by the research on urban form and travel behavior outlined above. These developments could include, for example, mixed-use employment centers, and higher density residential development, among others. This study would locate communities where these types of projects have been either successfully or unsuccessfully attempted. It would then determine which factors determine success or failure. Factors that will be examined include regional location, site features (e.g., lot patterns), access, regulations, interagency and interdisciplinary cooperation, public involvement, neighborhood resistance, state roles, market conditions, roles of elected leaders, and financial arrangements. When possible, data on successful projects' travel behavior will also be examined to determine whether the expected travel behavior outcomes were realized.

Estimated Cost \$100,000

Possible Funding WSDOT, PSRC

Land Use, Urban Design, and Transportation Planning Tools that Affect Travel Behavior

Description This study will examine the various tools used by local government to influence the relationship between land use and travel behavior, such as demand management, parking caps, downzoning, concurrency, housing linkage, parking pricing, mixed-use zoning, and design guidelines. It will survey local governments across the U.S. to determine the extent to which these tools are being used, how they are being used, and their effectiveness. Examples of successful programs will be compiled and studied in greater depth.

Estimated Cost \$70,000

Possible Funding WSDOT, FTA, PSRC

A Critical Assessment of Auto-Dependent Bias in Planning and Design Manuals and in Local and Regional Growth Management Plans and Regulations

Description This project will examine nationally and locally published planning and design manuals, as well as local growth management plans and regulations adopted by jurisdictions in Washington state and identify the elements in them that discourage transit and HOV use. The manuals examined will be prominent national manuals, such as the *Subdivision and Site Plan Handbook* or the *Federal Highway Capacity Manual*. Local growth management plans will include city, county, and county-wide plans, in particular their land use and transportation elements. Regulations would include zoning, subdivision, and parking codes. The result would be a checklist of items that discourage transit and HOV use and recommendations for making revisions to codes, design manuals, growth management plans and regulations.

Estimated Cost \$50,000

Possible Funding WSDOT, Washington State Department of Community Development (WSDCD), FTA, Municipality of Metropolitan Seattle (METRO), Snohomish Transit Authority (SNOTRANS)

Model Guidelines for Pedestrian and Bicycle Planning

Description This study would yield a set of guidelines on how to retrofit existing settings and how to equip new suburban or urban areas with pedestrian and bicycle systems. The guidelines would summarize knowledge gained from the existing literature, as well as from practice, and make it readily accessible to the planning staff and constituencies of counties and cities. The guidelines would include the following:

1. a description of the process by which a jurisdiction can define potential pedestrians and bicyclists and what services they would most likely need to support their activities; and
2. examples of how to retrofit existing areas or develop new areas with appropriate pedestrian and bicycle facilities, such as

- (a) prototypical conditions of area- or city-wide networks connecting employment, retail, education, and activity centers with residential areas;
- (b) prototypical facilities for existing or new retail and employment activity centers that connect to adjacent residential areas (e.g., mall, neighborhood commercial strips, school campuses, office complexes, etc.);
- (c) prototypical facilities for existing or new residential developments (e.g., dense single-family areas, apartment complexes, public utility districts, etc.) that connect to adjacent residential areas, as well as activity centers, and
- (d) prototypical facilities for existing or new educational developments and community centers.

Estimated Cost \$50,000

Possible Funding WSDOT, Bullitt Foundation, National Endowment for the Arts

Design Guidelines for Retail Shopping Areas that Address Parking Placement

Description One of the strongest biases of site design in favor of automobiles is the location of parking relative to shopping facilities and surrounding streets. Typical shopping malls are located as islands on vast seas of parking, without a strong orientation to the surrounding street system. Direct connections to bus stops on adjacent streets rarely exist for pedestrians, or when direct bus service is available, it is usually via circuitous routes that sacrifice time and efficiency for the rest of the transit-served area. There are more effective ways to design retail center sites, but retail merchants and customers resist shifting parking lots to areas less disruptive to pedestrian, bicycle, and transit access. Consumer and merchant preferences regarding parking location need to be researched to determine whether significant changes can be made to parking and site design to better accommodate HOV travel. The implications of replacing surface parking with structured or underground parking also needs to be studied. Converting surface parking to structured or underground facilities would allow for more compact transit/pedestrian-scaled site design.

This research will consist of the following broad tasks:

1. Survey shoppers and merchants at targeted retail shopping areas, including large shopping malls, to determine consumer perceptions and preferences for retail parking locations and availability; questions will be designed to assess what other more compact parking alternatives might be feasible for shoppers and merchants.
2. Interview developers to determine what would be needed to make the building of parking facilities within or beneath buildings economical for developers.
3. Develop guidelines for planning and designing retail parking locations and access to better accommodate HOV and non-motorized transportation.

Estimated Cost \$45,000

Possible Funding WSDOT

MARKET STUDIES

Today's primarily auto-dependent urban forms will need modifications if we are to achieve our transportation goals. While the studies above will determine how different the new forms will be, it is important to ask why the market is producing so few urban forms that are transit-friendly and how this can be changed. It is possible that consumers (both firms and households) and suppliers (e.g., developers and bankers) are economically better off by selecting locations and developments that are auto-dependent. If this is true, then shifting production toward less auto-dependent forms will require new designs, regulations, incentives, or efforts that change the priorities of consumers and suppliers. On the other hand, the market may be operating with imperfect information. House buyers often believe, for example, that they will have more mobility if they live in low-density suburban developments — only to find this not to be true. Similarly, developers often erroneously believe that retail stores in mixed use developments are less profitable. If imperfect information is discouraging transit-dependent urban form, then these forms can be made more competitive by giving consumers and suppliers accurate

information about how different urban forms can meet their needs and satisfy their preferences.

If we better understand the current development trends and if we know the reasons why transit- and HOV-supportive development is only a small part of this production process, we will be better equipped to promote an increase in the production of less auto-dependent development. The following studies are designed to accomplish this.

Trends and Patterns of Transit-Oriented Development

Description This study will determine trends in the development of transit-dependent development and explore the reasons for them. Developers and real estate experts will be interviewed to collect data on the quantity, timing, and location of the development types found in the previous studies to reduce reliance on driving alone, such as urban infill, higher density housing, and mixed-use employment centers. It also will examine factors that may be associated with their quantity, timing, and location, such as access, transit service, zoning rules, tax rates, and infrastructure facilities. Researching these trends and the factors that are associated with them will help us understand why the trends are occurring and, thus, improve our ability to encourage and predict them.

Estimated Cost \$65,000

Possible Funding WSDOT, Metro, PSRC, Lincoln Institute

Consumer Choices of Auto-Oriented versus Transit-Oriented Development

Description This study will survey employers and residents that have chosen to locate in auto-dependent and transit-oriented developments to determine (1) the factors that influenced their choice of these locations and how they rate these factors in both the location they chose to locate and the location where they did not locate. Factors to be examined include consumer characteristics (e.g., household or firm size, household life-cycle stage, household income, firm industrial classification, and firm functional activity) and development characteristics (e.g., location, amenities, rent/price, public services, and environmental quality). The results will enable the researchers to better understand how locators (i.e., firms and households) perceive the relative strengths and weaknesses of auto-dependent and transit-oriented developments. This would increase our ability to plan transit-oriented developments that are more attractive to consumers.

Estimated Cost \$45,000

Possible Funding WSDOT, Urban Land Institute

Marketing Transit- and HOV-Oriented Development

Description This study will be a follow-up on the previous study and determine what should be done to increase the competitiveness of transit-oriented development, given the locators' perceptions of their merits relative to auto-dependent development. The first task is to evaluate auto-dependent and transit-oriented development to determine whether consumers' perceptions are accurate. If they are, then recommendations will be made, based on the perceived strengths and weaknesses that can increase the competitiveness of transit-oriented development. If the perceptions are inaccurate, then recommendations will be made for improving the accuracy of information in the market-place. This will result in a strategy for improving the competitiveness and, thus, the production and use of transit-oriented developments.

Estimated Cost \$55,000

Possible Funding WSDOT, Urban Land Institute

RESEARCH PLAN IMPLEMENTATION

This research program will serve as a guide in submitting individual research project grants to various funding sources. We have identified several possible research funding sources. The following agencies and organizations will be given the opportunity to review this report and to determine which studies they may be interested in funding or co-funding:

Washington State	{ Department of Transportation Department of Ecology Department of Community Development Washington State Energy Office State Transportation Commission University of Washington
Regional Agencies	{ Municipality of Metropolitan Seattle (Metro) Snohomish Transit Authority Puget Sound Regional Council
Federal Agencies	{ Federal Highway Administration Federal Transit Administration National Science Foundation National Endowment for the Arts
Private Organizations	{ Lincoln Institute for Land Policy The Urban Land Institute The Bullitt Foundation The Ford Foundation The Henry M. Jackson Foundation

The researchers' intent is to complete the studies of this plan within a 4-year time frame, with the first studies beginning to yield results within one year. This time-frame may be considered too short and too ambitious from a research point of view. For policy makers, however, it may seem too long to wait for answers and to get results on their research investments. We recognize the necessity of balancing the short time frames normally associated with research for policy purposes with the longer time frames associated with research for scientific purposes. We will attempt to balance these needs in at least two ways. First, the overall research program has been subdivided into several study questions. Each question will be answered by a separate project. By breaking the

overall program into smaller sequential projects, we will be able to generate a series of answers beginning early and continuing throughout the program. Second, each individual project will begin with the preparation of a policy paper, based on a literature review, that discusses the problems and summarizes state-of-the-art knowledge on the issue. This paper will help policy makers understand the nature of the problem, the kinds of issues the study will address, and the research results that can be expected given the study hypotheses. It will help the researchers build on existing knowledge in that area. The policy paper will be followed up with data collection, an analysis, and a final report, all of which will be released several months after the policy paper. In this way, each project will have an initial product and a final product.

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