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Regional transportation planning in the US: An examination of changes in technical aspects of the planning process in response to changing goals

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Abstract

This paper presents a framework for examining the ways in which technical aspects of the regional transportation planning process are changing in response to a broadening of goals and strategies, driven in part by an increased emphasis on public involvement. As an illustration of this framework, the long-range plans of four Metropolitan Planning Organizations (MPOs) in the US are analyzed with respect to goals, performance measures, and use of forecasts. These examples suggest that changes in the technical aspects of the process are lagging changes in planning goals. As a result, plans may implicitly emphasize congestion relief even if they put forth a much broader range of goals. This paper provides a basis for further analysis of the current evolution of transportation planning in the US.

Keywords: Transportation planning; Perfomance measures; Travel demand forecasting

1. Introduction

Following the lead of the European community and other parts of the world, the US is edging toward a new philosophy of transportation policy. Growing recognition of the inevitability of traffic congestion and the significance of environmental and equity impacts associated with driving are leading to increased support for policies to discourage driving and to improve alternatives. For example, the perceived success of the London congestion-pricing scheme has fueled interest in this strategy in San Francisco and New York. Safe-Routes-to-School programs, widely adopted throughout the UK, have spread across the US with help from state and federal funding. Recent climate change legislation in California is generating momentum for innovations in fuel technology as well as increased attention to land use policy. But the regional transportation planning process was designed for an era when efficiency was the sole concern and road building was the primary strategy (Meyer and Miller, 2001; Wachs, 2004). With a broader range of goals and new kinds of strategies under consideration, the traditional congestion-focused process with its traditional congestion-focused tools may no longer be adequate.

Regional transportation planning agencies have been working to revise their planning processes and develop new tools appropriate for a wider range of goals and strategies (e.g. TRB, 2001). An increased emphasis on public involvement has gone hand-in-hand with an expansion of goals, both contributing to the inclusion of new goals and increasing in importance in response to new goals. Particularly interesting in light of both a broader range of goals and increased emphasis on public involvement are changes in the quantitative aspects of the process, namely the development of performance measures and the use of forecasts. Performance measures are used to monitor progress toward adopted goals and to evaluate the likely effectiveness of the proposed plan in achieving these goals in the future. For the latter purpose, travel demand models[1] are commonly used to generate forecasts of the

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[1]By "travel demand model," I mean the traditional four-step model widely used throughout the US since its institutionalization by the federal government in the 1960s (Weiner, 1992). See Meyer and Miller (2001) and Beimborn and Kennedy (1996) for descriptions and critiques of these models.

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Table 1
Sample of regional transportation plans

MPO	Location	2000 Population	2003 Delay per traveler	Plan	Adoption date
MTC—Metropolitan Transportation Commission	San Francisco Bay Area, California	6.8 million	62 h	Mobility for the Next Generation: Transportation 2030 Plan for the San Francisco Bay Area	February 2005
SACOG—Sacramento Area Council of Governments	Central Valley of California	1.9 million	40 h	A Bold First Step for Mobility in the Sacramento Region: Metropolitan Transportation Plan for 2025	July 2002
PSRC—Puget Sound Regional Council	Seattle region, Washington State	3.3 million	46 h	Destination 2030: Metropolitan Transportation Plan for the Central Puget Sound Region	May 2001
Met Council—Metropolitan Council	Minneapolis—St. Paul region, Minnesota	2.6 million	43 h	2030 Transportation Policy Plan	December 2004

Sources: 2000 US Census; Shank and Lomax, 2005.

measures at the end of the planning horizon, 20 or more years into the future, with or without the plan. A lag between changes in the technical aspects of the process and in other aspects of the process could significantly impede the achievement of the broader range of goals now driving regional transportation planning.

The purpose of this paper is to provide a framework for examining changes in performance measures and the use of forecasts relative to changes in goals in regional transportation planning and within the context of public involvement requirements. It applies this framework in an examination of the long-range transportation plans of four Metropolitan Planning Organizations (MPOs), the federally required agencies responsible for transportation planning in metropolitan regions in the US. These plans illustrate the range of ways in which MPOs are broadening their goals and adapting their planning tools to reflect these goals, and they suggest the significant challenges MPOs face in responding to a new transportation planning philosophy.

2. Method

Although they are not the only policy document required of MPOs, regional transportation plans serve as the guiding vision for the future of the transportation system in the region. Federal law lays out numerous requirements with respect to the development of regional transportation plans, including updates at least every 5 years, fiscal constraint in proposed improvements to the transportation system, extensive public involvement efforts, and consideration of eight planning factors, as described in the following section. These requirements are largely procedural, with the substance of the plan left to the discretion of the MPO. In general, these plans state the transportation goals for the region for the next 20 years or longer and present the strategies the region will use to achieve those goals, including proposed improvements to the transportation system. Shorter-term actions, such as the prioritization of improvements for funding within the next 3 years, must be consistent with the regional transportation plan. The plan is thus arguably the most important and most public statement of the MPO's intentions and of the basis for these intentions, and it thus an appropriate object of analysis.

For this study, I selected MPOs based on my prior knowledge of their planning efforts (Handy, 2005; Lovejoy et al., 2006) and so as to illustrate the diversity of current practice. The Metropolitan Transportation Commission represents the nine counties that encircle the San Francisco Bay Area. The Sacramento Area Council of Governments serves the region around the state capitol in the Central Valley of California. The Puget Sound Regional Council is the MPO for the Seattle region in Washington State. The Metropolitan Council is located in the Minneapolis-Saint Paul region of Minnesota. Although specific transportation challenges vary across these regions, they all face increasing congestion and expect significant population growth in coming years. The plans analyzed here were those in effect as of June 2006; their dates of adoption range from 2001 to 2005 (Table 1).

Guided by the framework outlined in the following sections, I analyzed the content of the plan for each MPO with respect to three questions:

- What goals have MPOs chosen to guide their plans, and how much importance do they give to congestion reduction?
- What measures, if any, are used to monitor progress toward these goals?
- What role do travel demand models play in forecasting these measures and how are these forecasts used in the plan?

To address the first question, I searched each plan electronically for a section explicitly labeled "goals"; in the absence of an explicit statement of goals, I scanned the plan for a statement of future aims in some form. In addition, I searched electronically for the terms "congestion" to identify its connection to the goals in the plan. To address the second question, I searched each plan electronically for the term "measure" and scanned the plan for the use of quantitative or qualitative measures used to monitor changes in the region and to evaluate the performance of the plan. To address the third question, I searched each plan and its appendices electronically for the terms "forecast" and "model" and scanned the plan for the use of quantitative predictions of future conditions in the region. I also looked for other documentation on forecasting procedures readily available to the public through the website. For all three questions, I also examined the role of the public, in two different respects: the extent of public involvement in the selection of goals and measures, and the nature of the presentation of forecasts to a public audience.

This examination is illustrative rather than conclusive. My choice of MPOs is not scientific, I do not examine changes in practices over time for these MPOs, and my analysis of their plans involves interpretation that reflects my own experiences and biases. Plans offer just one perspective on the planning process and do not always document the discussion and analysis that contributed to their development. Nevertheless, this examination provides a snapshot of the current state of transportation planning in the US that shows significant variation across MPOs in their response to a broadening of transportation goals.

In the following three sections, I offer central propositions for each question and provide a discussion of related issues, drawing on the transportation planning literature. This discussion provides the framework for the analysis of the four regional transportation plans that follows within each section. The paper concludes with speculation, based on the preceding analysis, of the possible implications for the regional transportation planning process.

3. Goals

Central to the transportation planning process is the establishment of goals, guided by a larger vision and then used to guide more specific planning objectives (Pickrell and Neumann, 2001). Whether explicitly stated or implicit and unstated, goals help to define the desired future for a place. If the most likely future for a place does not match the desired future, policies can be adopted and investments made that will help move a place toward that desired future. Thus, goals serve as a standard by which to judge existing conditions and evaluate current trends and as a guide to policy and investment decisions.

In the US, transportation goals have been changing at both the federal and regional levels. The Intermodal Surface Transportation Efficiency Act of 1991 instituted important changes in the planning process for MPOs. Among these changes was a requirement to consider 15 specific planning factors, including, for example, the overall social, economic, energy, and environmental effects of transportation decisions. According to the Act, failure to consider these factors was not subject to review by the courts. Even so, the requirement brought new attention to a much broader range of issues and served as an official sign that federal transportation priorities were no longer focused solely on congestion (Braum, 1994; Meyer and Miller, 2001).

In 1994, not long after the passage of ISTEA, President Clinton signed an executive order on environmental justice. Based on Article VI of the Civil Rights Act of 1964, the order requires all federal agencies to make environmental justice a part of their mission. The requirement covers the positive and negative impacts of federal policy on minority and low-income communities, and also requires that agencies ensure "the full and fair participation by all potentially affected communities in the transportation decision-making process" (FHWA, 2000). The emphasis on public participation reinforced elements of ISTEA that called for improved public involvement in the transportation planning process. These changes implicitly reflect an acknowledgement that the transportation planning process had been focused too narrowly on the traditional concerns of transportation agencies, not necessarily on the goals and values of the public that they serve (Poorman, 2001). Increased public involvement contributed to a broadening of transportation planning goals in many regions.

Subsequent legislation has modified but reinforced these changes. The most recent federal transportation bill, the Safe Accountable Flexible Transportation Efficiency Act—a Legacy for Users (SAFETEA-LU) of 2005, lists eight planning factors (Table 2). Although the factors do not explicitly mention congestion, a continuing concern over growing levels of traffic are implicit in terms such as "economic vitality," "efficiency," "efficient system management," and "mobility." Still, the factors emphasize many other concerns as well, notably the need to increase

Table 2
SAFETEA-LU planning factors

1. Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency
2. Increase the safety of the transportation system for motorized and nonmotorized users
3. Increase the security of the transportation system for motorized and nonmotorized users
4. Increase the accessibility and mobility of people and for freight
5. Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and local planned growth and economic development patterns
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight
7. Promote efficient system management and operation, and
8. Emphasize the preservation of the existing transportation system

accessibility, protect the environment, and improve quality of life.

These changing goals are evident in long-range regional transportation plans, developed and adopted by MPOs under federal requirements. It is not clear if changes in federal legislation caused changes in goals at the regional level, or whether both changes followed from the same underlying shift in thinking in the field more generally. The certification process for MPOs provides a mechanism by which the federal government can ensure that MPOs are adequately addressing to the planning factors. Some MPOs have largely embraced non-traditional goals (e.g. Poorman, 2001), but others remain focused on congestion, depending on public sentiment within the community, as expressed in part through the public involvement process. The following examples illustrate the range of ways in which MPOs have responded to the federal planning factors with respect to the type of goals they have adopted and the degree of emphasis they continue to put on congestion.

3.1. Examples

The Metropolitan Transportation Commision (MTC), the MPO for the San Francisco Bay Area, adopted a new regional plan in 2005 (MTC, 2005). Based on extensive public outreach (p. 8), the MPO established six general goals: safety, reliability, access, livable communities, clean air, and efficient freight travel (Table 3). The plan acknowledges that traffic congestion "plagues the Bay Area" (p. 3), but the goals focus more on ways of dealing with congestion rather than reducing it. The goal of reliability, for example, aims to ensure consistent travel times from day-to-day. In the chapter that discusses goals, the plan describes strategies to reduce "the impact of traffic

Table 3
Goals from regional transportation plans

MPO	Goals	Location in plan
MTC—Metropolitan Transportation Commission	*Safety*: a safe and well-maintained system *Reliability*: a reliable commute	Chapter 2: "Goals"
	Access: access to mobility	
	Livable communities: a region of vibrant neighborhoods	
	Clean air: clearing the skies	
	Efficient freight travel: moving goods to market	
SACOG—Sacramento Area Council of Governments	*Quality of life*: develop a fully-integrated, multi-modal transportation system to serve as a catalyst to enhance the quality of life enjoyed by the current and future residents of the Sacramento region	Chapter 4: "Meeting the Plan's Goals"
	Access and mobility: improve access to goods, jobs, services, housing, and other destinations; provide mobility for people and goods throughout the region, in a safe, affordable, efficient and convenient manner	
	Air quality: develop a transportation system and related strategies that contribute to achieving healthy air in the region	
	Travel choices: provide affordable, convenient, safe, and integrated travel choices	
	Economic vitality: enhance the economic vitality of our region by efficiently and effectively connecting people to jobs, goods, and services, and by moving goods within our region and beyond with an integrated multi-modal freight system	
	Equity: enhance the economic vitality of our region by efficiently and effectively connecting people to jobs, goods, and services, and by moving goods within our region and beyond with an integrated multi-modal freight system	
	Transportation and land use: enhance the economic vitality of our region by efficiently and effectively connecting people to jobs, goods, and services, and	

Table 3 (*continued*)

MPO	Goals	Location in plan
	by moving goods within our region and beyond with an integrated multi-modal freight system	
	Funding and revenue: in order to adequately fund the Plan, develop appropriate, innovative, equitable, and stable funding sources (both short- and long-term) and identify cost-reduction measures	
	Health and safety: improve the health of our residents by developing systems that would encourage walking and biking, and improve the safety and security of people on all modes in all areas	
	Environmental sustainability: develop the transportation system to promote and enhance environmental quality for present and future generations	
PSRC—Puget Sound Regional Council	Support maintenance and preservation of existing transportation infrastructure and services as a high priority	Chapter 1 ''Background''
	Provide stronger links between the transportation system and land use development to encourage growth within defined urban growth areas with balanced investments in multimodal transportation improvements	
	Identify and prioritize projects, programs and policies to improve all modes of transportation and keep up with growth	
	Improve the region's financial capacity to fund needed investments	
	Tailor recommendations at the sub-regional and corridor levels, in recognition of the region's social, physical and cultural diversity	
Met Council—Metropolitan Council	Goal 1: working collaboratively with regional partners to accommodate growth within the metropolitan area. Policy 1: work with local communities to accommodate growth in a flexible, connected and efficient manner	Regional Growth Framework, Chapter 1 and Transportation Policy Plan, Chapter 1
	Goal 2: maximizing the effectiveness and value of regional services, infrastructure investments and incentives Policy 2: plan and invest in multi-modal transportation choices, based on the full range of costs and benefits, to slow the growth of congestion and serve the region's economic needs	
	Goal 3: enhancing transportation choices and improving the ability of Minnesotans to travel safely and efficiently throughout the region Policy 3: encourage expanded choices in housing location and types, and improved access to jobs and opportunities	
	Goal 4: preserving vital natural areas and resources for future generations Policy 4: work with local and regional partners to reclaim, conserve, protect and enhance the region's vital natural resources	

congestion on people's lives and businesses'' (p. 13) rather than to reduce congestion itself. The plan also notes that ''over the next 25 years, the needs of elderly travelers are likely to grow and command our attention every bit as much as headline-grabbing traffic congestion.'' Congestion reduction is not a priority in the plan, though providing relief for congestion in other ways is.

The Sacramento Area Council of Govenments (SACOG), the MPO for the rapidly growing Sacramento region, adopted its Metropolitan Transportation Plan 2025 in 2002 (SACOG, 2002). Over a period of $2\frac{1}{2}$ years, a ''roundtable'' of 55 residents of the region, representing a variety of interests, formed a consensus on 10 specific goals, with ''quality of life'' as an overarching goal (p. 12). Other goals focus on providing for multiple modes of travel and emphasize access to destinations (Table 3). Although the brief descriptions of the goals do not explicitly mention congestion, a concern for congestion emerges in the detailed discussion of each goal in Chapter 4. For example, the plan notes that ''congestion limits accessibility and mobility'' and lists ''congestion relief projects and programs'' as a strategy for addressing the access and mobility goal (p. 28). In discussing the goal of economic vitality, the plan states that ''carpool lanes on the freeways will help clear up congestion that slows down trucks.'' Congestion reduction is not an explicit goal but the plan portrays it as a means to achieving its stated goals.

The Puget Sound Regional Council (PSRC) (2001), the MPO for the Seattle region, adopted its Destination 2030 in 2001. In the process of being updated as of this writing, the 2001 plan won an award from the American Planning Association as the best regional transportation plan in the US Rather than goals, the plan lays out ''objectives'' that emphasize a multimodal system, coordination with land use planning, and practical concerns such as financing and maintenance needs (Table 3; Chapter 1). In numerous places the plan stresses the importance of supporting federal, state, and local goals, suggesting that its role is to support these goals rather than to establish a separate set of goals. The plan frequently emphasizes the need to ''keep up with growth'' and aims for consistency with regional growth management policies. Although the objectives do not refer to congestion, the executive summary of the plan does, in phrases such as ''to ease current congestion…'' (p. 5) and ''a plan that produces real traffic relief'' (p. 5). The executive summary states, ''it's about traffic congestion and making it easier to move between home and work, school, shopping, and recreation'' (p. 8). Congestion reduction is not a stated goal, but it emerges from the discussion as an unstated goal.

The Met Council, the MPO for the Minneapolis—St. Paul region, adopted its 2030 Transportation Policy Plan in 2004 (Metropolitan Council, 2004b). The plan refers to four goals and matching policies established in a separate document, the 2030 Regional Development Framework (Metropolitan Council, 2004a; Table 3). The Met Council is unusual for an MPO in that its planning responsibilities extend beyond transportation, as reflected in the goals of the development framework. The Transportation Policy Plan is designed to support these goals (p. 1); its purpose is to ''develop an integrated transportation system that advances regional economic land use and growth management goals'' (p. 36). The transportation plan lays out 18 policies designed to achieve these goals (see Chapter 3) and provides an analysis of the match between these policies and the 8 federal planning factors (see Table 6–1). Like the PSRC plan, this plan emphasizes the need to accommodate projected growth in the region. Significant attention is given to the need to coordinate land use policy and transportation investments and to provide transportation choices. Although congestion figures prominently in the discussion of these policies, the summary for the plan stresses that ''there are no 'silver bullets' that will eliminate congestion'' and notes that the plan aims instead ''to slow the growth in congestion and improve mobility'' (p. 1). The plan thus emphasizes a reduction in congestion relative to what it would be without the plan rather than a reduction relative to today's congestion.

In summary, these plans reflect concern with a wide range of problems other than congestion and put significant importance on goals other than congestion relief. The degree to which they prioritize congestion varies, with the MTC plan at the low-priority end of the spectrum and the Met Council plan perhaps at the high-priority end of the spectrum. Interestingly, the two plans that describe extensive public involvement efforts to develop goals, the MTC and SACOG plans, put less emphasis on congestion reduction than the other two. Congestion relief is defined in different ways in the four plans and sometimes in different ways within the same plan. In the MTC plan, for example, congestion relief encompasses improved reliability of travel times. In the Met Council plan, in contrast, congestion relief is defined with respect to a slowing in the growth of congestion. All four plans note the impossibility of reducing congestion solely through capacity expansion, and all four emphasize, though to varying degrees, the importance of transportation choices as a form of congestion relief.

The continuing attention to congestion reflects continuing public concern with congestion; all four plans refer to local polls that identify congestion as a significant problem. But the regional attention to congestion also echoes a continuing emphasis on congestion at the federal level, despite the broad range of planning factors established in the federal transportation bill. In May 2006, US Secretary of Transportation Norman Mineta announced a new national initiative to address highway congestion (US Department of Transportation, 2006). The plan calls for greater involvement by the private sector in providing new transportation capacity, as well as the deployment of new technologies to manage traffic congestion. In announcing this plan, Mineta said, ''Congestion is not a fact of life. It is not a scientific mystery, nor is it an uncontrollable force. Congestion results from poor policy choices and a failure

to separate solutions that are effective from those that are not.'' Although new goals have come into play, planners and policy makers have not entirely abandoned hopes of reducing congestion.

4. Measures

Also essential to the transportation planning process is the development of measures to monitor progress toward adopted goals and to evaluate the likely effectiveness of the proposed plan in achieving these goals in the future.[2] These measures must directly relate to the goals and provide a valid and reliable gauge of the impact of plans with respect to the goals (Pickrell and Neumann, 2001; Meyer and Miller, 2001; Hendren et al., 2004). If measures do not closely match the goals, then they may lead planners and policy makers away from those goals and in effect towards others. If there are no measures for certain goals, then these goals potentially have little effect on policies and project selection. Because unmeasured concerns may have less weight in the planning process than measured concerns, it is important to develop measures to match each of the goals of the plan.

Planners have traditionally measured progress towards the goals of their plans through measures of the performance of the transportation system, and they have measured the performance of the transportation system using the concept of level-of-service. Level-of-service measures, as defined by the Highway Capacity Manual (TRB, 2000), are based on estimates of vehicle delay as determined by the relationship between the volume of traffic and the capacity of the facility, whether an arterial road, an intersection, a controlled-access freeway, or another type of facility. These measures were developed in the 1950s when congestion was the primary concern (Meyer, 2001). Despite their limitations, they have long played a dominate role in guiding investments in regional transportation systems, evaluating proposed traffic control improvements, and assessing potential land development impacts. They have also traditionally been used in the development of long-range regional transportation plans for the purposes of evaluating the ability of the transportation system with proposed expansions to accommodate projected population and employment growth.

Level-of-service measures have dominated transportation planning for several reasons. They are appropriate measures for the goal of reducing congestion and improving efficiency, the goals that have traditionally dominated transportation planning. The history of these measures dates back decades. In the 1950s, travel demand modeling techniques were developed to forecast level-of-service to determine whether proposed highways would meet projected demand (Rosenbloom, 1988). These techniques evolved into the well developed and widely used four-step modeling approach, helped along by federal guidelines (Weiner, 1992). Federal requirements necessitate the use of this approach in evaluating plans, conducting air quality analyses, and analyzing proposed rail projects. MPOs have invested substantial resources in developing these models, updating and improving them over time, and applying them in evaluating regional transportation plans (Johnston, 2004). Given this combination of factors, it is not surprising that the outputs of models are given considerable weight in the planning process, even as goals move beyond a focus on congestion.

With the broadening of transportation planning goals comes the need for new measures: the performance of the transportation system with respect to concerns other than congestion, and the performance of the plan with respect to elements beyond the transportation system. However, there is as yet little standardization of measures appropriate for these broader goals (Hartgen and Neumann, 2002). Instead, MPOs are inventing them as needed as a part of a larger movement toward performance-based planning in transportation (TRB, 2001, 2004; Hartgen and Neumann, 2002). In some cases, they find ways to extract new measures from their travel demand models. In others, they develop measures that do not rely on their models. The public sometimes also plays a role in the selection of measures. A significant constraint on these efforts is a lack of data (Pickrell and Neumann, 2001); for new measures, appropriate data may simply not exist. New measures might also be difficult to forecast when evaluating long-range plans. As a result, the fit between goals and measures might be less than ideal. In addition, the development of new measures is no guarantee that they will affect the planning process: measures must be widely reported, and institutional changes may be needed (Hartgen and Neumann, 2002).

To gauge progress towards new measures, it is helpful to examine what measures are used to monitor the performance of a plan, how these measures match—or not—with the goals of the plan, how the travel demand model is used—if at all—to forecast these measures, and the stated role of the measures in the plan. The following examples show significant variation in the use of performance measures in regional transportation plans.

4.1. Examples

For each of its six goals, the Metropolitan Planning Commission (MTC) lays out specific objectives with specific ''measures of progress'' (MTC, 2005, in Chapter 2). This

[2] Meyer (2001) notes that there is ''a clear distinction between performance measures and the valuation criteria used to analyze alternatives, although the literature and practice often blur the distinction'' (pp. 107). He suggests that the primary role for performance measures is to ''monitor the performance over time of the transportation system and to relate that performance to the decision-making process leading to investments in that system'' (pp. 107). Hargten and Neumann (2002) emphasize a similar role for performance measures. I use the term ''performance measure'' here in the sense of measuring the actual performance of the system but also in the sense of measuring the expected performance of the system in the future under different assumed conditions. The latter role is important in long-range planning.

effort is more systematic than in the other plans, though the match between goals and measures is not always clear (Table 4). For the reliability goal, for example, specific objectives include providing travel options and increasing the number of on-time trips. But performance measures include capacity added and level-of-service in congested corridors, both traditional measures of congestion that do not directly measure reliability. A more direct measure of reliability would be variation in congestion levels, but no data are readily available on current variation in congestion levels, and traditional travel demand models do not provide a way to forecast reliability. For other goals, measures generally consist of counts of completed projects of different types or "progress" in particular programs; very few measures rely on the travel demand model. The plan notes that the measures "focus on areas where MTC does have some influence and can make a difference" and will be used "to monitor the degree to which its actions advance the Transportation 2030 goals" (p. 9).

The SACOG plan uses a set of 11 performance measures, called "performance indicators," to assess progress towards the goals of the plan (SACOG, 2002; Table 4). The MPO considered 35 different measures and chose 11 based on "meaningfulness" and data availability (p. 27). How the 11 measures map onto the goals outlined in the plan, however, is not entirely clear. The measures relate most directly to the goals of access and mobility, air quality, travel choices, and perhaps economic vitality. They are not directly matched to the plan's goals of equity, transportation and land use, funding and revenue, health and safety, environmental sustainability, or the overarching goal of quality of life. According to the plan, SACOG intends to "reconsider other measures where practical in the future, toward developing a more complete assessment for future versions of this Plan" (p. 27). The measures are all derived

Table 4
Performance measures

MPO	Measures		Location in plan
MTC—Metropolitan Transportation Commission	Safety goal	• Number of injuries and fatalities at identified safety "hot spots" • Pavement Condition Index (freeways and roads) • Average age of transit fleet • Progress in completing bridge seismic retrofit program	Chapter 2: Goals
	Reliability goal	• Capacity added to the Metropolitan Transportation System • Levels of service in congested corridors • Progress with freeway ramp meters and traffic signal retiming • On-time transit performance • Effectiveness of incident management strategies • New transit connectivity projects • Progress in improving traveler information	
	Access goal	• Amount of lifeline transportation service provided • Progress in implementing transportation programs for older adults • Progress in completing community based plans • MTC and transit operator Title VI reports	
	Livable communities goal	• Number of Transportation for Livable Communities (TLC) projects completed • Number of new transit-oriented development projects assisted with the Housing Incentives Program (HIP) • Number of new mixed-use development projects assisted with HIP • Annual results of T-PLUS program	
	Clean air goal	• Periodic analysis of consistency between the Transportation 2030 Plan, Transportation Improvement Program (TIP) and the federal air quality plan (also known as transportation "conformity") • Progress in retrofitting urban buses with new emission controls • Development of new episodic controls on Spare the Air days • Progress in funding bicycle and pedestrian projects	
	Efficient freight travel goal	• Identification of key freight projects and associated funding • Development of a regional truck network on local arterials • Inclusion of a regional air cargo plan element in the next Regional Airport System Planning Analysis	
SACOG—Sacramento Area		• Total VMT • Per capita vehicle-miles-traveled (VMT)	

Table 4 (*continued*)

MPO	Measures	Location in plan
Council of Governments	• Total transit ridership • Congestion index for peak and off-peak periods • Percent of vehicle hours of travel at LOS E and F • Percent of travel time lost to congestion • Accessibility index (transit) • Accessibility index (drive) • Daily mode shares • Peak period mode shares • Vehicle emissions (tons/day)	Table 8: Key Performance Indicators
PSRC—Puget Sound Regional Council	• Daily vehicle miles traveled on the Arterial and Freeway Network • Average daily vehicle delay • Percent of freeway network experiencing congestion (PM peak period) • Mode share—all trips • Mode share—work trips • Facility travel speeds by mode (AM peak period) • Travel time and speeds for travel between regional urban centers (AM peak period) • Person trips at selected screenlines (AM peak period)	Appendix 8. Destination 2030 System Performance
Met Council—Metropolitan Council	• Lanes-miles constructed each year • Growth in vehicle miles per capita per day • Growth in hours spent in congestion per year • Violations of federal air quality standards • Growth in transit vehicle revenue miles per year • Growth in transit peak-hour seat miles • Growth in annual transit ridership	Table 2–3. Regional Transportation Benchmarks

from the travel demand model and are used to examine the impact of the plan between the base year and the plan year, with and without proposed projects.

The PSRC plan discusses performance monitoring, including growth monitoring, system performance monitoring, and financial monitoring (see Chapter 7). The plan relies primarily on its travel demand model in evaluating system performance (see Appendix 8). Specific "performance data" derived from the model and reported in the plan include vehicle miles traveled, vehicle delay, percent of freeway network experiencing congestion during peak periods, mode splits for all trips and work trips, facility travel speeds by mode, and travel times and speeds between regional centers during peak periods (Table 4). The plan labels these "measures of mobility" and notes that they "provide information about how well transportation systems are functioning" (p. 91). Although the objectives outlined in the plan reflect a broad range of concerns, the performance measures are more narrowly focused on the priorities expressed in the executive summary: relief from traffic congestion and making it easier to get from home to various destinations. The plan states that the PSRC will update these measures in periodic progress reports (p. 90).

Rather than performance measures, the Met Council plan offers general "benchmarks" related to highway capacity, roadway usage, highway congestion, air quality, transit service, peak-hour transit capacity, and transit ridership (Table 4). Current performance on these measures and expected performance given trends are reported, as are targets for each measure. The plan does not discuss the match between these measures and the 18 policies listed in the plan along with the specific strategies outlined for each policy. These measures are consistent, however, with the plan's emphasis on slowing the growth in congestion, both through expansion of highway capacity and through expanding the use of transit. Several of these measures are derived from the travel demand model, including growth in VMT, highway congestion, and transit ridership. The plan states that the benchmarks "will be used to monitor the success of achieving the goals and objectives of the *Framework* and system plans" (p. 11); this role is consistent with the concept of a performance measure, even if the plan does not use that term. According to the plan, the Met Council "committed to examine and refine the benchmarks and issue updates on progress" in response to the public input process (p. 11).

In summary, three of the four plans do not systematically match measures to goals. The MTC plan, in which specific performance measures are listed for each goal, is the exception. The SACOG plan provides a detailed discussion of its measures, which relate to a subset of its goals. The PSRC and Met Council plans are less clear as to the match between goals and measures, though both stress the importance of the measures to monitoring the progress of the plan. Interestingly, the MTC plan makes little use of the travel demand model, while the other three MPOs rely

heavily on their models as a source for their measures. This difference points to the limitations of these models for measuring performance with respect to today's expanded set of goals: the one MPO with measures matched to goals makes limited use of the model, and the three MPOs who rely heavily on the model do not closely match measures to goals.

5. Use of forecasts

Good planning depends on a good understanding of the future implications of decisions made today (Meyer and Miller, 2001). No one knows exactly what will happen in the future, but the performance of proposed transportation systems over the time frame of the long-range plan can be forecast. As noted earlier, the traditional tool for forecasting the performance of the transportation system, the four-step travel demand model, produces forecasts for a limited set of measures, a significant constraint as goals expand beyond a concern over congestion, and a limited range of alternatives, a significant constraint as strategies move beyond capacity expansion (Johnston, 2004). An additional limitation is that forecasts are often taken as a prediction of the future rather than as an assessment of possible futures. Because forecasts are not inevitable, it is important that they do not dictate the planning process but instead play an appropriate role along side other kinds of input within that process. In fact, strengthened requirements for public involvement aim to ensure other kinds of input, but they also magnify the challenge of defining an appropriate role for forecasts within the planning process.

Forecasts may be given excessive weight in the transportation planning process for a number of reasons. One factor is the "illusion of technical objectivity" (Wachs, 1987): travel demand models appear to be entirely objective but in reality depend heavily on subjective assumptions and the judgment of the modeler. As a part of model calibration, for example, decisions are made about what variables are appropriate for predicting trip generation, the inclusion of k-factors in gravity models to achieve a better fit with observed trip distribution matrices, which modes to include as choices in the mode split model, or whether to simply borrow elements from models for other regions. The use of the model to generate forecasts involves countless assumptions: the spatial distribution of population growth, trends in income and household size, future gas prices, and so on. Such assumptions are not pulled out of a hat, but the choice of techniques for developing these assumptions is itself subjective. Modelers often contribute to the illusion by presenting the models and their results as technical and objective. As a result, participants in the planning process do not appreciate the inherent subjectivity of the models and thus may give the forecasts more credence than they deserve.

Another factor is that forecasts are typically presented in such a way as to imply certainty about the future despite their inherent uncertainty. Errors and uncertainty enter into the model at every step and propagate from one step of the model to the next (Clay and Johnston, 2006); uncertainty in assumptions about population and employment are especially problematic (Rodier and Johnston, 2002). Yet model results are typically presented as point estimates, often precise point estimates at that (Wachs, 1989). Without knowledge of confidence intervals for these point estimates, users cannot judge the sureness of the forecasts or the significance of differences between forecasts. What appears to be a significant difference in predicted traffic levels or mode split for two different proposals may in fact be statistically meaningless. Misleadingly precise presentation of modeling results may lead to misunderstandings of the implications of the forecasts; these misunderstandings may then lead to misguided decisions.

The opposite problem may also sometimes occur: participants in the planning process may ignore forecasts altogether because they don't understand or trust them. Travel demand models are often described as a "black box," the inner workings of which are known only to the modelers themselves (e.g. Beimborn and Kennedy, 1996). Members of the public may feel that modelers are inserting their own partiality (or those of their clients or employers) into the models, leading to biased forecasts that support a favored alternative. In addition, if models produce forecasts of only a subset of performance measures, participants may be unsure how to make use of the forecasts. Given the substantial resources invested in the creation and application of travel demand models, the under-use of forecasts would be wasteful. Under-use of forecasts could have negative effects as significant as those of over-reliance on forecasts, by leading to decisions that do not consider all available information. Observers note a weak link between modeling results and decision making (Meyer and Miller, 2001).

The use of forecasts in the planning process is not always documented, but the discussion of forecasts in the plans themselves offers some indication of their role, both directly and indirectly. Does the plan present forecasts of performance for the proposed plan? With what level of precision are these forecasts presented, and does the plan give any indication of the uncertainty of these forecasts? Does the plan explain the use of a travel demand model to produce these forecasts? Does it explain how these models work and describe the assumptions that go into them? The answers to these questions provide an indication of the importance the MPO puts on helping the public understand both the value of forecasts and their limitations. The public understanding may influence both the relative influence of public input versus forecasting results on the development of the plan and the feasibility of integrating the public involvement and forecasting processes.

5.1. Examples

MTC's plan mentions its travel demand model only briefly, noting that computer models are used to "project

how much travel will occur, where people will travel and how they will travel'' (p. 12). Details on the model are provided through a separate webpage (MTC, 2006) in documents geared more for a knowledgeable reader than for the general public. Of course, as noted above, most of the performance measures used in the plan do not come from the model. In the plan, model results are used to characterize travel in the region in 2030 rather than to evaluate alternative plans (see Chapter 3). Measures such as average travel time to work, daily vehicle hours of delay, share of trips by purpose, and share of trips by mode are presented in tables and graphs. Measures are reported with certainty but not precision: differences in share of trips by mode from 2000 to 2030 are as small as 0.1%, with no mention of analysis of the statistical significance of the differences; total numbers of daily trips and vehicle-miles-of-travel are rounded to the nearest 1000th. In its language the plan also suggests certainty about the future: ''it is no surprise that the average travel time to get to work *will* increase to 31.1 min in 2030'' (p. 26; emphasis added). In other places, the language is more qualified: ''The total number of daily trips made by Bay Area residents *is projected to* grow by 35 percent to a total of 28.5 million by 2030'' (p. 26; emphasis added). Though it never says so, the plan presumably presents forecasts that reflect travel conditions should the plan be carried out.

In contrast, the SACOG plan makes explicit use of the travel demand model in a chapter that compares conditions with the plan to the baseline and to a no-plan alternative (see Chapter 5). This chapter notes at the outset that ''models can provide information about travel today, and forecast travel in the future, but do not make decisions'' (p. 41). Later on, the chapter includes a brief but useful explanation of the model, described as containing ''several equations that tie together information about how people choose where, when, and how to travel, based on tri purpose, minimum time, and affordable cost'' (p. 55). A discussion of the accuracy of the information produced by the models points to the problems of inaccurate information about current conditions and assumptions about future conditions: ''A model's calculations will be no better than the vision and instructions it is given'' (p. 56). The chapter notes that land use forecasts are the most contentious and thus uncertain input to the model. Appendix I, entitled ''technical analysis,'' gives further details on the model and discusses the limitations of forecasting in more depth.

This same chapter of the SACOG plan presents model results in map form, with color codes to show freeway segments with no congestion, heavy congestion, stop-and-go traffic, and points of extreme congestion. Maps are presented for the base year of 2000, for 2025 with the existing transportation network, and for 2025 with the planned network. Readers can assess the performance of the planned network by comparing these maps. The text describes results for all four sets of performance measures (system performance, mode choice, accessibility, and air quality) in a section of the chapter entitled ''What did SACOG learn from its models and research?'' This section presents specific numbers for some measures and talks about these numbers with some certainty; for example, ''Investments in highway, carpool, or transit capacity in a corridor *do* reduce congestion.'' (p. 47; emphasis added). However, in some places, the language accounts for the uncertainty of the forecasts: '' Unless community design changes prove successful, significant shifts from driving to bicycling or walking remain *unlikely*'' (p. 49; emphasis added); ''The model shows carpool shares for commuting reach *a maximum of about* 13 percent…'' (p. 49; emphasis added). All of the performance measures discussed in the chapter were forecast using the travel demand model, but as noted earlier, not all of the goals are matched with performance measures.

The Puget Sound Regional Council also relies on its travel demand model to forecast performance measures. Chapter 7, entitled ''Plan Monitoring and Assessment,'' describes the model in brief, leaving further explanation for Appendix 8. This appendix provides a simple explanation of the model and provides tables summarizing key assumptions about population and household data and characteristics of the planned network. Results are presented for the baseline and for two plan alternatives, one constrained by available funding and the other reflecting the possibility of additional funding. Although the plan notes that ''all computer modeling results contain elements of uncertainty'' (p. A8-1), results are presented as point estimates with one-decimal-point precision. For example, Tables 8–18 show that daily VMT per capita was 20.5 in 1998 and is forecast to be 19.9 in 2030, with no indication of a confidence interval for this forecast. The executive summary of the plan states that ''compared to current trends, *Destination 2030 will* produce dramatic decreases in freeway congestion and traffic delay'' (p. 13; emphasis added), suggesting a high level of certainty.

The PSRC plan includes a brief but cogent discussion of the limitations of the model and its proper role in the planning process. The appendix emphasizes that ''the regional travel demand model is not a crystal ball; it can't predict the future'' (p. A8:1). It goes on to note that ''the model does provide technical information which helps guide and support good decision-making'' (p. A8-1). These models are ''intended to aid decision-making by providing information about how transportation systems function under a variety of different circumstances and are not intended to predict exact characteristics'' (p. A8-1). As the plan notes, the forecasts generated by these models are ''only one of the many pieces of information used in developing a regional plan'' (p. A8-1). How the forecasts fit into the larger planning process given these limitations is not discussed, however.

In contrast, the Met Council plan says almost nothing about its travel demand model. Forecasts of daily person trips and vehicle-miles-traveled for 2030 are included in Chapter 2 to set the context for the plan. Whether these

forecasts are based on the planned improvements to the transportation system or a "no build" scenario is not clear. Appendix K provides an explanation of the travel demand model as a part of a larger discussion of the process of meeting federal air quality conformity requirements. This appendix refers the reader to "technical memorandums" for more information about the model and notes that more information is available through the Met Council website (though I was unable to find any at the time of this writing). The limited presence of forecasts in the transportation plan is surprising, given the plan's focus on the traditional goal of congestion relief. Although travel demand models are well suited for evaluating the effectiveness of a plan in reducing (or slowing the increase in) congestion levels, this plan does not take advantage of that capability.

In summary, the use of forecasts is quite varied across these four plans. The SACOG and PSRC plans make greater use of their forecasts and put more effort into explaining their models, but they are also careful to discuss the limitations of the models and warn against over reliance on the forecasts. The MTC plan makes limited use of the model, but this seems appropriate given the goals and performance measures they have chosen. The Met Council plan makes surprisingly little use of its forecasts, given the emphasis on congestion relief in the plan. Overall, the plans suggest some struggle on the part of MPOs with how best to use forecasts in the planning process, given changes such as a broadening of transportation goals and the expanded emphasis on public involvement.

Some MPOs are finding ways of reconciling the technical exercise of forecasting with improved public involvement programs. For example, SACOG recently employed a simplified version of its travel demand model in a series of public workshops as a part of the process of developing its new regional transportation plan (Vellinga, 2004). In these workshops, participants created alternative transportation scenarios, and the model was then used to evaluate the effectiveness of the scenarios. However, participants had little exposure to the inner workings of the model and no opportunity to choose performance measures other than those provided by the model. Still, they may have come away with a better understanding of the strengths and limitations of forecasting models. In general, effectively communicating and reporting modeling results presents a significant challenge for planners but is essential for integrating them into the decision making process (Pickrell and Neumann, 2001).

Impending improvements in the practice of travel demand modeling, such as activity-based modeling and micro-simulation models, may help in a couple of ways. Some modelers argue that activity-based models are more intuitive and thus less of a black box for participants in the planning process. In addition, they enable new performance measures that may better match new goals. For example, activity-based models can be used to estimate accessibility measures based on all activities and trips throughout the day rather than on individual trips (Dong et al., 2004). Micro-simulation models can be used to estimate benefits and impacts for different subsets of the population based on individual characteristics such as gender, income, auto availability, and households structure (Castiglione et al., 2006). Micro-simulation models also offer the potential for predicting travel time reliability in future networks. It is unlikely that all performance measures can be derived from even these new travel demand models, but they offer potential.

6. Conclusions

Observations of the regional transportation planning process point to these propositions about that process:

1. Goals that have performance measures that can be forecast using travel demand models get the most weight in the process.
2. Goals that have performance measures that cannot be forecast using the travel demand model are unlikely to be forecast using other techniques and get less weight in the planning process.
3. Goals without performance measures get the least weight in the planning process.

If these propositions hold in practice, then congestion relief may still be driving the planning process, despite the adoption of a broader range of goals, simply because of the entrenched use of travel demand models to forecast system performance. If so, and if the new goals are truly important, then new planning tools are needed. First, transportation planning agencies need to develop performance measures for all their goals, not just the traditional measures, and must clearly match performance measures to goals. Second, they need to find ways to forecast all of these measures, whether through improvements in their travel demand models or using other approaches. Third, if some measures cannot be forecast, then agencies must find a way to give equal weight to concerns with and without forecasts, even if this means downplaying the role of forecasts in the process (Poorman, 2001).

How is the regional transportation planning process likely to evolve in the future? One possibility is that it will become a much less quantified process. Not all new goals lend themselves to measurement or forecasting, and increased interest in these goals may reduce the importance of performance measures in favor of more qualitative assessments. A second possibility is that it will become a more simply quantified process, with simple counts or ratings as performance measures for new goals. A third possibility is that it becomes a more sophisticatedly quantified process. As activity-based and microsimulation models come on line, better measures for the traditional goals become possible, as do measures for many new goals.

A fourth possibility is that some combination of these changes will come about.

Changes in professional practice do not come about quickly or easily, but there are ways. Professional associations such as the Institute of Transportation Engineers (ITE) and the Transportation Research Board are important in establishing the legitimacy of new tools and disseminating them widely. Educational programs, including graduate programs in transportation engineering, city planning, and related fields, as well as continuing education programs, should help to raise awareness of the limitations of existing tools and train students in the use of new tools. Conferences provide a forum for transportation planners to learn about the efforts of other agencies and their promising new approaches. The federal government might also play a role (Hartgen and Neumann, 2002).

The new philosophy of transportation policy requires changes in the planning process. The process must incorporate many improvements, for example, a better public involvement process for establishing the goals that guide the development of plans. But the process must also encompass changes to more technical aspects, in particular the development of performance measures and use of forecasts in the planning process. As illustrated here, transportation planning agencies in the US have made progress in meeting these challenges, but still have a ways to go.

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