A Planning Template for Nonwork Travel and Transit-Oriented Development

Task 2 Report: Preliminary Template Design

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PROJECT OVERVIEW

This project seeks to improve the planning methodology for Transit-Oriented Development (TOD) by bringing into sharp focus the dynamics of the retail marketplace and nonwork travel demand. Specifically, it will:

- Analyze the current state of understanding of nonwork travel demand in the context of retail market dynamics on a national level.

- Review the state of the art in transportation planning with respect to nonwork travel.

- Create a planning template for transportation and land use planners who are pursuing TOD.

The central Puget Sound region (Seattle-Tacoma-Bellevue-Everett metropolitan area) will be used as a case study for development of the template. The nonwork travel environment of the region will be mapped and analyzed, and the findings generalized to other large metro regions. Of particular interest are "retail" activities that have flexible locations and that together generate more than half of all person trips: shopping for goods and services, eating out, entertainment, recreation, and other leisure pursuits.

The planning template will specify the major nonwork venues that should be mapped and spatially analyzed, the forces shaping urban retail form that need to be monitored, and the factors that will determine TOD regional (not just station-area) success.

EXECUTIVE SUMMARY

Transit-oriented development (TOD) is a policy response to the impacts of metropolitan growth and its effects including traffic congestion and travel-related environmental impacts, and to the concern that growth patterns threaten the livability of American communities. As TOD has been implemented, it has come to mean compact, mixed-use development supported by and in turn supporting new rail transit systems. The number of metro areas, large and small, that have embraced this approach to managing growth has increased over the last two decades to the point that it can be said that rail-TOD is the dominant urban planning paradigm in the United States.

In Chapter One we outline the rail-TOD paradigm and the impetus for its widespread adoption. We review federal policies and initiatives that support it, including land use criteria for "new starts" transit projects that seek to qualify for federal funding assistance. We also review the limited amount of experience to date with TOD and its actual effect on travel and land use patterns. And we summarize the growing critique regarding the benefits of TOD compared to its costs as measured by changes in regional transportation system performance and development patterns.

The possibility that rail-TOD will not produce substantial changes in activity patterns leads to a review in Chapter Two of the market forces that appear to be shaping urban form and human activity patterns today, in particular patterns of nonwork activity, and that can be expected to influence future patterns of development and travel. The number and strength of these forces suggest a growing level of complexity and uncertainty that complicates the task of metropolitan transportation and land use planning.

In Chapters Three and Four we propose and offer for review and comment a new planning template and process that we believe is suited to the task of providing guidance to metropolitan decision makers involved in transportation planning in the context of a very uncertain future. Given the predominant focus on commuting trips in the planning activities of local governments, we have designed the template as a supplement to those activities and with a focus on nonwork trip-making. The Non-Work Travel Improvement Planning Process directly responds to the complexity of urban development and activity by employing a diverse Delphi Expert Panel for forecasting and backcasting in the major steps of the process.

CHAPTER ONE

TRANSIT-ORIENTED DEVELOPMENT: CONCEPT, EXPERIENCE, AND IMPETUS FOR WIDESPREAD ADOPTION

INTRODUCTION

Low-density, separated-use development has become the predominant land use form across much of urban America in the post-World War II period. This form's connection to the large growth in personal and commercial travel in the same time span is well recognized, if not fully understood. Concerns over the impact of land use and personal transportation on the human and natural environment have been voiced in rising and falling crescendos over the last fifty years. Recently, concern has risen anew in response to the continuing growth and spread of urban development, ever higher rates of personal travel, and to the linkage between increasing travel and the greenhouse gases responsible for the suspected warming of the earth's atmosphere.

Public concern over growing congestion is the most tangible manifestation of problems linked to current urban form. In reaction, the federal government, states, local jurisdictions, metropolitan planning organizations, and transit agencies have adopted policies and strategies directed at reshaping development into more compact, mixed-use patterns. These efforts have been encouraged by numerous non-governmental organizations and individuals who view our current land use patterns as both environmentally and socially damaging.

One policy that has gained wide acceptance is transit-oriented development. TOD has over the last decade become the dominant urban planning paradigm in the United States. Proponents of TOD envision dense, mixed-use activity centers connected by high quality transit systems. Metropolitan planning organizations, local governments, and public transit agencies have launched major efforts to direct growth to existing centers, infill sites, and new suburban communities, and in some cases to constrain growth from leap frogging and spilling into adjacent jurisdictions. These efforts are motivated by the belief that new urban forms, which in some ways replicate older forms, will produce significant transportation benefits. TOD will, it is assumed, induce more pedestrian and transit trips, and reduce both the average length and frequency of household auto travel.

TOD: THE CONCEPT

Figure 1-1 depicts TOD's hypothetical spatial environment. Calthorpe has provided a detailed delineation of the TOD concept (Calthorpe 1993). He defines a TOD as a center with a mix of high-density residential, retail, office, public, and open space uses. Retail shops and services are in a commercial core within an easy walk of homes (600 meters, or about ten minutes). A transit station is at the center of the core. Uses in the core are "vertically integrated" -- apartments and offices rise above ground-floor stores.

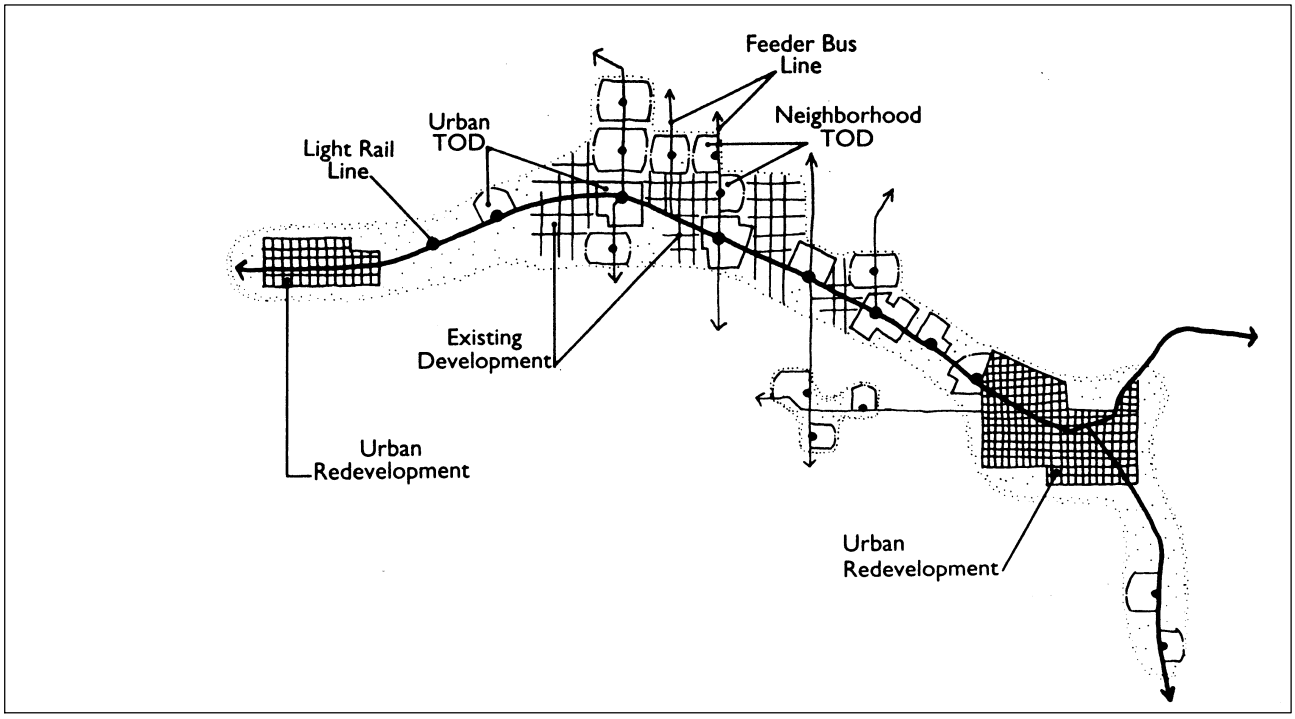


Figure 1-1 Schematic of the Transit-Oriented Development (TOD) Planning Concept (Calthorpe 1993)

Secondary areas for lower intensity uses surround the core to a distance of 1600 meters. These areas might be locations for single-family housing in a range of sizes, small parks, schools, and light industry. Housing design features include front porches, shallow setbacks from the street, and alley access to off-street parking. Streets largely conform to a grid pattern and link directly to the TOD for walking and biking access.

Calthorpe explains that the number and mix of commercial establishments in each TOD would vary depending on the size, location, and overall function of each center, whether servicing nearby residents or an entire community.

Linkage of Centers

Proponents of TOD acknowledge that for meaningful regional transportation benefits to be achieved, centers must be linked by a high quality regional transit system, and the number of centers must be sufficient to allow for cost-effective transit operation. There must be a "transit metropolis" providing high accessibility to distant work centers from all areas (Bernick & Cervero 1996). In other words, TOD will induce significant new transit commuting only if the work locations for many are within walking distance of stations. The regional linkage will also enable access to a range of goods, services, and recreation unavailable in a community center.

Types of Centers

Calthorpe distinguishes two types of TODs -- urban and neighborhood -- depending on their articulation with the transit system and the intensity of their development.

- Urban TODs are located at stations on a trunk line of the regional system, which could be light rail, heavy rail, or express bus. Their locations are determined by station spacing, and are typically 0.8 to 1.6 kilometers apart. Urban TODs have high commercial intensities, employment clusters, and moderate to high residential densities. If urban TODs are located in established neighborhoods, Calthorpe recommends that they be developed at the mix of uses and densities allowed or required under current planning rules.

- Neighborhood TODs are located on a local or feeder bus line within three miles (no more than ten minutes) of a trunk line transit station. They are developed at moderate residential densities and provide for retail, service, entertainment, recreation, and civic uses. Neighborhood TODs can be closely spaced to form a "corridor" of activity nodes.

Proximity of Competing Retail

Since a TOD depends, in part, on retail uses to attract pedestrians and transit riders, nearby auto-oriented retail centers can compete with and diminish its utility. For this reason, Calthorpe (1993, p.82) proposes that new competing retail uses should be strictly limited within one mile of the core commercial area through zoning amendments within the TOD market area.

TOD: THE NEW NATIONAL PLANNING PARADIGM

So numerous are the metropolitan planning organizations across the United States that have embraced transit-oriented development (TOD), that it would not be inaccurate to describe it as the national transportation-land use planning paradigm. It's genesis goes back at least to the rail systems built just after WW II. Porter (1997, 1998) recently reviewed the status of station-area development for North American urban rail systems that were placed in operation beginning in the mid 1950s. His categorization of these systems and older systems by generation is shown in Table 1-1.

Efforts are underway to extend and upgrade several of these current systems, and many other regional and local transit agencies have initiated or are contemplating major investments in new transit capacity, particularly light rail systems. These agencies expect that dense and mixed-use development around stations will follow and cause significant shifts away from automobile usage for both work and non-work trips.

Federal Encouragement of Transit-Supportive Land Use

Federal support for construction of these new systems is conditioned on a showing of supportive land use patterns. And several separate federal initiatives have been mounted to encourage the integration of transportation with land development.

Federal interest in the linkage between land use and transportation goes back to the late 1970s when new subway systems in the San Francisco Bay area and metropolitan Washington, DC failed to gain the ridership expected because not enough housing and commercial development

Table 1-1 Generations of Urban Rail Transit Systems (Porter 1997, 1998)

Generation	City or Region (Year Operations Initiated)
Simultaneous city/transit development, continuous since the mid 1800s, including modern extensions:	Boston Chicago Cleveland New York Philadelphia
Mid 1950s to mid 1970s major region wide systems:	Toronto (1954) San Francisco (1973) Washington, D.C. (1976)
The Third Wave, late 1970s through 1980s:	Atlanta (1979) San Diego (1981) Miami (1984) Buffalo (1985) Pittsburgh (1985) Portland (1986) Vancouver (1986) Baltimore Metro (1987)
New systems: the 1990s	Los Angeles (1990) Sacramento (1990) San Jose (1991) Baltimore LRT (1992) Detroit (1993) St. Louis (1993) Denver (1994) Dallas (1996)

was close to the train stations. Authority for the most recent efforts was granted in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and revised in the Transportation Equity Act for the 21st Century (TEA-21) of 1998. TEA-21 requires that the metropolitan planning process provide for consideration of projects and strategies that will, among other things, "protect and enhance the environment, promote energy conservation, and improve the quality of life."

Regulations implementing the Act (23CFR450.316) require several factors to be considered and reflected in metropolitan transportation plans including: "the likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land use and development plans." The regulations specify that this analysis should include "projections of metropolitan planning area economic, demographic, environmental protection, growth management, and land use activities consistent with metropolitan and local/central city development goals, and projections of potential transportation demands based on the interrelated level of activity in these areas."

Thus TEA-21 appears to explicitly require a future estimate of the level of activities encompassing both work and nonwork and their impact on transportation patterns.

Federal New Starts and Funding Criteria

"New starts" transit projects are funded by the Federal Transit Administration under authority granted by Congress in TEA-21 and the federal transportation budget. Recommendation for full funding is now based, in part, on a number of land use criteria that are strongly supportive of TOD goals (Table 1-2). Projects receive higher ratings and are more likely to be funded when there are transit-supportive land use conditions and government policies, including regional growth management policies to control dispersed development.

Table 1-2 FTA Land Use Criteria for New Starts

Category	Rating Based On:
Corridor Economic Conditions	Demand for locating in corridor
Existing Zoning	Density and mixed-use allowable
Existing Station Area Development	Existing land use is transit-supportive
Station Area Planning	Is being conducted and is supportive of TOD
Regional Growth Management	Effective region wide policies implemented
Urban Design Guidelines	TOD-supportive; implemented for station areas
Promotion and Outreach	Agencies actively conducting for TOD
Parking Policies	Strength of restrictive policies
Zoning Changes	TOD-supportive, implemented or developed
Market Studies	Comprehensive analysis of TOD market potential
Joint Development Planning	Strength of public-private program

Source: USDOT 1998

Table 1-3 lists projects that have existing federal "full-funding" agreements, those proposed for full-funding commitments, and others recommended to receive funding for preliminary engineering. The U.S. General Accounting Office, in a recent report to Congress that scrutinized the "new starts" transit projects, identified 14 projects under construction, and 42 other projects

Table 1-3 Transit "New Starts" With Existing Full-Funding, Proposed Full-Funding, or Funding of Preliminary Engineering Status

City/Region	Project	Total Capital Cost ($ Millions)
Existing Full-Funding Commitment:		
Atlanta	Heavy rail extension	463
Boston	Underground bus transitway	513
Denver	Southwest light rail extension	176
Houston	Regional bus improvements	625
Los Angeles	Heavy rail extensions (three)	3,136
Maryland	Commuter rail extension and upgrade	132
Hudson-Bergen (NJ)	Light rail line	992
Portland (OR)	Light rail extension	964
Sacramento	Light rail extension	222
Salt Lake City	Light rail line	312
San Francisco	BART heavy rail airport extension	1,233
San Jose	Light rail extension	325
San Juan (PR)	Heavy rail line	1,550
St. Louis	Light rail extension	339
Proposed for Full-Funding Commitment:		
Dallas	Light rail extension	517
Ft. Lauderdale	Heavy rail upgrade	422
Memphis	Light rail extension	30
Newark	Light rail system	989
Orlando	Light rail system	600
Salt Lake City	Light rail system/connector	1,233
San Diego	Light rail extension	361
Proposed for Preliminary Engineering Funding:		
Baltimore	Light rail line upgrade	150
Minneapolis	Light rail line	447
Raleigh-Durham	Regional commuter rail	284
Seattle	Light rail system	2,900

Source: USDOT 1999

already either in final design or preliminary engineering stages (GAO 1999b). The GAO estimated that the $8.2 billion Congress authorized in 1998 for new transit projects will fall $7.6 billion short of the federal money needed to construct these projects. In addition, the GAO said the FTA expects that over $40 billion more in federal dollars will be requested to help fund another 100 projects currently in the early planning stage.

Scope of Current TOD Planning

Planning for TOD tends to be designed around efforts to maximize the density and uses at individual transit stops--urban centers on the trunk system and at neighborhood centers on the feeder/collector bus system. Its current status ranges from rather complete development for rail systems that have been operating for some years to conceptual plans for rail systems that have not yet been built and placed in operation. Planning manuals are abundant-- by one count 30 are in print, and tend to cover a similar set of issues (Table 1-4). Explicit in these manuals is the assumption that TOD produces benefits. Implicit is the assumption that if the transit investment is to be successful, TOD must generate significant new transit ridership.

Table 1-4 TOD Planning Manual Topics

Opportunities- number and characteristics of station areas
Stakeholders in station-area development
TOD guiding principles
• Compact, mixed-use
• Pedestrian-friendly design
• Parking and access management
Assessment of the market for TOD
Implementation
• Regulatory and legislative changes to encourage
• Funding sources
• Public actions to promote

Source: Puget Sound Regional Council 1999

National planning groups have also published guidelines to assist TOD planning. Prominent among these are the American Planning Association (Pollack 1996) and the Urban Land Institute (1994). The Institute of Transportation Engineers (1997) has recommended street design guidelines for traditional neighborhood development (TND) which is closely related to TOD. Also, several books covering TOD planning principles have been published (Calthorpe 1993, Bernick & Cervero 1996, Katz 1994).

Other Federal Support for TOD

Several federal agencies, including Department of Transportation, Department of Housing and Urban Development, and Environmental Protection Agency have initiated efforts to encourage more compact and efficient patterns. These new initiatives include grant programs announced in January 1999 by the Federal administration to protect sensitive lands and leverage new, more intensive forms of development (Table 1-5). They supplement efforts begun under ISTEA and continued under TEA-21 to rate and fund new mass transit starts on the basis of a set of land-use criteria.

Table 1-5 New Federal Transportation-Land Use Initiatives

Agency	Program
Environmental Protection Agency	Better America Bonds -- $700 million over five years
Department of Transportation	Transportation and Community and System Preservation Pilot (Livable Communities Initiative) -- $120 million FYs 1999- 2003
Department of Housing and Urban Development	Regional Connections Initiative -- $50 million in FY 2000

Fannie Mae Mortgage Initiative

In August of 1999, Fannie Mae announced a $100 million "location efficient" home mortgage initiative (Fannie Mae 1999). The program will attempt to increase home ownership in densely populated communities accessible to efficient public transit. It recognizes the lower household expenditures that result if household members use transit rather than a personal vehicle. More of a household's income is thus available to pay housing costs, and the owner can qualify for a mortgage loan at a lower level of income. The program is currently underway as a trial in five cities.

ACTUAL EXPERIENCE AND GROWING CRITIQUE

In spite of these unprecedented efforts, real benefits of TOD on a metropolitan scale remain problematic, in part because of the difficulty in predicting with sufficient certainty the market's response to policies seeking major land use and transit system changes. In particular, the effect of TOD on non-work activities, from which a majority of all personal travel is derived, has not been thoroughly addressed. The analysis of travel for purposes of shopping, eating out, and recreation

is complex because of the interplay of numerous variables that determine developer, store owner, and consumer reaction to transit investments, land use policies, and other government actions. New data and insights regarding the consumer marketplace are obviously needed to realistically evaluate the likely success of TOD and the expensive investments in new transit capacity that it requires.

TOD often involves major new transit capacity investments, usually light and commuter rail systems. These investments are typically made before supportive land uses -- employment, housing, and commercial services --- are in place. And they are made without the assistance of empirical data or even predictive models that can test, with sufficient certainty, the veracity of the assumption that benefits commensurate with costs will be achieved.

Furthermore, many elements that combine to determine the current patterns of retail structure and consumer behavior are usually missing from the analyses that justify TOD investments (Nelson & Niles 1999). Retail, when broadly defined as activities involving shopping, eating out, engaging in recreation and other leisure pursuits, constitutes a major portion of all personal and household trips. It also accounts for much of the growing intra urban commercial vehicle travel. An understanding of retail structure and derived travel is thus essential for the determination of TOD success.

Information that reveals consumer preferences and activity is important for the purpose of validating two widely-held planning assumptions: 1) TOD, and its required transit expenditures, will actually result in dense, mixed-use centers, and 2) these centers will, if created, appreciably change the overwhelming preference for auto mobility

Determining TOD's Success

A central question for planners and decision makers is the magnitude of TOD's travel impacts when translated to a regional scale in established metropolitan areas. Since new urbanism on the regional level is largely still a planner's vision, the impact of TOD on travel demand, patterns and mode choice cannot be directly measured. Consequently, researchers have resorted to comparing older neighborhoods that approximate TOD and conventional suburban neighborhoods that do not. Other studies attempt to isolate the influence of specific design features and land use density and diversity. Also, metropolitan planning organizations and others have carried out limited modeling of TOD.

Measuring Success Economically

From an economic perspective, regional success of TOD will depend on the benefits it produces-- both public or societal and personal -- relative to its costs (Table 1-6). The public may experience benefits in the form of congestion reduction and air quality improvements. To the extent that TOD reduces excessive infrastructure costs associated with dispersed development, these would be accounted as secondary public benefits. The principal personal benefits may be travel time and expense saved, in addition to reduced congestion time. Personal benefits also include the possibility that some households can reduce the number of cars they own and the costs of

operating them. Other benefits, of a social nature and more difficult to quantify, may be associated with the enhanced quality of living TOD is believed to produce (TRCP 1997).

Table 1-6 Simplified TOD Regional Cost-Benefit Accounting

Costs	Benefits
• Transit system construction	• Congestion reduction (time delay and excess fuel)
• Transit system operations	• Air quality improvement (health costs reduction)
• Mitigation of traffic congestion caused by compact development	• Reduced infrastructure costs
• TOD planning, developer incentives	• Personal travel time, vehicle operation savings
	• Personal vehicle ownership reduction

Source: Nelson & Niles 1999b

Public costs are primarily the transit capital and operating costs. The cost of housing in proximity to stations may be higher. Other direct costs may arise. To the extent that increased density does not result in reduced travel, congestion mitigation measures may be required. There may also be costs associated with TOD planning and any public incentives that may be needed.

Planning Factors Contributing to Success

In the context of planning, success of TOD depends on the response of developers, consumers, and taxpayers to the concept and to the public strategies that encourage it. Niles and Nelson (1999b) have identified 16 factors that will determine success at the regional or transit corridor level (Table 1-7). Fewer factors will control success at a single station-area.

Empirical Studies of TOD's Impacts

Previous empirical studies (Table 1-8) suggest that compact and mixed-use development may produce localized transportation benefits. However, these investigations fall short of giving planners and decision makers confidence that the promised macro-scale transportation benefits of new urbanism can be achieved (Nelson & Niles 1999). In particular, they do not sustain the belief that the necessary restructuring of the urban landscape and retail marketplace can actually be accomplished. And even if major restructuring can be realized, they provide insufficient evidence that the large transit investments supporting the restructuring are likely to produce transportation system performance benefits that the traveling public seeks.

Table 1-7 Factors Determining the Success of TOD

Factor	Station area success	Regional success
Number and siting of TODs (station areas)		X
Transit quality		X
Transit technology		X
Street pattern	X	X
Station area parking	X	X
Employment and housing density	X	X
Commercial mix	X	X
Retail siting criteria		X
Regional market structure		X
Consumer activity patterns		X
Travel behavior/trip chaining		X
Zoning flexibility/land assembly	X	X
Resident reactions	X	X
Housing type preference/life style & life stage		X
Self-selection in residential choice	X	X
Government policies		X

Source: Niles & Nelson 1999b

Table 1-8 Empirical Studies of the Travel and Land Use Impacts of Transit-Oriented Development and Related Design Elements

Neighborhood/Community Form Comparisons	**Authors**
Austin (Texas)	Handy 1996
Palm Beach County (Florida)	Ewing et al 1994
Puget Sound region (Seattle)	Moudon et al 1997
San Francisco Bay area	Handy 1992 & 1993
San Francisco Bay area	Friedman et al 1994
San Francisco Bay area	Cervero & Radisch 1996
Seattle area	Rutherford et al 1996
Density, Design, and Mixed Use Factors	
Los Angeles metro area	Boarnet & Sarmiento 1998
Puget Sound region (Seattle)	Frank & Pivo 1994
San Diego County	Crane & Crepeau 1998
San Francisco Bay area	Cervero & Kockelman 1997
Regional Congestion Management	
San Francisco Bay area	Luscher 1995
Post TOD Studies	
Portland metro area	Dueker & Bianco 1999
Los Angeles green line	Moore 1993

Source: Nelson & Niles 1999

Dunphy (1995) suggests that if TOD is to make a meaningful difference in development patterns, there must be significant change on a regional scale. This change must be accomplished within the economic and political context of a particular region whose urban form has developed over a long period, the result of local zoning policies and myriad private investment decisions. Zoning, once established, is difficult to change, especially if the intent is to increase density. And because real estate is inherently a long-lived investment, a large majority of structures will still be standing at the end of the normal planning period.

Assuming that higher density centers linked by a quality transit service can be created, the scale of the transit investment required is an important consideration. Downs (1994) provides one estimate by calculating the number of TODs needed to accommodate the average population growth during the 1980's of metropolitan areas with a 1990 population of one million or more. He concludes that TODs could handle the growth if their numbers were large, but that this would require a regional transit system that might not be financially feasible.

Public support for such major investments requires that the potential benefits of TOD be clearly identified. Although localized benefits are important, the public will gauge benefits on a regional scale, since travel patterns usually extend beyond an individual's home neighborhood. Most people will measure success by reduced congestion on major corridors and improved regional air quality, not by the more subjective goals of the proponents of New Urbanism such as less social segregation, a better quality of life, and a heightened sense of community.

TOD is more than a planning exercise; it involves major public investments. Sound public process dictates that officials estimate TOD's benefits before making major policy decisions. Beyond building new regional transportation systems, governments will need to buy public services and infrastructure that support compact development -- streets, sidewalks, parks. To the extent that mode shift does not follow from the changes in land use, there will be additional public expense associated with the management of increased vehicle traffic within compact areas.

These investments will likely compete with other demands on the public purse. And, if intended benefits are not forthcoming, they will translate to lost opportunity costs for government and to wasteful expenditures of political capital required to achieve significant urban restructuring.

As Bookout (1992) suggests, the challenge is to know the market that planning seeks to restructure, i.e., gain more information on the "ever-changing needs, preferences, and aspirations of people who make up communities." Howe and Rabiega (1992) posed a similar question after finding that the attitudes of members of the Oregon planning profession were negative toward strip malls and positive about "urban village" forms of commercial structure: "What do consumer choices and travel patterns reveal about their relationship to the most elemental parts of the commercial urbanscape -- the stores?" Calthorpe, a leading proponent of the New Urbanism, acknowledges this challenge: "Clearly much more research and analysis is needed to clarify and quantify the potential results of new land use patterns on our travel behavior. It is critical ... to effectively directing federal and state transportation dollars..." (Calthorpe 1993).

Portland's Experience

Portland, Oregon, has been a laboratory for TOD. Its Eastside light rail line, the first in a planned metro-wide radial network focusing on downtown Portland, opened in 1986. Portland has gone to considerable lengths to encourage development that supports light rail.

Dueker and Bianco (1999) used data for the first 10 years of operation to research the impacts of the rail line on development patterns, choice of residential location, freeway traffic, and transit ridership. They found that light rail alone was not been sufficient to change development patterns appreciably, and that the peak period for traffic in a freeway in the same corridor widened in the same period. Growth in rail transit riders occurred in the non-peak and weekend periods. An apparent self-selection in housing location choice was also observed: people who are already prone to use transit are willing to relocate to areas accessible to light rail.

Observations on the Land Use-Transportation Connection

Robert Cervero, who has done extensive studies of the land use and transportation connection, has commented that "transit investments that are out of kilter with how our cities and regions grow do nobody any good. Running trains and buses that fail to draw people out of drive-alone cars does little to relieve traffic congestion, conserve fuel, or reduce pollution. The best prescription for filling trains and buses, and winning over motorists to transit, is to find a harmonious fit between transit systems and the cities and suburbs they serve" (Cervero 1998).

URBAN TRANSPORTATION/LAND USE IMPACTS: IMPETUS FOR TOD

As metropolitan areas have become larger, efforts to counter the impacts of growing personal mobility and land development have loomed ever larger in the public's mind and the planner's agenda. We briefly discuss here the nature of these impacts, including traffic congestion, air quality and water degradation, climate change, and land consumption and use patterns. Each has a national as well as regional focus. Together, they explain the growing interest in transit-oriented development.

Traffic Congestion

Congested roadways have long been the bane of motorists in major urban areas. Only relatively recently have efforts been made to measure and track congestion systematically, and to estimate its direct and indirect economic cost to society. The Texas Transportation Institute has developed a comprehensive set of traffic congestion indices that has been used since 1982 to track congestion in 70 metropolitan areas with sizes ranging from very large to small. The indices are based on measured vehicle densities on freeways and major arterials as reported by state departments of transportation to the U.S. Department of Transportation. One index estimates the cost of congestion on a per capita basis as shown in Table 1-9 for ten cities having high levels of congestion (TTI 1999). This index takes into account the value of lost time, on both freeways and principal arterials, and the cost of fuel wasted because of congestion.

Traffic congestion is a complex phenomenon, and it is difficult to draw more than general conclusions from comparisons between urban areas. It is also clear that these indices provide a very imprecise tool to gauge the effect of regional or local policies directed at increasing mobility in a given urban area. However, the TTI data do reveal several important aspects of congestion: 1) most urban areas, whether small or large, showed increased levels of congestion from 1982 to 1996; 2) contrary to conventional wisdom, congestion growth does not correlate well with population growth, and even some of the large metro areas that have been growing rapidly (e.g., Phoenix and Houston) actually experienced declining congestion; and 3) recurring congestion, as distinct from nonrecurring, accounts on average for less than half of all congestion, and can be as low as one-fourth depending on urban area. The majority of delay is caused by accidents, weather, construction, and incidents such as material spills.

Table 1-9 Per Capita Congestion Costs For Selected Metro Areas

Urban Area	Annual Person-Hours of Delay per Capita	Annual Congestion Cost per Capita
Washington, DC	67	$1,055
Seattle-Everett	56	915
Los Angeles	56	885
Atlanta	54	855
Detroit	53	840
San Francisco- Oakland	52	835
San Jose	52	825
Houston	49	785
Dallas	48	770
Austin	47	750

Source: TTI 1999

Air Quality Impacts

Air quality, both localized and regional, is a significant problem in many urban areas and is a major part of the concern relating to dispersed growth and increasing personal travel. The Federal Clean Air Act requires that standards be set and adhered to in metro areas, and if exceeded, transportation control measures must be instituted. Pollutant emissions and concentrations from on-road mobile sources are systematically estimated nationally and measured regionally. Table 1-10 shows 20-year trends for emissions related to vehicle operation and compares them to the change in vehicle miles traveled. Not shown is ground-level ozone, a product of the reaction of VOCs and NO_x in the presence of heat and sunlight. Average ozone concentrations at measuring points (annual second daily one-hour maximum) have undergone a 19% decrease form 1988 to 1997 (EPA 1998).

Table 1-10 Change of Pollutant Emissions and VMT from 1970 to 1990, and On-Road Vehicle Share in 1996

Principal Pollutant	Change in Tons Emitted 1990 Compared to 1970	Proportion from On-Road Vehicles (1996)
Carbon Monoxide (CO)	-32%	60%
Nitrogen Oxides (NO_x)	+11%	30%
Volatile Organic Compounds (VOC)	-38%	29%
Particulate Matter (PM-10)	-75%	47%
Sulfur Dioxide (SO_2)	-35%	2%
Lead (Pb)	-98%	0.2%
Vehicle Miles Traveled (VMT) Change 1970-1990:	*+127%*	

Source: EPA 1997 & 1998

Greenhouse Gas Emissions

Total greenhouse gas emissions in 1996 were 9.5% higher than 1990 baseline levels. The major contributor to greenhouse gases is carbon dioxide (CO_2). Carbon dioxide emissions were 82 % of greenhouse gas emissions in 1996, and 19% of these emissions (tons of carbon basis) were the result of the combustion of gasoline in motor vehicles (USDOE 1998). Most carbon dioxide is released through the combustion of fossil fuels in electric power generation. However, as personal vehicle travel grows, as predicted, its contribution to greenhouse gases will certainly grow in absolute terms.

Transit vs. Private Vehicle Energy and Environmental Impacts

Comparisons are often made between the fossil fuel energy consumption, and hence the air quality and greenhouse gas impacts, of public transit and private vehicles. It is frequently suggested that increased public transit capacity can reduce these impacts. The practical reality is that transit, when viewed nationally, has roughly the same energy intensity on a per passenger basis as does the private automobile (Table 1-11). And the trend for both bus and rail transit has been toward higher intensities. This results from the need to provide transit service in low density areas and for predominately unidirectional trips, such as commutes from suburbs to central cities. Consequently, buses and trains, just as cars, operate on average with many empty seats.

The relative fossil fuel combustion impacts will depend, of course, on the particular transit system or line under consideration, and whether its capacity utilization rate can be increased. It will also depend on the number of new riders it attracts and their former mode. Since light trucks are a rapidly growing proportion of the private vehicle fleet, the extent that more light truck passengers can be attracted to transit the greater will be the positive impact.

Table 1-11 Energy Intensity of Passenger Modes (Btu per passenger-mile)

Year	Automobile	Light Truck	Transit Bus	Rail Transit
1,970	4,896	12,492	2,472	2,453
1,975	4,745	11,890	2,814	2,962
1,980	4,166	10,230	2,813	3,008
1,985	3,990	8,754	2,421	3,461
1,990	3,864	7,774	3,735	3,453
1,996	3,671	7,247	4,512	3,444
Average annual percentage change				
1970-96	-1.1%	-2.1%	2.3%	1.3%

Source: USDOE 1998

Surface Water Quality Impacts

Stormwater runoff from roadways carries away pollutants that impact the water quality of streams and lakes. These nonpoint source pollutants include dust, rubber, and heavy metal particles from tire wear, and antifreeze and engine oil that has leaked from vehicles. Engine oil also is often discarded onto pavement or into storm drains instead of being recycled. In areas where snow is frequent, road salts can be a major pollutant. Several federal laws, including the Clean Water Act and ISTEA, have addressed ways to manage and control these impacts (EPA 1995). Management practices include retention systems and traps that are incorporated into new roadway design.

Land Use Impacts

Land consumption compared to population growth is a major concern expressed that is related to transportation impacts. The lower the density of development, the more travel. One national index of land consumption is found in the urbanized area data developed from each census. Table 1-12 indicates the growth of developed land compared to population from 1950 to 1990. As the number of urbanized areas (defined generally as areas with a population of at least 50,000 with a central city or place) and total developed land has increased from 1950 to 1990, the average density has fallen to about half. The proportion of all land that is developed is less that two percent and contains almost two-thirds of the population.

Table 1-12 Growth of Urbanized Areas, 1950-1990

Year	No. of UAs	Population (millions)	Land Area (sq. mi.)	Average Density	% of Total Population	% of Total Land Area
1950	157	69.2	12,805	5,408	45.4	0.36
1960	213	95.8	25,544	3,752	53.0	0.72
1970	275	120.7	36,290	3,327	58.8	1.03
1980	366	139.2	52,017	2,675	61.3	1.47
1990	396	158.3	61,015	2,594	63.3	1.73

Source: U.S. Census Bureau

Table 1-13 looks at similar data for the 33 urbanized areas with a 1990 population of at least one million. These urban centers showed a wide disparity in their population and land development in the twenty-year period between 1970 and 1990, but major trends are apparent. The most notable trend has been the relative shift of population from the older Northeast and Midwest cities to the Southeast and Southwest, and a decrease in density of the former and an increase in density of the latter.

Table 1-13 Growth of Urbanized Areas with a Population of One Million or More (in 1990), 1970-90

Urbanized Area	1970 Pop (million)	1990 Pop (million)	1970 Land Area	1990 Land Area	% Pop Change	% Land Area Change	Density Change %
New York	16.21	16.04	2,425	2,966	(1.0)	22.3	(19)
Los Angeles	8.31	11.40	1,572	1,966	37.2	25.1	10
Chicago	6.71	6.79	1,277	1,585	1.2	24.1	(18)
Philadelphia	4.02	4.22	752	1,164	5.0	54.8	(32)
Detroit	3.97	3.70	872	1,119	(6.8)	28.3	(27)
San Francisco-Oakland	2.99	3.63	681	874	21.4	28.3	(5)
Washington, DC	2.48	3.36	495	968	35.4	95.6	(31)
Dallas-Ft. Worth	1.34	3.20	674	1,443	138.8	114.1	12
Houston	1.68	2.90	539	1,177	72.6	118.4	(21)
Boston	2.65	2.78	664	891	4.9	34.2	(22)
San Diego	1.20	2.35	381	690	95.8	81.1	8
Atlanta	1.17	2.16	435	1,137	84.6	161.4	(29)
Minneapolis-St. Paul	1.70	2.08	721	1,063	38.0	47.4	(17)
Phoenix	0.86	2.01	388	741	133.7	91.0	22
St. Louis	1.88	1.95	461	728	3.7	57.9	(34)
Miami	1.22	1.91	259	353	56.6	36.3	15
Baltimore	1.58	1.89	310	593	19.6	91.3	(37)
Seattle	1.24	1.74	413	588	40.3	42.4	(1)
Tampa	0.37	1.71	131	650	362.2	396.2	(7)
Pittsburgh	1.85	1.68	596	778	(9.2)	30.5	(30)
Cleveland	1.96	1.68	646	636	(14.3)	(1.5)	(13)
Denver	1.05	1.52	293	459	44.8	56.7	(8)
San Jose	1.03	1.44	277	338	39.8	22.0	15
Norfolk	0.67	1.32	299	664	97.0	122.1	(11)
Kansas City	1.10	1.28	493	762	16.4	54.6	(25)
Ft. Lauderdale	0.61	1.24	212	327	103.3	54.2	32
Milwaukee	1.25	1.23	457	512	(1.6)	12.0	(12)
Cincinnati	1.11	1.21	335	512	9.0	52.8	(29)
Portland-Vancouver	0.82	1.17	267	388	42.7	45.3	(2)
Riverside-San Bernardino	0.58	1.17	310	460	101.7	48.4	36
San Antonio	0.77	1.13	223	538	46.8	141.3	39
Sacramento	0.64	1.10	254	334	71.9	31.5	31
New Orleans	0.96	1.04	184	270	8.3	46.7	(26)

Source: U.S. Census Bureau

Some urbanized areas either lost population or grew at very small rates even as their developed land area expanded. All of the population losses were experienced by the central cities as their residents moved to the suburbs. In other areas, both the population of the central cities and surrounding suburbs grew at modest rates. A few cities, particular in the Southeast, grew rapidly both in area and population. A number of areas actually increased in density as population grew at a faster rate than land was consumed (Dallas-Ft. Worth, Ft. Lauderdale, Los Angeles, Miami, Phoenix, San Diego, San Jose, Riverside-San Bernardino, San Antonio, and Sacramento).

Impacts on Sensitive Areas

There are few reliable national or regional statistics that indicate the impact of development on lands that the public tends to place a higher value on, namely farm lands, open space, and environmentally sensitive areas. That the public values these lands is clear. For example, in November 1998, U.S. voters considered 240 different local ballot measures designed to protect or improve parks, open space, farmlands, historic resources, watersheds, greenways, and biological habitats. Voters approved 72 percent of them, triggering more than $7.5 billion in additional state and local conservation spending (Myers 1999).

Central City Decline and Renewal

Of interest from a land use and transportation planning perspective is the longer-term development patterns in the older urban areas that experienced a decline in central city population and a simultaneous growth of suburban population. Some researchers suggest that there will be a turn around for these older, formerly industrial cities, but that population gains will only build slowly over the next few decades (Kasarda et al 1997, Downs 1997). And the factors that determine the new patterns differ greatly from city to city (Wyly et al 1998).

Quality of Life Impacts

Efforts to control growth and increased levels of personal travel are often expressed in terms of the need to improve livability and a sense of community. The concern is that the livability of our neighborhoods and communities has declined as urbanized regions have become less concentrated and fewer activities are accessible by pedestrian and transit modes. The U.S. Department of Transportation has incorporated the concept of livability in its transit policy and strategy (Figure 1-2).

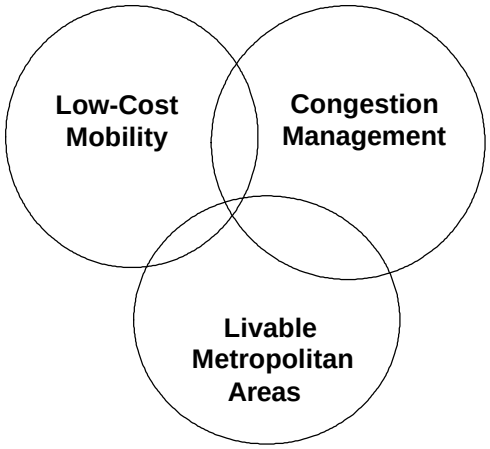


Figure 1-2 Conceptualization of the Public Policy Functions of Transit (USDOT 1997)

Sprawl

Sprawl has been defined as "low-density development beyond the edge of service and employment, which separates where people live from where they shop work, recreate, and educate -- thus requiring cars to move between zones" (Sierra Club 1998). Sprawl has long been an issue for urban planners and policy makers. Concerns were expressed in the 1930's and 1940's about growing residential development around cities even before the great postwar suburban expansion occurred, and some of the first studies of urban dynamics were performed (Colby 1933, Harris 1943). One aspect of sprawl, strip commercial development was first noted in that period (Proudfoot 1937). The term “sprawl” itself entered the land use and political lexicon with the publication of The Exploding Metropolis by William Whyte (1957). Sprawl has been pushed to the forefront of the public agenda by political and academic debates again in the late 1990s (Brookings 1998, APA 1997).

The cost of sprawl, including high infrastructure costs per unit of development, has been the subject of major studies (RERC 1974, TCIP 1998). These have attempted to assign costs and benefits, and assess the net costs or benefits. More recently, the U.S. General Accounting Office, responding to a Congressional request, investigated the influence of federal policies on sprawl (GAO 1999a).

Sprawl is a concept that is definitely in the eye of the beholder, and as such it is a controversial subject. For some it's any land use that fosters auto access over pedestrian and transit modes. Others see it in terms of low-density, single use suburbs that consume farm land, forests, and sensitive areas at the growing edge of cities. And it is often connected with the decline of some downtowns, central cities, and even the older inner ring of suburbs. It has become the general-purpose cause of all of the impacts discussed above and more. For this reason, we believe

it is best approached and understood in terms of the individual components rather than a separate and distinct phenomenon. We thus consider the aspects of sprawl independently in designing a planning template.

CONCLUSIONS

Regional and federal planners and decision makers, in response to traffic congestion and other impacts resulting from growth and change in human activity patterns, have embraced transit-oriented development. However, there is a growing body of research suggesting that TOD, when it involves large investments in rail system capacity, may not produce benefits commensurate with costs sought by a concerned public. Because of this, TOD planners need to be informed of the factors that cause traffic growth and congestion and related environmental impacts. In addition, they need to appreciate the difference between TOD's success at the station-area level as compared to the regional level, and adopt methods to measure regional success.

The large differences in patterns of population and land use change across metropolitan America over the past few decades suggests that a one size fits all approach to land use and transportation planning is not appropriate. Each urban region has its own unique set of characteristics and forces that are determining settlement and mobility patterns.

CHAPTER TWO

FACTORS THAT URBAN TRANSPORTATION AND LAND USE PLANNING MUST TAKE INTO ACCOUNT

INTRODUCTION

Anthony Downs points out that every city is really the locus of dynamic movements of people and firms into, out of, around, and within its boundaries (Downs 1997). With this characterization, Downs implicitly suggests the importance of understanding the factors that are producing constant change in human settlement patterns.

In this chapter we identify some of the key factors that are currently shaping the residential, and employment environments, and that produce demand for personal and commercial travel. (The retail environment was considered in Report #1). We briefly discuss the ongoing technological changes that are impacting personal mobility--changes affecting private vehicles and public transportation systems. We discuss their probable importance to TOD planning. We conclude with a summary of retail and other factors that are likely to determine future urban development and travel patterns and that consequently should be taken into account in any comprehensive land use and transportation planning exercise. This leads to an exploration of the complexity and uncertainty inherent in any effort to predict future human activity and derived travel demand which is covered in Chapter Three.

RESIDENTIAL PATTERNS

How often households change the location of their residence, where they move to, and the housing they select are all important determinants of land use and transportation patterns. Obviously, the residential environment is constantly changing, even in situations of stable metro population and land use patterns, as important factors influencing household location such as employment, lifestyle, and life stage change over time. But the overall metro population distribution and land use pattern can change, especially when population concentration shifts from central city to suburbs, or from one geographic region of the country to another. In each of these cases, transportation patterns can be impacted in ways that are complex and difficult to predict. We briefly explore some of the important changes in American living patterns as they have occurred in the last several decades.

Rates of Residential Mobility

American households have been, and continue to be, highly mobile as shown in Tables 2-1 and 2-2. About 16 percent of the population moved between March 1995 and March 1996, including 30 percent of renters and 10 percent of homeowners. Most of the relocation is local, with three-fifths of movers remaining in the same county. Lower income households tend to move more often than higher income. Mobility rates vary by region, with the West and the Northeast showing the greatest differences from the average, higher and lower, respectively.

These average figures do not disclose the distribution of residence duration across the population. Some households move very frequently and others not at all. Almost as high a proportion of the population (15 percent) have lived in the same house for more than 20 years as move each year (Hansen 1998). For those living in owner-occupied units, the number is 21 percent; for renter-occupied units, just 3 percent.

Table 2-1 Percent Distribution of Population that Moved During 1995-96*

	Non-movers	Movers to:		
		Same county	Different county/Same state	Different state
Total persons	84	10	3	3
Tenure:				
Owner-occupied units	93	4	1	1
Renter-occupied units	67	21	6	5
Household income:				
Less than $50,000	82	12	3	3
$50,000 and over	88	7	2	2
Region:				
Northeast	88	8	2	2
West	80	13	3	3

* Movers from abroad less than one percent

Source: U.S. Bureau of the Census, Current Population Reports

Table 2-2 Percent of Population that Moved During a Year

Period	Non-movers	Movers to:		
		Same county	Different county/ same state	Different state
1950-51	79	14	3	4
1960-61	79	14	3	3
1970-71	81	11	3	3
1980-81	83	10	3	3
1995-96	84	10	3	3

Source: U.S. Bureau of the Census, Current Population Reports

Reasons for Moving and New Location Selection

The American Housing Survey, conducted by the U.S. Census Bureau, gathers data on the status and condition of the Nation's housing stock. The survey returns to the same housing units year after year, and thus can analyze the movement of households through housing, both renter and owner occupied. Specifically, it probes for the reasons people move and choose their new neighborhood.

Among the many reasons cited for leaving a previous home, reasons relating to employment were mentioned most frequently, followed by personal life stage and household makeup (Table 2-3. The desire to establish one's own household and the need for more space also ranked high.

Table 2-3 Frequency of Major Reasons Cited for Moving

Reasons for Leaving Previous Unit	Percentage Citing*
Employment related (includes new job or job transfer, to be closer to work/school)	21.0
Family/personal (includes married, widowed, divorced, separated)	14.4
Establish own household	11.7
Need more space	10.6
Improve housing quality	9.1
Change from renter to owner	5.1
Change from owner to renter	0.9
Lower housing costs	4.6
Other housing related	5.1
Owner induced displacement (includes owner to move into unit, conversion to condo)	4.1
Government induced displacement	0.9
Other	14.2
Not reported	2.5

* More than one reason may apply to particular unit.
Source: Census 1997

Among the top reasons for choice of neighborhood, the attributes of the house itself and its convenience to job were given most often, while convenience to public transportation was seventh on the list, just 2.5 percent of all reasons cited (Table 2-4).

Table 2-4 Reasons Cited for Choice of New Residential Location

Reason	Percentage Citing*
House itself	16.9
Convenient to job	16.8
Looks/design of neighborhood	13.6
Convenient to friends/relatives	12.5
Good schools	6.5
Convenient to leisure activities	3.4
Convenient to public transportation	2.5
Availability of other public services	1.5
Other	23.0
Not reported	3.2

* More than one reason may apply to particular unit.
Source: Census 1997

Instruments such as the American Housing Survey are useful but imperfect to the extent that they cannot easily gauge the interplay between several factors that may determine residential location. TOD obviously presents a situation where a combination of reasons may be present. In theory, people will move to a TOD because it offers convenience to public transportation and accessibility to the work destination as well as to local shops and services. However, rather than just asking respondents for all reasons that were involved in their choice of neighborhood, surveys could also be designed to reveal the logical linkages of reasons. Surveys might investigate what tradeoffs were involved in choosing a neighborhood. For example, was housing cost or space sacrificed for convenience to jobs and to public transportation.

The impact on home location of working at home and using telecommunications as a substitute for travel -- including the cases of both telecommuting to a job site and self-employment in a home-based business -- could also be analyzed if questions were asked on the tradeoff between living in a less accessible location, and having to travel from home fewer times per week.

Housing Type and Size Preferences

Housing style, whether single-family or multi-family, determines density of development and figures in the success of TOD. The Census Bureau surveys on a monthly basis the number of new privately owned housing units for which construction is started. Annual supplemental reports issued by the Census Bureau also provide detail on the type of design and intended use of structures for a calendar year. The fraction of housing construction starts that are single-unit structures, while showing some cyclical change, has generally trended upward over the past three

decades (Figure 2-1). It's highest point was reached in 1993 when 87 percent of all housing starts were single-unit structures.

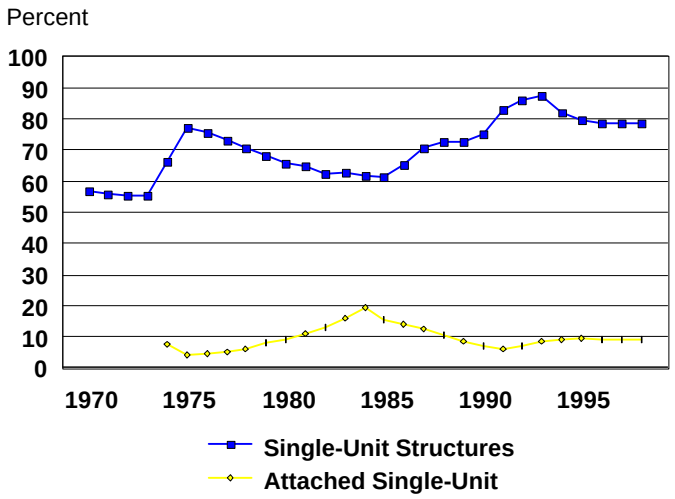


Figure 2-1 Fraction Of Home Construction that is Single Unit Structures, Total and Attached

Of particular importance to TOD are data that distinguish between one unit (single-family) structures that are detached, and one unit structures that are attached, such as townhouses that share a common wall. The proportion of attached structures provides one measure of the density that TOD seeks to achieve. In 1998, approximately 9 percent of one-unit structures were attached units, a fraction that has not changed appreciably over the 25 years this information has been collected.

The Census Bureau also keeps track of the size of new single-family and apartment units. For the past 30 years the housing market has produced a growing proportion of single family units with steadily increasing floor area (Figure 2-2). New multifamily units have also been increasing in size, growing 20% in average floor area from 1988 to 1997.

Lot Size

The size of lots for new single-family homes is another indicator of the preference for private space. Figure 2-3 shows average and medium lot size trends over the past quarter century. Although the data for average size indicates considerable scatter from year to year, the general trend has been to smaller size lots. The medium size lot is significantly smaller, suggesting the effect of a relatively small number of very large lots that push up the average. These are probably located on the urban fringe were land prices are low.

Figure 2-2 Size of New Single Family Houses and Apartments

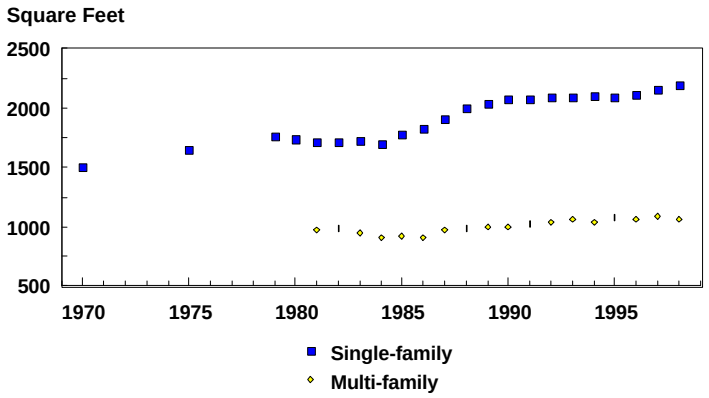
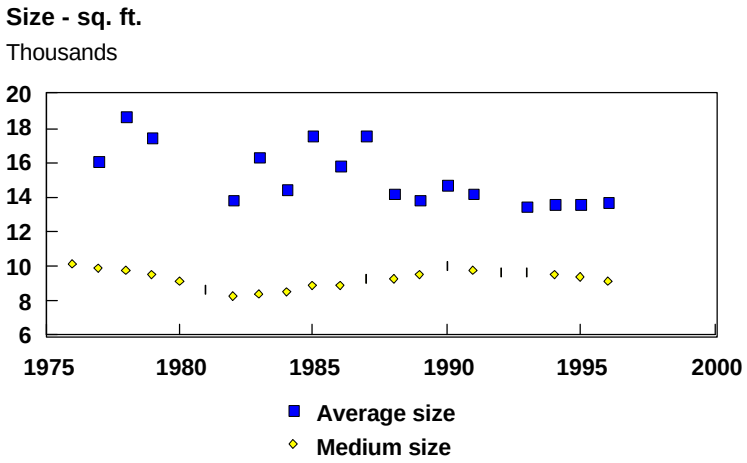


Figure 2-3 Average and Medium Lot Size for New Single-Family Homes



Home Ownership

Low mortgage interest rates, relaxed borrowing requirements, and strong economy of the late 1990's have pushed home ownership rates to record levels (Table 2-5). Yet there remains a large home ownership gap between white and nonwhite Americans. Even if this gap is not closed, home ownership rates will, by one prediction, reach 68 percent by 2010 (Harvard 1998).

Table 2-5 Home Ownership Rates

Period	Total	White	Black	Hispanic	Other
1983	64.6	69.1	45.6	41.2	53.3
1985	63.9	69.0	44.4	41.1	50.7
1987	64.0	68.7	45.8	40.6	48.7
1989	63.9	69.3	42.1	41.6	50.6
1991	64.1	69.5	42.7	39.0	51.3
1993*	64.0	70.2	42.0	39.4	50.6
1995	64.7	70.9	42.9	42.0	51.5
1997	65.7	72.0	45.4	43.3	53.3
4th Qtr. 1998	66.4	72.6	46.5	45.7	53.1

Source: HUD 1999
*Revised based on 1990 Census weights rather than 1980 Census

Household Size Trends

Changing household makeup and size has been a major determinant of residential patterns. After falling rapidly between 1960 and 1990, household size decreased at a slower rate in the 1990s (Figure 2-4). The Census Bureau predicts that it will continue at about the same rate of decline at least to 2010. Decreasing household size is important beyond its contribution to household formation and residential size. It can be correlated with more vehicle trips per capita. For example, households with one car that is shared among several adults tend to produce significantly fewer vehicle trips per capita (Table 2- 6).

Figure 2-4 Household Size Trends

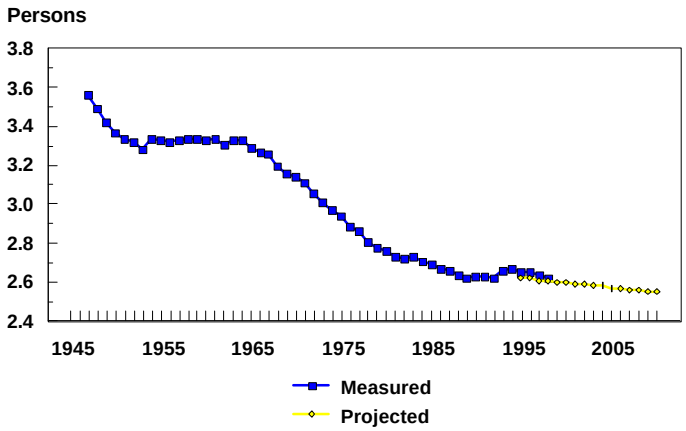


Table 2-6 Average Annual Vehicle Miles Per Adult Person for Households with One Vehicle

Household	1983	1990
One Adult	9,617	11,692
Two Adults	5,395	6,272
Three Adults	3,545	5,158
Four or More Adults	<3074	<3614

Source: USDOT 1993b

FUTURE RESIDENTIAL PATTERNS

Past and current housing choices are instructive, but they may not be indicative of future patterns. Support for TOD is based on the premise that actions by government, aided by groups and individuals in the private sector, can in fact modify these trends. Proponents of TOD believe that more Americans will choose "traditional" housing types -- small houses on small lots, condos, walkup apartments, accessory units -- if they are conveniently located near transit and amenities such as parks, other public spaces, and stores, and if the design elements of this more dense housing is varied and made attractive.

This assumption cannot be verified empirically. Even though the market has begun to deliver more housing of a traditional character, and buyers and renters have responded well to many of the new

developments (Steuteville 1998), the number of developments, especially on urban and suburban infill sites, is still relatively small.

Yet, for planning purposes, it would be instructive to know whether the current market response reflects new converts to the less automobile-oriented lifestyle implicit in the occupancy of TOD housing, or whether consumers are simply selecting housing that they would have otherwise chosen. And if there is a conversion process underway, how significant will it be in the longer term? Is it more than a small niche market? Will most home buyers and renters continue to be attracted by the affordability of housing on the metro fringe, as well as other attributes of suburban and exurban living?

Stated Preferences for Home Size and Style

Without the revealed preference of consumers, we are forced to fall back on what people say about the housing they prefer. National surveys commissioned by Fannie Mae (1996, 1997, 1998) provide some perspective on American's housing preferences including type of home, size, location, and willingness to make tradeoffs. The surveys have been varied each year to uncover different features of the housing market.

In 1996 Fannie Mae asked adult American about their attitudes towards housing and home ownership. Of those contacted, 73 % said their ideal home is a single-family detached house with a yard on all sides. Since ownership of all types of homes, including townhouses and condos, is currently at about 66 %, if the future trend follows stated preferences, it should be toward more single-family detached ownership, not less. The same survey found that Americans are willing to make significant tradeoffs for home ownership. Four of five would drive a longer distance to work if they could own rather than rent a home.

With regard to home ownership, Fannie Mae's most recent survey, in 1998, indicates that a majority of renters have a strong desire to move up to ownership. It will be of interest to see if the detached single-family preference and size trends continue as ownership rates increase.

Another recent private sector survey (American LIVES 1995), for the real estate industry, found that four of five consumers who bought or shopped for a home in several states, were unwilling to give up the cul-de-sacs, large yards, and privacy that comes with single-family detached homes set back from the street. Although a large majority didn't like the often homogenous form of the conventional suburban development, they still preferred a suburban location but with a different look: a town center as a community-gathering place, small shops, green space, and plenty of convenient parking.

Locational Preferences

Also of interest to urban planning are the preferences people express for residential locations that are not necessarily constrained by current personal circumstances. Fannie Mae's 1997 survey asked people where they would like to live in the geographical range from central city to small town. A large majority indicated they preferred either a small town or a suburb near a large city.

Only nine percent favored a large city. Since new community designs are intended to replicate the feel of a small town and enhance sense of community, it would be useful to extend this locational preference question to include alternative environments such as TOD and planned neo-traditional communities.

Baby Boom Wild Card

A difficult to gauge factor that may effect average housing type and size is the impending retirement of the Baby Boom generation (Little 1998). People age 55 and over will increase from 21% of the population in 1995 to over 29% in 2020. It is of interest whether these "empty nesters" will choose to down size their housing and opt for more locational convenience. Fannie Mae explored the future housing preferences of Baby Boomers in its 1998 Survey. A majority, 53%, said they will remain in their current house, either as is or with renovations, while 35 % indicated that they would sell, and either buy or rent a new house. The survey did not probe whether the size of the new house had been considered in retirement plans, or whether geographical relocation may be an option.

Self-Selection by Transit Riders

Another phenomenon that relates housing type preference to travel behavior is the propensity for self-selection in choice of residence location, i.e., people who are current transit users are more likely than others to choose housing near transit stations. Self selection, to the extent it occurs, will mask and reduce the true magnitude of new transit investments on travel behavior.

Crane (1998) points out that empirical studies comparing the travel behavior of people who live in one kind of neighborhood with people who live in another ignore this data bias. To identify the occurrence of self-selection, Boarnet and Sarmiento (1998), modeled both the choice of where people live and how they choose to travel to nonwork activities. They could find no influence of land use on travel in their Southern California sample when controlling for self selection.

Other researchers have suggested that transit ridership gains experienced by new rail systems may be in part the result of current bus riders choosing to live in TODs in order to ride a faster mode of public transit. A recent study indicated that this factor may have complicated observed transit ridership increases in a Portland light rail corridor (Dueker 1999).

Since the number of TODs is still small, national surveys such as the American Housing Survey would not provide data to clarify this issue. Yet, for planning purposes, it would be instructive to know whether there is a predisposition to live in a transit convenient location were it available, and how significant it will it be in the longer term. Will it be more than a small niche market, or will most home buyers and renters, even if transit users, be attracted by the affordability of housing on the metro fringe, as well as to other attributes of suburban and exurban living?

THE CHANGING WORK ENVIRONMENT

The traditional work environment is rapidly disappearing. Gone, at least for many workers, are 8 to 5 days and Monday through Friday work weeks. Where people work is also changing. Central business districts have been overshadowed by suburban job centers, and increasing numbers of people are working outside of any job center at least part of the time. Superimposed on this is a high level of temporary and part-time employment. This strong and continuing revolution in the spatial, temporal, and organizational dimensions of the work environment has important implications for personal travel, residential patterns, and transportation planning.

Spatial Distribution of Work Locations

A major shift of work centers from central cities to suburban and exurban sites has occurred over the past five decades. The general decentralization trend is most apparent from data on commute trip destinations obtained through the decennial Census (Table 2-7). The national data does not, however, portray a further important level of decentralization, i.e., the dispersion of work such as business parks across suburban counties.

Table 2-7 Workplace Location Trends (Percent of All Jobs)

Job Location	1980	1990
Central City	41	38
Suburbs*	37	42
Outside of Suburbs	22	20
Outside County of Residence	21	24

Source: ENO 1996; USDOT 1993a

* Part of metro area (MSA) outside of central city.

Job Mobility

Contrary to popular belief, the rate that people move from job to job through their working life has not changed greatly over the last two decades in the changing economy. Several studies show no evidence of widespread decrease in job tenure (U.S. Department of Labor 1995) . Yet job mobility is high especially for younger people and those with low educational qualifications and skills. The National Longitudinal Survey of Youth found that the average individual holds 8.6 different jobs from the ages of 18 to 32 (U.S. Department of Labor 1998).

Multiple Job Workers

A small but significant number of workers hold more than one job. In 1998, 6 percent of workers held two jobs, and this number has been essentially constant in the past five years (U.S.

Department of Labor 1997). However, there is considerable geographical variation. Seven Midwest states have rates exceeding 9 percent.

Self-Employment/Work at Home

On the basis of a survey done in May 1997, an estimated 21 million people, or approximately 13 percent of the working age population, did some work at home as part of their primary job (U.S. Department of Labor 1997). More than half of these were wage and salary workers who were not paid expressly for the hours they put in at home, and who averaged about 9 hours per week. Nearly all of the remainder were self-employed, two-thirds of whom, or 4.1 million, had home-based businesses.

The data showed trends that may be significant for planning. Over the six-year span from 1991 to 1997, the number of wage and salary workers being paid for work at home grew by almost 90 percent, to 3.6 million. This suggests that the demand for a centralized workforce is moderating.

Changing Hours/Days of Employment

We might expect that the ongoing changes in the economy would cause a redistribution of the total hours worked over the weekday and weekend day. The move to flextime, to businesses open longer hours and more days of the week, and to part-time, contingent and alternative work arrangements should show up in a shift in the timing of trips to and from work locations. For example, 1993 data indicates that the proportion of part-time works in the retail trade and services workforces has grown to 40 and 31 percent, respectively (Fallick 1999).

However, the latest national survey of personal travel did not reveal evidence of a change in the temporal distribution of all trips when 1995 and 1983 survey results were compared (Hu & Young 1999). It is probable that this effect is still too small to detect against the backdrop of all personal travel, but it does merit further consideration and tracking. Some major manufacturing companies, including Boeing, have indicated an interest in moving to a 24-hour, 7-day work week for line workers to maximize the efficient utilization of the company's capital investment and to give more employees opportunities for hours that better fit personal needs. Such changes could effect local and even regional traffic conditions.

IMPROVEMENTS IN PERSONAL MOBILITY

The private vehicle and has undergone important changes that have contributed to the high rates of auto ownership, utilization, and personal travel. These changes must be taken into account in transportation planning because more similar improvements can be expected. We can only summarize some of that we have garnered from the literature (Table 2-8). Personal mobility will undoubtedly benefit from Intelligent Transportation System (ITS) applications that are only now beginning to be introduced that will squeeze more effective capacity from existing roadways, reduce congestion and increase speed. Computer systems synchronize traffic signals and meter vehicles entering freeways to maintain constant traffic flow. Information systems warn of congestion and advise alternative routes and schedules. In some areas, new toll roads employ

pricing signals to manage traffic demand. Futher down the road are automated highways -- freeways guidance systems that will allow cars to move in platoon formation at high speeds. Some ITS applications will also benefit public transit, including real-time schedule information systems and integrated fare systems.

Table 2-8 Improvements That Contribute to High Rates of Private Vehicle Utilization

Private Vehicles:
Dependability/durability/longevity
Increased fuel efficiency
Improved emission controls
Improved safety systems
Wide range of vehicle designs
Mobile communications
Enhanced rider comfort
Roadways:
Increased capacity
Metropolitan-wide accessibility
ITS enhancements
Improved design for safety

DISCUSSION

Table 2-9 summarizes key factors that should be accounted for in long-range transportation and land use planning. Many are obviously interrelated. These factors will play a strong role in determining future land use and personal transportation patterns. Other factors, not indicated, may be operative in a particular metropolitan region.

It is important to note that many of these factors carry both a weight and direction in terms of their impact on metropolitan spatial form and travel patterns. In other words, they differ in the effect they have on the compactness and integration of land uses. Some are centripetal, tending to produce lower densities and separation of uses, e.g., the need of families for affordable housing tends to move demand and growth to the periphery of an urban region.. Others are centrifugal, tending to cause higher land use densities and an amalgamation of uses. This could be the case for some members of an aging population who seek to downside their residence and find a location convenient to goods and services. The factors are really vectors in mathematical terminology, and should be treated as such when used in a planning exercise. All may change in both strength over time.

An understanding of these factors is enhanced by both national and regional empirical data and other more subjective information. We have presented national data in this chapter, and in our

Task One report. Regional nonwork-related data for the case study region, the central Puget Sound area, will be presented in the Task 3 report. However, this data is meant to be illustrative and is not as comprehensive as would be required for the actual planning approaches that we discuss in Chapters 3 and 4 of this document.

Table 2-9 Key Factors to be Accounted for in Transportation and Land Use Planning

Demographics/Socioeconomics
• Net population change, including migration
• Household size trends
• Age profile, life span, and lifestyle
• Income levels and distribution
Residential Dynamics
• Residential mobility
• Preference for residential size, style, and environment
• Effects of aging population
• Preference for home ownership
• Self-selection by transit riders
• Reaction to congestion
Employment/Education Dynamics
• Industrial structure
• Spatial distribution of workplaces
• Change in work day and week
• Part-time and temporary work
• Multiple job holders
• Self employment/work at home
• Telecommuting/telelearning
• Reaction to congestion
• Work-based travel for work-related and other purposes
Population Distribution
• Growth beyond central cities and counties
• Intra-regional shifts
• Inter-regional shifts
• Older central city resurgence
Land Use Dynamics
• Land use policies and regulations
• Redevelopment and infill development
• Open space preservation
• Public reaction to density and mixed-use
Nonwork Activity
• Variety and spatial distribution of “retail”
• Impact of local government need/competition for tax revenues on location
• Trends in going out vs. staying home
• E-commerce
• Impact of broader distribution of wealth

Table 2-9 continued

Freight and Goods Movement
• Just-in-time delivery to industry
• Home delivery of e-commerce goods
• Courier services
Costs, Benefits, and Other Fiscal Factors
• System capital and operating costs, including those for feeder
• System utilization rate--new transit riders
• Externalities, including delay time and wasted fuel
• Direct private vehicle costs, including demand pricing
• Net benefit (cost) of alternatives
• Opportunity costs
• Available government and private resources
• Employer subsidization of alternative modes
Personal and Public Transportation Technology
• Alternative fuels
• Advanced vehicle propulsion technology
• Advanced fixed-guideway systems
• Safety improvements
• ITS applications
Other Technology Advances Affecting Travel to Work and Nonwork
• Teleconferencing
• Electronic service delivery
• Ubiquitous internet
• Virtual reality
Environmental Policy
• Air quality standards
• Greenhouse gases

CONCLUSION

A large number of socioeconomic, technological, and other factors, in addition to those that define the retail environment, are active in a metropolitan region, and they produce a state of continuous dynamic change in urban form and personal travel patterns. Key among these are preferences for the location and size of residence, the location of work centers, and the growth and spatial disperson of nonwork activities. These forces appear to be stronger than the regulations and incentives that government jurisdictions have at their command to shape urban growth. The combination of markets and preferences imply a future planning environment that is complex and uncertain.

CHAPTER THREE

KEY ELEMENTS OF AN IMPROVED URBAN TRANSPORTATION PLANNING PROCESS

INTRODUCTION

The array of issues in Table 2-9 -- covering land development, human activity at various locations, and travel to get to those locations -- establishes the dimensions of the complex, dynamic urban system that is the focus of land use and transportation planning. The complexity encompasses the interaction of known, multiple forces and the continuing introduction of new forces as a result of the dynamics of technological innovation, entrepreneurship, and competition. As Richmond (1998) points out, planners have to face up to this complexity in their planning: "Recognizing that transportation is inevitably tied in to an intricate web of overlaps with all other urban functions and with the rich morass of human life complicates the planning task but makes it more likely to achieve meaningful results." Along the same lines, Innes and Booher (1999) note that in the complex metropolitan development system "simplification results in fundamentally wrong answers, and focus on individual sectors separately will be counterproductive."

This chapter describes the key elements of a new urban transportation and land use planning process that encompasses the complexity of the dynamic urban system.

CHARACTERISTICS OF COMPLEX SYSTEMS

As Casti (1997) describes, complex systems generate surprises from five distinct mechanisms:

- Paradoxes, leading to inconsistent phenomena
- Instability, leading to large effects from small changes
- Uncomputability, leading to behavior that transcends rules
- Connectivity, leading to behavior that cannot be decomposed into parts
- Emergence, leading to self-organizing patterns

These mechanisms work across the dynamics of daily vehicle traffic, of consumer response to opportunity over a seasonal buying period such as Christmas or summer, of the labor market as firms start up, expand, contract, and shut down, and of industry responses to business opportunity, whether the industry is commercial real estate, entertainment, or retail.

The surprises that come from complexity force planners to grapple with three forms of uncertainty about the future (van der Heijden 1996):

- Risk, where the occurrence has historical precedent, and the probability of reoccurrence can at least be estimated.

- Structural uncertainties, where we can understand how a unique new event can happen, even though there is not enough experience to judge the likelihood.

- Unknowables, where a future event cannot even be imagined. The existence of unknowables calls for enhanced perception and skill in reacting appropriately.

COMPLEXITY AND THE CURRENT PLANNING PROCESS

As we observe the plans that result from MPO planning processes, we see very little recognition of the complexity and uncertainty that we have detailed in this report. It is rare to see a section within a Metropolitan Transportation Plan (MTP) that discusses and describes the risks and areas of uncertainty. The recommended outcomes of most MTPs, an emphasis on guiding development toward areas of geographic concentration and then connecting the areas with mass transit, do not seem to embrace the need for flexibility to respond to unknowables.

As we described earlier, the response to complexity seen in the typical MPO planning processes (standardized in Federal laws such as ISTEA and TEA21) yields a rather simple model of travel analysis zones (TAZ) made up of three kinds of subzones where people to varying degrees sleep, work, and engage in buying goods and services. The model is a series of equations calibrated to the latest available data on traffic flows and transit patronage. The model defines a structure of how land use is related to the movement of cars and buses. The basic structure of the model is then applied 20 or more years in the future against the same zones with new estimates of who and what is in the zones, based on assumptions for future residential population, employment, and kind of development. The mode by which people will travel in the future, car, train, or bus, is also estimated.

We find that the modeling process carried out as described has a number of significant limitations (Nelson & Niles 1999), summarized in Table 3-1.

Table 3-1 Limitations of Urban Modeling Applied to Nonwork Travel

Difficulty encompassing all forces shaping form & activity
Simplistic characterization of nonwork travel
Lack of nonwork activity data for calibration
Lack of transparency
Functional relationships not constant over time
Human response to congestion & time costs unpredictable
Not transferable between geographic areas

CURRENT MAJOR PREMISE: GOVERNMENT ACTION SHAPES URBAN FORM

The overarching paradigm and set of policies governing all the assumptions in MPO planning is a government plan for changing transportation and land use in the future -- typically, new roads, expanded public transportation systems, and more density near the places to be served by public transportation.

The very common TOD-rail paradigm is essentially a high-stakes gamble that in the long-run, government investment, incentives, and rules will cause the density of population, employment, and service offerings to increase around a network of transit stations. This density boost on top of the availability of transit capacity is assumed in the future to cause a reduction in driving, to be replaced by transit use, walking, and bicycling.

Ironically, while TOD-rail responds to the complexity of the marketplace, technology, and entrepreneurial behavior with a seemingly elegant concept, TOD also introduces additional complexity to both urban development and the lives of individuals.

- Mixed use buildings in a dense configuration are more complex to construct and operate than single uses in a more dispersed configuration.

- Experience has shown that mixed-use TOD projects introduce complications to the development process. For example, as Boarnet et al (1997, 1998, 1999) have found in California, even local governments that are pursuing the TOD-rail paradigm seek to maximize their tax revenue by emphasizing commercial and minimizing housing near transit stops. In most cases they pursue local needs over regional policies.

- For travelers, journeys involving transfers between modes or vehicles are often more complex and time-consuming than single-mode auto journeys.

- Visible stores in a traditional mall with parking may be easier for more consumers to find and use more of the time than multilevel retail packed around a train station.

Our view is that the probability of generating innovative, market-driven public policies for improving nonwork travel in a metropolitan area would be improved if there were a new, additional process of structured examination of the assumptions and results of the MPOs planning work. A new process would ensure that the complexity in metropolitan markets and the resulting uncertainty about the future would be inserted into the results of the MPO planning process, and add value to it. The new planning process could generate a range of possible future scenarios as a response to growing complexity and the uncertain impact of policies designed to achieve goals.

KEY ELEMENTS OF A NEW NONWORK TRAVEL PLANNING PROCESS

We call the new approach the Nonwork Travel Improvement Planning Process (NWTIPP). These are the definitions of terms we commonly use:

- Paradigm -- a vision of how society could work if certain premises about individual and organizational behavior hold true and if certain policies are implemented.

- Scenario -- summary description of patterns of events in the future, as influenced by uncontrollable external forces and by public policies and spending. Alternate implementation paths for paradigms to manifest.

- Policy or strategy -- broad principles that guide action by government and the private sectors, often in pursuit of a paradigm in the case of government land use and transportation planning.

- Program or tactic -- specific action that conforms to and implements policy or strategy.

- Premise -- the assumptions about how the world operates that stand behind paradigms, scenarios, and policies.

One objective in the design of the NWTIPP is to create a planning template that is capable of identifying strengths and weaknesses in the main premise behind the TOD-rail paradigm. The major premise behind this paradigm is that low-density, single-use urban form can be reshaped by government action -- rail (mass) transit investments and land use policies/strategies -- resulting in compact, mixed-use urban form that in turn supports and justifies the rail investment by producing new transit riders.

Example statements that summarize the TOD-rail paradigm are shown in Table 3-2. They range from general to specific, and from national to regional to local. The first is from a meeting of U.S. planning professionals and local government officials in 1991 (Local Government Commission 1992), the second from a metropolitan planning organization (Puget Sound Regional Council 1995), and the third from a city planning department (City of Seattle 1998).

We think a good planning process needs to consider alternative premises, for example, that the forces at large in the marketplace may be too numerous and strong for government actions to reshape regional form and travel to any meaningful degree. Following from revised premises, the NWTIPP would be able to identify alternative paradigms, scenarios, and policies/strategies.

Other characteristics we are designing into the NWTIPP:

- **An emphasis on continuous learning by participants in the planning process.**

From analyzing urban development in California as a complex system, Innes and Booher (1999) conclude that more sustainable urban development will come from learning that is generated from the individual interactions of system participants. They note that “sustainability is about process, not about a particular vision, pattern, set of rules, or criterion.”

Table 3-2 The TOD Paradigm: From General to Specific

Congress of New Urbanism: The Ahwahnee Principles
Guidelines for New Urbanism Development--Community Principles

"Community size should be designed so that housing, jobs, daily needs, and other activities are within walking distance of one another.
"As many activities as possible should be located within easy walking distance of transit stops."

Puget Sound Regional Council -- Vision 2020 Plan for Urban Centers

"The VISION 2020 strategy is to reinforce and diversify our existing urban centers ... to build an environment that will attract residents and businesses to the advantages it offers. These advantages include excellent access to frequent and fast transit that connects to other centers and to surrounding neighborhoods, a selection of attractive and well-designed residences, and proximity to a diverse collection of services, shopping, recreation and jobs."

City of Seattle Transportation Strategic Plan -- October 1998

"Support Development of 'Full Service' Neighborhood Business Districts."
"This strategy promotes shopping within neighborhoods by helping Seattle's urban villages to offer a full range of products and services to meet people's day-to-day needs."

It is our view that a uniform, nationwide mechanistic planning model imposed by the Federal Government on complex metropolitan transportation development may not yield sufficient learning to successfully address the complex problems at hand.

- **Explicit focus on nonwork travel**.

Travel for shopping, eating out, culture, and recreation constitutes the majority of urban trips and these activities are an important shaper of urban form. Our process also includes the residential and employment site location dynamics -- the places where nonwork trips either originate or terminate.

- **Metro-region-wide process.**

Many retailers now think in terms of total metropolitan areas, so we recommend that thinking about nonwork travel improvement be focused on this scale as well, instead of at the corridor level or subarea level like the Major Investment Studies (MIS) carried out under ISTEA and now merged into Environmental Impact Statements (EIS) as a result of TEA21. As to TOD in particular, much of the research and planning focus is now carried on at the station-area level, which may be acceptable until regional patterns are fully comprehended.

- **Explicit recognition that not making an additional transportation investment, or doing less than initially contemplated, may be the most desirable alternative.**

There are two reasons for this recognition -- (1) people can adapt to reduced transportation services by using alternative locations and behaviors, and (2) there are productive, non-transportation purposes for spending the money that is diverted from transportation-related spending, with some of these purposes serving the same needs that transportation spending would fulfill.

For example, as a general example, it may make more sense to build a new shopping center close by to a place that lacks adequate roads to a distant shopping center, rather than expanding the road capacity. By limiting transportation spending, the planning process remains open to the larger array of issues in which transportation planning is embedded.

- **May be carried out by Metropolitan Planning Organizations (MPOs), but more likely to be carried out initially by civic interests not officially-sanctioned by the MPO.**

MPOs are generally deeply invested in a limited set of options. The opportunity for designing new alternatives is most likely to come from a new set of actors. If not carried out by an MPO, the end result of the planning process will have influence on official decision making to the degree that the analysis carries the authority of expert knowledge and persuasive reasoning.

- **Will not necessarily follow federal planning guidelines, programs, and other requirements for transportation planning by MPOs.**

Figure 3-1 depicts a general representation of the urban transportation planning process carried out by MPOs, as described by Pas (1995). The NWTIPP emphasizes just the underlined portions of the overall process, in addition to the focus on nonwork travel. The Planning Team may recommend changes in federal requirements if they appear to block the execution of a superior planning process and set of resulting outcomes. Table 3-3 makes a comparison between the NWTIPP and the typical Metropolitan Transportation Plan carried out by MPOs.

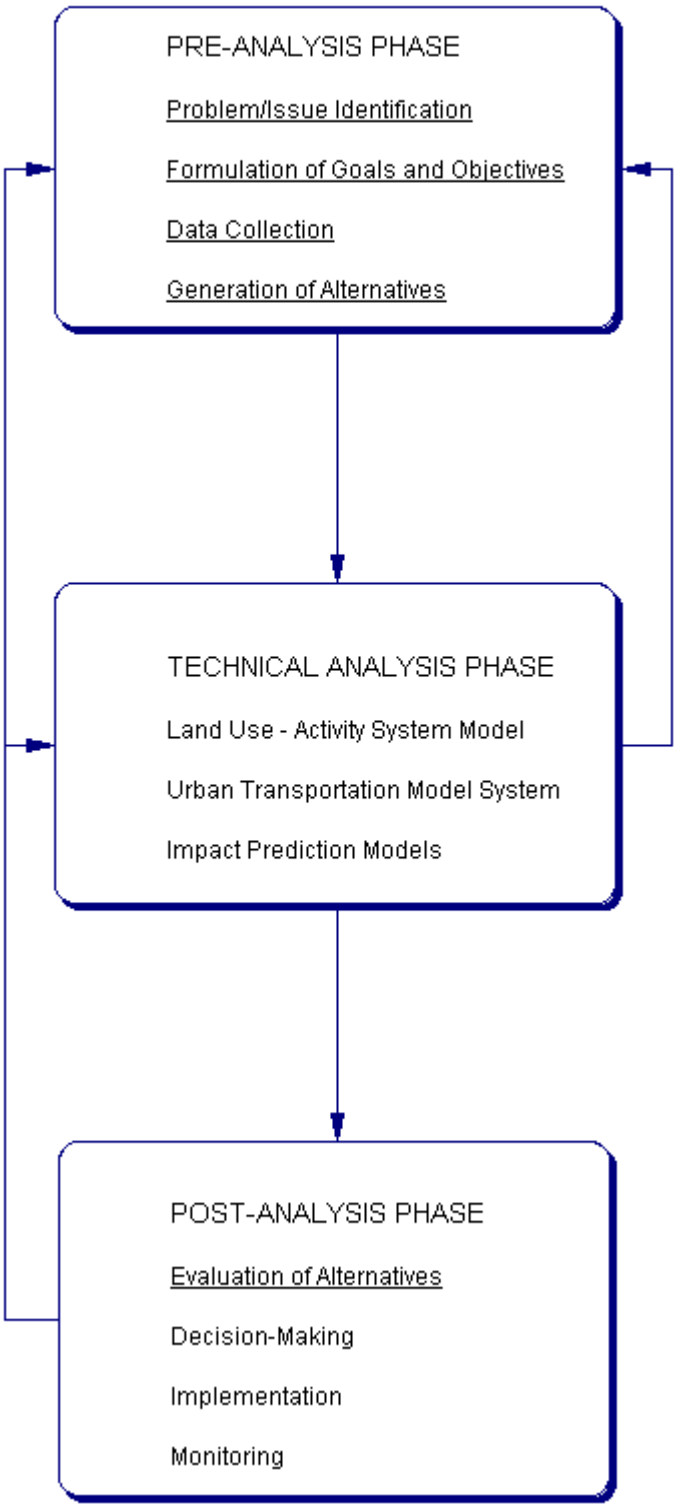


Figure 3-1 Urban Transportation Planning Process (Pas 1995)

Table 3-3 Comparison Between the Proposed Transportation System Improvement Planning Process, and the Current Metropolitan Transportation Planning Process (MTP)

MTP	NWTIPP
Carried out by MPO	Initially carried out by other civic interests
Legal basis for regional transportation investments	Potential influence based on quality of results
Based on Federal regulatory requirements	Not constrained by Federal regulations
Seeks to optimize the morning peak period	Can be focused on other problems and issues
20+ year time horizon mandatory	Shorter time horizons preferred
Typically begins with a paradigm and justifies it	Seeks to find a paradigm that addresses a problem of public policy importance
Centered on the 4-step urban transportation model	4-step model results are just one input to Expert Panel

- **Able to work within a more time-constrained planning horizon than the 20 years mandated by the U.S. government for a Metropolitan Transportation Plan, and much more constrained than the 30 to 50 year time frame utilized by some MPOs.**

We have stressed the complexity of the urban milieu that governs human activity and transportation, and entrepreneurial real estate development and consumer service offerings. The rapidly emerging Internet economy adds to the complexity. The notion of planning beyond a decade in the future seems problematic to us.

The reason that a constrained (limited-time) planning horizon may be preferable goes beyond the uncertainty about the future that is inherent in a complex system. The accelerating rate of change of the system adds to the uncertainty. The volume curves for several drivers of our society at the end of the century show accelerating rates of growth -- transistors in a microchip, Internet hosts, Internet web sites, volume of online shopping, business-to-business electronic commerce, and e-mail messages.

Long planning horizons may also tend to proscribe some policies and strategies. Solutions that are more easily implemented and more flexible may be ignored in comparison to solutions that appear to be more durable and long-lasting, yet less effective in terms of public benefits (Zwerling 1974).

- **Generates and supports strategies and policies that are flexible and adaptable.**

Given the complexity of urban development and of the market economy that drives development, we expect that premises may need to be modified with the passage of time as a result of new understanding about the way the metropolitan area is functioning, and about the impact of public policies. Governments need to be able to react flexibly to unforseen future developments of either kind.

- **Incorporates predictive models that are transparent.**

The four-step, gravity-analog transportation models that are at the heart of MPO transportation planning are notoriously obscure for the non-specialist. We believe it is important to carry out additional processing on the raw outcomes from these models.

Assumptions, simplifications, and their impact on accuracy need to be apparent and outside the complex inner workings of the "black box" computer model.

- **Provides outputs as a range, rather than discrete values.**

The empirical data, estimates, and assumptions would be available for public inspection. A report can be issued after each step, which would allow stakeholders, including elected officials, the opportunity to provide feedback throughout the effort.

- **Acknowledges and manages all technical transportation system alternatives -- immediately feasible or not.**

Individual members of the public and the media are very interested in the prospect of advanced transportation systems. Businesses around the world have new options on the drawing board. A higher level of public involvement will result if a fairly open process of considering all technical transportation options is maintained These can be handled fairly through a consideration of their performance and cost parameters. We observe that transportation planning in practice focuses very quickly and conservatively on a rather narrow range of technical alternatives -- light rail, commuter rail, and standard buses.

- **Comes to grips with the emergence of the Internet economy, widely-deployed microcomputers, ubiquitous personal communications, and other likely technology expansions over the next five years.**

The rise of the network economy is already a distinctive feature of the present era. The ubiquitous presence and use of computers and telecommunications is not yet mentioned in very many Metropolitan Transportation Plans, yet already is producing impacts on transportation. The routine use of cellular phones in cars is increasing the value of time alone in a moving automobile, for example. The continuing growth in small package delivery services in urban areas is another example, along with the announcement of billions of dollars in warehouse construction by firms selling goods on the Internet. The growing impacts from online selling on particular categories of retail businesses -- bookstores, automobile dealers, and travel agencies -- is a third illustration.

- **Accounts for the range of costs and benefits of the various scenarios that will arise from each examined alternative paradigm and its associated policies.**

This accounting will also provide a budget for each paradigm and policy package that describes the public costs and potential revenue sources to implement the policies.

- **Utilizes Delphi for both forecasting and backcasting to integrate expert opinion around the normative process of plan development.**

A Delphi panel is a structured interaction among the members of a group with different kinds of expertise that allows them to reach consensus on an informed opinion about a complex topic. Forecasting means making judgments about the future, and backcasting makes judgments about the steps to take reach a desired future state of affairs. Table 3-4 summarizes Delphi and backcasting, the combination of which is a distinct feature of the proposed planning template.

Table 3-4: The Components of Delphi Backcasting

Delphi: Diverse expert opinion collected from a group and iteratively presented as feedback to the group to modify opinions and converge on a consensus.
Backcasting: Working backward from a particular desirable future endpoint to determine the feasibility of that future and what policy measures would be required to reach it.

DELPHI METHOD APPLIED TO URBAN TRANSPORTATION

We searched the planning literature to find a new planning approach that matches the difficulty of the urban transportation planning problem. Table 3-5 lists decision-supporting methodologies that have been applied to TOD planning in approximate order of their increasing complexity. Each has both unique advantages and limitations (Nelson and Niles 1999). Each has been used to examine some aspect of TOD, but none of them offer much guidance on the difficult question of how to decide if the predictable regional benefits of a paradigm like rail/TOD justify the necessarily associated large investment in infrastructure and operations.

We have concluded that there is a clear need for a new planning approach that more directly matches the difficulty of the problem. A good tool would take into account the complexity and ongoing dynamic evolution of the metropolitan economy. A good tool would employ available descriptive data and information, but not demand that only quantitative results be relied upon for estimating the likely impacts of TOD.

Table 3-5 Decision-Support Methods That Have Been Applied to TOD

Method	Selected Application/Reference
Structured discussion	Berkeley Planning Journal (1994)
Visual simulation	Cervero & Bosselmann (1998)
Metro area case study (interviews, field inspection)	Boarnet & Compin (1999)
Economic estimation	Downs (1994); Luscher (1995)
Sketch planning	Fox & Bowlby (1997)
Travel demand modeling - assumed growth scenarios	Thompson & Audirac (1999)
Travel demand modeling - estimated real growth	Puget Sound Regional Council (1990)

Our search led us to a method that can meet these requirements: the Delphi expert panel. It uses diverse, informed opinion to reach consensus through a structured iterative process. Delphi is a technique developed at the Rand Corporation in the early 1950s. A group of experts (who are asked not to meet or interact on this planning problem outside of the structure described here) are sent information on a topic, and are asked to express opinions on a series of questions or statements in a structured way along a monotonic scale. The expert responses, including supporting arguments, are made anonymously and forwarded to a processing secretariat. All responses are compiled in a feedback document, with display of the reasons for responses that deviate from an emerging consensus average. The feedback document is sent back to each participant, each of whom now given the opportunity to change opinion and provide new responses. If a response will lie outside the average found in the previous iteration, the respondent is asked to supply supporting information. The goal is to achieve consensus among the experts as they learn from each other. Consensus is typically achieved after three to five rounds of feedback and response (Irving and Conrath, 1988).

Backcasting Delphi

Traditionally, Delphi has been used in making forecasts of the future. In the application of Delphi method to backcasting, the expert opinions sought are on the subject of how to achieve a desired future result, such as reduced traffic congestion. The panel works backwards from the desired outcome to determine if it is feasible, and then assesses necessary policies and other inputs that will produce the outcome or a feasible alternative outcome. When consensus cannot be reached on proposed solutions, the alternative solutions are modified or some aspect of the goal is changed based on new knowledge (Robinson 1990, Dreborg 1996).

Backcasting and Delphi have been applied separately and together to energy and transportation forecasting, principally in Europe and Canada. Hojer (1998) used Backcasting Delphi to study the feasibility and effectiveness of three alternative passenger transportation scenarios: improved road system with user fees, improved public transit through rider information, and a hypothetical dual mode system which combines the flexibility of the private car with the capacity of public transport. Backcasting Delphi was also employed by Marchau and van der Heijden (1998) to explore the likely benefits of driver support systems.

In the NWTIPP, we envision engaging a multidisciplinary panel with expertise to understand the many areas of substantive knowledge and experience necessary to comprehend the topics listed in Table 2-9. Before the backcasting exercise, we would orient the panelists to the substantive topic and the process of providing opinions and receiving feedback with two forecasting exercises. We envision that a draft problem statement, set of alternative solutions, and framework for evaluation would be initially provided by a Professional Planning Team at the beginning of the backcasting procedure, but the panelists themselves as independent authorities would have the opportunity to modify all inputs in the pursuit of solving what is a widely-perceived problem.

For the purpose of TOD evaluation, backcasting Delphi provides several advantages over other methods. In the ideal case, it would precede decisions to invest in capital-intensive transit capacity such as light rail. It would allow involvement of a broader range of expertise than is normally the case in transportation and land use planning. For example, retail industry site selection managers would have equal status with regional transportation planners. All of the significant forces shaping urban form would be considered. It would allow the setting of a planning horizon that reflects the uncertainty inherent in these forces. The land use-transportation scenarios evaluated would not be limited to the regional planning vision and to no-build and build transportation alternatives. Through the iterative process, both capital-intensive and low-cost incentive and marketing solutions would be considered until a consensus is reached on a feasible scenario that is compatible with the forces shaping the urban environment. With appropriate framing, broader social equity questions would be considered, as well as a range of opportunity costs. The attributes of Backcasting Delphi are summarized in Table 3-6.

Table 3-6 Attributes of Backcasting Delphi

Embraces multiple disciplines of expertise
Considers all forces shaping urban form
Encompasses total sustainability
Allows for iteration to reach policy consensus
Can be executed regionally or nationally
Transferable across regions
Transparent and open to public view

An example of how Backcasting Delphi might be applied to considering the regional success of TOD is seen in Table 3-7 (Nelson and Niles 1999).

Table 3-7 Example of Applying Backcasting Delphi for Predicting Metro-Wide Success of TOD

Partially-formed vision: Make broad comparison of desired TOD structure with present urban structure.
Detailed vision: Define desired TOD structure and underlying transit system in detail.
Success specification: Specify future transportation performance desired from TOD.
Forces, trends, policies assessment: Assess forces, trends, and public policies affecting evolution to the future desired TOD structure, transit system, and resulting transportation performance.
Convergence through iteration: Reconcile the vision and success specification with the reality of the forces, trends, and policies; then re-vision and re-specify TOD and transit as needed.

CHAPTER FOUR

PROPOSED TEMPLATE FOR PLANNING GOVERNMENT POLICIES AND INVESTMENT FOR NONWORK TRAVEL[1]

INTRODUCTION

This chapter provides a description of the template for the Nonwork Travel Improvement Planning Process that implements the characteristics we described in the previous chapter. As described earlier, we see the NWTIPP as an overlay and supplement to the existing, Federally-mandated MPO metropolitan transportation planning processes. The recommended steps can be carried out by existing MPO staff, or by a new set of regional players.

PROPOSED TEMPLATE AND PROCESS

Table 4-1 provides a summary overview of the steps we recommend for the NonWork Travel Improvement Planning Process. The heart of the process is the interaction between a small core Planning Team and a diverse Expert Panel that will carry out two forecasts and one backcast using the structured Delphi technique.

Table 4-1 Steps of the Nonwork Travel Improvement Planning Process

Establish the Planning Team.
Recruit the Delphi Expert Panel.
Research the current and future state of consumer activities.
Delphi Panel forecasts the future of consumer activities.
Research current and future nonwork trip making.
Delphi Panel forecasts baseline future trip-making for consumer activities.
Establish public policy objectives for nonwork travel.
Generate alternatives for achieving public policy objectives.
Delphi Panel backcasts a policy package to achieve recommended objectives.
Planning Team prepares end product documents.

In detail, we see the ten steps of the NWTIPP as follows:

[1] The work in this chapter has been substantially revised and made a part of Task 4, Chapter 3.

One: Establish the Planning Team.

A first step is to establish authority for the process. Every U.S. metropolitan area in which the suggested NWTIPP would apply already has a Metropolitan Planning Organization (MPO) and an established process of transportation planning. The MPO may also be involved in regional land use planning. This report makes the case that this planning process is incomplete with respect to nonwork travel, and yields recommendations that are at odds with the reality of what is happening with commercial development and human activity.

Our planning process is not a straight up replacement of the existing MPO process, and the NWTIPP does not attempt to meet all of the Federal requirements set in the ISTEA and TEA21 legislation. We would encourage a shorter time horizon than the 20 years mandated by the Federal Government.

Although not necessarily carried out by a government agency, we do recommend that the NWTIPP be carried out by an organization with some standing in the community -- a community-minded civic leadership association such as an economic development council, a chamber of commerce, or a local chapter of the American Planning Association comes to mind. Still another option would be a graduate school student project within a university urban planning program.

The Planning Team may want to contract with the MPO for activities in the technical analysis phase, such as some special runs of the 4-step model.

We recommend that the Planning Team taking on the responsibility of preparing a NWTIPP formally organize with a team leader and other assignments. The following are useful roles: research coordinator, student intern supervisor, liaison with MPO, public involvement coordinator, meeting process facilitator, Expert Panel recruiter and coordinator. At least a few members of the Planning Team should have some transportation planning experience.

Because established wisdom is to be challenged, confidence and mutual trust must be high on the Planning Team. We recommend that time be taken for team-building exercises that establish productive interpersonal group dynamics.

Early on, the Planning Team needs to establish its budget, mission statement, and ground rules. A minimum reasonable resource level for the Project Team's effort would be approximately 6,000 person hours over a year-long elapsed time. Some of these hours may be from volunteers, but this total does not include the preparation of review comments by the general public or other readers of project documents who emerge from the community. The total does include about 500 hours that would need to come from the Expert Panel convened.

A mission statement, a planned end date, and a list of planned deliverable documents would all add coherence to the effort.

The Planning Team should define the geographic area which the NWTIPP will attempt to influence. We will call this the Defined Metro Area (DMA). We have observed that the boundaries set by MPOs are often drawn too close-in to capture all the significant real estate development, consumer activity, and trip-making that is going on in outer ring counties.

Because of the complexity of the environment and the relative lack of data, we feel that the Planning Team should consider the general public an important data source. Channels for public input should be established, the input should be taken seriously, and feedback provided to those who provide input to tell them how the additional information was used. This includes maintaining an easily-accessible, documented record of comments and suggestions from the general public and others not part of the Planning Team, as received throughout the course of the NWTIPP.

Two: Recruit the Delphi Expert Panel.

According to our design for the NWTIPP, a Delphi Expert Panel will be engaged in two forecasting exercises and one backcasting exercise. We recommend that the Delphi Expert Panel consist of at least ten persons with a range of diverse expertise. Areas of useful expertise for this panel are shown in Table 4-2.

Table 4-2 Areas of Expertise for the Delphi Panel

Regional economics
Retail store location planning
Retail business strategy
Consumer behavior
Commercial real estate development
Commercial real estate leasing
Residential real estate development
Electronic commerce
Public transit
Highway planning
Intelligent Transportation Systems (ITS)
Freight logistics
Rideshare/vanpool promotion and coordination
Local government lawmaking and regulation
Urban land use planning
Architecture
Urban geography
Environmental quality

As part of the interaction with the public, the Planning Team should publish a list of the names and biographies of the members of the Expert Panel who will review and reach consensus on the specifics of a transportation and land use policy package designed to achieve success in the resolution of the problems defined below

There also needs to be a plan for eliciting structured opinions and justifications for those opinions from the members of the Expert Panel in the three Delphi processes. This requires a series of questions that can be answered along a monotonic scale.

Three: Research the current and future state of consumer activities.

The first Delphi exercise described in Step Four below will generate a forecast of the retail and consumer services industry in the Designated Metropolitan Area. One preparation step for the panel is to understand the activities and locations where consumers go to shop, eat out, recreate, and partake of culture, all of which constitute the cluster of activity we term "retail.."

Understanding the present status of the DMA would be aided by having descriptive data on present land use and land use trends underway, including where residential, office, and retail/service facility growth is occurring, and on the human activities that cause nonwork "retail" trips to be made. Acquiring this descriptive data is an ongoing quest. Often, only samples are available. Extrapolation from fragmentary data will frequently be necessary.

Another preparation step for the first Delphi forecast is the Panel understanding the forces shaping the future of retail. In this step, the Planning Team identifies market, technological, demographic, business, and social trends that are shaping development, activities, and movement in the present and in the foreseeable future. Areas of uncertainty should be compiled as part of this research.

Also, using available industry forecasts prepared by associations, consulting firms, think tanks, and government agencies, the Planning Team should compile a series of baseline general forecasts (applicable to the U.S.A. as a whole) of likely technology availability, environmental conditions, and socioeconomic development. Topic categories are those shown in Table 2-9: demographics, socioeconomics, residential dynamics, employment/education dynamics, population distribution, land use dynamics, consumer market dynamics, freight and goods movement, fiscal factors, transportation technology, transportation substitution technology, and environmental policy. Relevant source documents are indexed and abstracted monthly in Future Survey from the World Future Society, among other sources.

Based on a review of the forecasts, the Planning Team should develop a consensus list of the exogenous forces shaping retail land use and activity in the DMA over the next five to ten years. The items on the list should have weights assigned to indicate the relative importance of these trends, and also the degree to which local public policy can influence each trend in a constructive way.

Four: Delphi Panel forecasts the future of consumer activities.

Forecasting consumer activities over the next five to ten years in the DMA would be the first occasion for the Delphi process to be exercised with this group. This forecast would consist of informed, subjective specification of likely futures. It may or may not be informed by models or other quantitative information.

While the Expert Panel would of course be provided with the results of the work of the Planning Team from the previous step, we envision that the Panel would be encouraged to ask for information as they see fit from the Planning Team or anyone else. Information requested by one Panel member would be sent to all panelists.

Five: Research current and future nonwork trip making.

In preparation for the second Delphi forecasting exercise, the Planning Team researches how and why people travel now: purposes, origin and destination pairs, modes, routes, and volumes; present public transportation services, including usage and capacity; the locations, time-duration, and causes of traffic congestion and related environmental impacts.

The current Metropolitan Transportation Plan developed by the MPO is a key input document for the NWTIPP. The Planning Team should understand and assess the MPO's transportation forecasts across their planning horizon, in particular, the MTP forecast for nonwork trips. There may be major capital investments in new road capacity or mass transit systems already programmed, and these need to be assessed by examining the claims made for their impacts by the MPO. For example, what is the nonwork mode share mix between private vehicle use and public transit?

Another useful input to the Planning Team is a "present commitments" land use map of the DMA in the MPO's planning horizon year prepared with input from the judgment of the MPO planners and of the planning departments in the local government jurisdictions of the DMA. The map shows projected zoning and built area within that zoning, and also the projected network of highways and arterial roads, transit centers, park-and-ride lots, intra-urban rail lines, train stations, and other transportation infrastructure.

Particular transportation-related actions to be taken by governments, large employers, and significant trip-attraction sites need to be assessed. For example, in Seattle, the Regional Transit Authority is introducing all-day express bus service between the major urban centers over the next few years. As another example, from metropolitan Atlanta, BellSouth Corporation has announced it will close 75 of its 100 suburban office locations in the 2001-2003 period and relocate 13,0000 of its 19,000 employees into three large offices located nearby to MARTA subway stops (Saporta, 1999). This may have a significant impact on nonwork destinations for these workers. The imminent opening of a regional shopping mall would also fall into the category of significant transport-related actions to be evaluated.

Six: Delphi Panel forecasts baseline future trip-making for consumer activities.

In this second of two forecast exercises carried out by the Delphi Expert Panel, a consensus is sought on a baseline forecast for nonwork trip making in the DMA as a function of alternative scenarios that are dependent on existing policy and investment commitments. This forecast like the previous one will be quantitative to the degree possible, but not beyond the comfort level of the panelists. It will take into account the MTP and visible trends.

It is also important that the forecast reflect an understanding and dissection of the MPOs existing central paradigm for transportation and land use. In many DMAs this is the rail-TOD paradigm that uses infrastructure investments to stimulate the concentration of growth at high-density, mixed use centers immediately adjacent to train stations, thus providing a motivation for a number of people to use trains for their most frequent trips instead of cars. The underlying premise for this paradigm -- that government action can significantly shape urban form and travel through a package of policies that includes investment in rail construction, incentives on development near stations, and restrictions on development that is not near stations -- needs to be carefully thought through by the Panel. The Expert Panel needs to pivot off of the nonwork trip forecast in the MTP, which will reflect the central paradigm.

Seven: Establish public policy objectives for nonwork travel.

In this step, the Planning Team establishes draft public policy objectives for nonwork travel. This means defining the problem that NWTIPP is addressing, and how one would know the problem is solved. Reduce the congestion caused by the growth of nonwork travel? Move more nonwork trips to transit? The objectives may go beyond those in the MTP.

The objective for nonwork travel may be the same as the objective for all travel in the DMA. It may be that the public policy objective for nonwork travel is related to land-use; freezing the number of major decentralized shopping destinations, for example. The objective should reflect what people as residents and as representatives of businesses and other organizations say they want in transportation performance and environmental quality, and what they show they are willing to act on and pay for: neighborhood traffic calming, access to transit services, one-way streets, bus-priority lanes, or free parking, for example.

The statement of the problems or issues that the NWTIPP is intended to address also needs to specify how to measure these problems in a base year and in a defined out year, and how success in the resolution of these problems will be judged in the out year.

The latter stages of the NWTIPP raise the potential for a need to adjust the problem definition or at least the goals associated with the definition if the Expert Panel is unable to find a set of policies and investments that is likely to solve the defined problem.

Eight: Generate alternative paradigms for achieving public policy objectives.

In this step, the Planning Team would formulate one or more paradigms and the associated policy packages that potentially cause the DMA to achieve the objectives defined in the previous step. The output of this step is a draft consensus list from the Planning Team of three to five effective and efficient policy packages intended to impact transportation performance in the out year for submission to the Expert Panel. These alternatives should reflect an understanding of the existing institutional framework for planning and implementing changes in transportation and land use -- the institutional actors, plans, policies, strategies, and investments already in place.

Planners carrying out this template may want to include TOD as one of the alternative paradigms given its prominence in professional planning circles, but they should be free to design and choose whatever alternatives fit their circumstances.

Nine: Delphi Panel backcasts a policy package to achieve recommended objectives.

In this key portion of the NWTIPP, the focus for the Expert Panel would be on judging the effectiveness of different policy packages developed by the core planning team. The Panel would be asked to rank the options' potential for addressing the problems and issues defined. The process is designed to reach consensus on an optimal policy package that will likely achieve success in meeting the intended performance goal over the time frame of the NWTIPP. The Panel would be encouraged to suggest changes to the packages, especially if consensus were not forthcoming. Suggested changes would be compiled and used as the basis of a revised set of packages to be ranked by the panelists.

The recommended policy package may end up being one suggested by the Planning Team, or it may be an alternative policy design based on input from the Panel to the Planning Team. This process must further recognize the possibility that none of the suggested policy packages will reach the established performance standard, and that modification of the goal is required. Even more fundamental than the serious possibility of revising policies and performance objectives, the Expert Panel interaction on the research and forecasts developed by the Planning Team may lead to the generation of new scenarios that take into account previously unconsidered forces. This may lead to the revision or overthrow of a premise that is fundamental to a paradigm and all that follows from that paradigm in the way of policies and programs.

Realization that premises and the resulting paradigms are invalid naturally leads to creation of new paradigms, and correspondingly to a different set of policies and strategies. For example, in certain metropolitan areas the Panel may argue convincingly that governments are not sufficiently able to control patterns of development and travel to make the rail/TOD paradigm viable. New paradigms may include the acceptance of dispersed and decentralized growth supported by public policies and strategies that reduce travel impacts and increase environmental quality/livability.

The final result is a refined, winnowed package of policy initiatives that is the result of the Delphi expert consensus process. This selected package would be described in a report presented to

those officials in a position to consider the recommendations for implementation, and of course also made available to the general public.

Ten: Planning Team prepares end product documents.

The work of the Planning Team and Expert Panel should be carefully packaged for presentation to the media, the MPO, government administrators, elected decision makers, the general public, and the civic leadership of the DMA.

The Team should also recommend further planning steps. Under the influence of what the Expert Panel reports, the Planning Team may face the prospect of having to repeat and rework earlier steps to account for considerations brought to light by the interaction of the diverse experts. There may be a need for further iterations of the objectives-paradigms-policies development.

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