Relationships Between Major National Goals and TSM

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Transportation system management (TSM) has been a major element of transportation improvement programming in U.S. urban areas for the past four years. As such, it has evolved slowly: Thus, although no one can be sure of its current status, it appears that many actions are being planned and implemented in its name and that even the name itself—TSM—is becoming part of the jargon of those concerned with urban transportation improvement. It also appears, however, that such actions have rather consistently failed to develop and organize their actions as explicit responses to major transportation goals (as discussed by Lee and Meyer in the preceding paper in this special report). From the start of the program, local agencies have shown the capability to prepare substantial lists of management actions designed to improve the system but, at the same time, they have been unable or unwilling to demonstrate that the actions were prepared in response to specific goals or to indicate what the impacts might be on the attainment of these goals. The early problems in this regard were attributed to the novelty of the program, and great hopes were still expressed for early improvement (1). However, it is not at all clear that we are in a better position now than at the beginning. TSM programs continue to consist, in the main, of lists of tactical actions that have no apparent relationship to larger strategic goals. What are the reasons for this? Are TSM analytical processes inadequate? Is it simply inattention to the problem? Or is there some attribute of TSM that makes linking planning efforts to goals particularly intractable?

The purpose of this paper is to begin answering these questions so that the important link between TSM planning and national and regional goals can be made. I will begin by looking at transportation goals themselves—their sources, nature, and intrinsic internal conflicts—and then ask questions about the true effects of TSM; i.e., if we assume a perfect TSM planning process, what achievement of transportation goals can reasonably be expected from management actions? Finally, I will end by examining the role of TSM in an environment where goal priorities may be changing.

MAJOR NATIONAL GOALS RELATED TO TRANSPORTATION

Before we look at the goals related to transportation themselves, it will be useful to note two facts that are usually suggested in discussions of normative TSM planning processes. These are (a) that the goals should be explicitly established at the outset so that responsive action packages can be developed and (b) that, after implementation, it is then equally important (as a guide to future planning) to evaluate the effects of the TSM actions and the degree to which the goals have been satisfied (2). Clearly, in either case, an explicit statement of goals is needed.

The first thing that can be said about national transportation goals is that they are elusive. There is no single person, location, or document that can articulate them. A comprehensive goals statement in a very large and pluralist society such as ours is extremely difficult, perhaps even impossible, to develop, given that the responsibilities for transportation are so decentralized and scattered. Even within urban areas, transportation is the responsibility of numerous government agencies and an even larger number of private companies and individuals of varying functions and interests. Goals development must thus be an evolving process that reflects and builds on the existing laws, precedents, and programs of the many actors found in the transportation arena.

When one examines statements of national transportation policy, legislative histories of major transportation acts in Congress, policy statements, regulations and guidelines published in the Federal Register, and speeches of U.S. Department of Transportation (DOT) officials, a substantial commonality of major goals expressed as a general intent or direction can be found (3-7). Those that can be identified as relevant to TSM are related to the following:

1. Mobility,
2. Economic efficiency,
3. Environmental conditions,
4. Energy use,
5. Urban economics and land use, and
6. Transportation for the disadvantaged.

[Safety and security are obvious omissions from this list, but these issues at the local level more often involve tactical (intramodal, intrajurisdictional, or intraagency) actions rather than strategic ones.]

At the federal level, these goals are translated into the programs and administrative regulations executed in various agencies. At the local level, the goals are often translated into objectives—quantified statements of intent—that lead to primary goal satisfaction. A typical objective might be to shift a specific percentage of travel from automobiles to public transit within a specific time period. Clearly, this objective has no intrinsic merit; however, it is seen as a means to achieve energy conservation, environmental improvement, or some other primary goal.

What we would all like, and what the planning process seeks in the first instance, are those actions that have a positive effect on the satisfaction of one or more of the goals while having little or no negative effect on the others. A supersize bus, for example, put into service on a route that has a high passenger volume has the potential for positive effects on mobility (fewer buses needed and thus less traffic congestion), on the environment (fewer buses mean less noise and fumes), and on economic efficiency (fewer drivers mean lower costs). The negative effects would appear to be negligible, and a decision for implementation is easily taken if the required conditions are met. Similarly, carpool matching and promotion programs, improved bus service and marketing programs, or provision of bicycle paths are programs that have positive effects that most communities endorse (except for some marginal effects on the goal of economic efficiency in some cases).

Unfortunately, many of the more-effective TSM actions cannot be implemented without negative effects on important goals. Take-a-lane bus-priority schemes, road tolls, parking pricing, large automobile-free zones, and fuel taxes are effective in reducing environmental pollution and increasing fuel conservation, but to the detriment of personal mobility. Not surprisingly, few such schemes have been adopted. In fact, there are relatively few instances where schemes that seriously impinge on personal mobility have been accepted.

Table 1. Alternative goal hierarchies of different groups.

Emphasis	Metropolitan-Area Residents (1)	Residents of an Environmentally Sensitive Area (2)	Local Residents in a Neighborhood Traffic Study (3)	Local Officials in a CBD Study (4)	EPA Officials (5)	U.S. DOT Regulations (6)	Citizens after Additional Fuel-Supply Interruptions (7)
More	Mobility			Mobility			Mobility and energy
		Mobility	Environment		Environment	Mobility and other goals	
				Economic revitalization			
		Environment					Other goals
			Mobility				
					Other goals		
	Environment	Other goals	Other goals	Other goals			
Less	Other goals						

This suggests that there is an implicit hierarchy among major transportation goals as reflected in the attitudes of urban residents and that, not surprisingly, mobility tops the priority list. The nature of this goals relationship is illustrated in Table 1. The first column suggests that mobility is the dominant goal of most urban residents, with environmental considerations secondary, and other goals generally lower than that. The willingness to improve automobile accessibility through traffic engineering, new signal improvements, and selected street improvements continues unabated despite the potential for increasing automobile use that these actions imply. Congress has been unable to take any actions that inhibit mobility, despite the almost unanimous official agreement on the need for fuel conservation. A good illustration of this constraint occurred in the unsuccessful attempt by the U.S. Environmental Protection Agency (EPA) to trade off ease of personal mobility for improved air quality (8). And perhaps the most dramatic demonstration of goals ambivalence has been the unwillingness until very recently at DOT to increase parking charges for its employees in Washington, D.C., while advocating such programs for others nationwide.

In some environmentally sensitive and politically active areas (e.g., Portland, Oregon, and Denver), there is greater acceptance of marginal subordination of mobility for the sake of the environment—at least officials are willing to consider it. This is illustrated by column 2 of Table 1 as a slightly modified goals hierarchy that reflects an increased emphasis on environmental considerations. Note, however, that mobility is still the most important goal.

In small subareas, i.e., local neighborhoods, mobility is sometimes displaced by environmental considerations (see column 3 of Table 1). Several neighborhood-traffic-circulation studies have occurred solely in response to a local citizenry upset by the environmental degradation caused by through traffic in the neighborhood. In some cases, traffic restraints and regulations that reduce mobility have been implemented. It is important to note, however, that in reality this represents a triumph of a local us over an areawide them, rather than a willingness of an entire constituency to favor environmental improvements over mobility. The neighborhood is willing to reduce the mobility of people who live elsewhere in order to improve its own environment.

Another goal that has become important in recent years is the economic revitalization of central cities (see column 4 of Table 1). Many central business district (CBD) studies have focused on this goal—sometimes even to the extent of encroaching on mobility. Although the use of automobile-free zones and malls is evidence of this, the importance of accessibility (i.e., mobility) is not lost on the economic planners.

The fifth column in Table 1 illustrates the goals of EPA officials and of some environmental legislation. Special-interest politics, widely practiced by many groups on the current U.S. scene, is able to obtain passage of legislation that has unknown effects on other values that become known only on implementation. Although environmental advocates might fault TSM as impotent or irrelevant from their perspective, the problem is not in the program or analysis methods nor in the lack of effective potential actions. The problem is that their goals do not reflect those of much of the citizenry. (This statement stands independent of whether the environmentalists are, in the end, right or wrong. Decreased mobility is immediately perceived, whereas the incidence of disease and the costs of health care due to environmental pollution are not fully understood and are, in any case, deferred. Thus, health-care disbenefits tend to be discounted except by people who have lung cancer or emphysema.)

The DOT regulations, including those requiring TSM, stress the evaluation of actions against goals achievement (see column 6 in Table 1). Disillusionment and criticism begin when actions favoring mobility at the expense of other goals seem to win. Fault is sought in the planning process, in institutional arrangements, or in official timidity. In fact, the same results might occur if the process were perfect, organized ideally and headed by heroic officials, so long as the goals hierarchy remained the same.

What, then, is the future of TSM? Is it forever doomed to be simply the compilation of lists of actions that would have taken place anyway, to have only a marginal effect on the way we use and operate the system, or at best be a watchword or banner under which the use of tactical actions favoring mobility can be promoted during periods of fiscal austerity? The best answer to this would appear to be "no". Barring new technological solutions, the energy problem will perturb the transportation system in ways that will make management of the system ever more essential. Automotive fuel will be rationed either by price (whether permitted or prohibited by government action), coupons, occasional short-term supply interruptions, or combinations of these factors. In the event of price or coupon rationing, the need for high-occupancy vehicle (HOV) programs will be significant and the need to expand the capacity of our transit systems rapidly will be great. Supply interruptions will bring into play the energy contingency plans now being prepared in each urban area and the term "management" in the context of the urban transportation system will take on a new meaning. All of these factors have the potential for shifting the goals hierarchy (see column 7 of Table 1) such that the possibility of difficult, perhaps even agonizing, trade-offs between conflicting TSM actions may be required. In the event of this occurring, the fact that TSM is known—that a program has

been established, that research has started and results are partially available, that transportation professionals are trained, and some technical analysis processes are available—will be of enormous help. TSM will then be an idea whose time has truly come.

POTENTIAL FOR SATISFACTION OF GOALS THROUGH TSM ACTIONS

None of this discussion of goal conflicts and hierarchies will have any significance if TSM is, as some have alleged, simply a tinkering with the system, a marginal manipulation that, in the end, is too small to matter. If TSM actions have, in the aggregate, effects that are too small to significantly affect goal satisfaction, or if it is possible to satisfy some goals but not others, then we should recognize this now and not strive for trade-offs and evaluations that are intrinsically irrelevant. This section of the paper deals with TSM effects, their nature and size, and how they could relate to the satisfaction of major goals if we were of a mind to implement TSM without reservation.

As noted above, perhaps the three most important goals to which TSM is relevant are mobility, energy conservation, and reduced air pollution due to emissions. Both energy-conservation and emissions-reduction goals are favorably affected by a reduction in vehicle travel (VT) in an urban area. Thus, although other variables also affect energy use and emissions, this variable (VT) will be used as a surrogate for them in the discussion below.

The percentage changes in travel time (a measure of the satisfaction of the mobility goal) and VT (a measure of the satisfaction of energy-conservation and emissions goals) of four different TSM strategies (involving packages of diverse TSM actions) for work, nonwork, and all trips in a typical city of one million population are given in Table 2. The four strategies are different in the way in which they affect the demand for vehicle travel on highways and those in which they affect the quality or speed of travel on the system (i.e., affect the quality of the supply of transportation). [Details of the methodology and the many assumptions necessary to make this analysis can be found elsewhere (9).] These effects were calculated by assuming a significantly higher commitment to TSM improvements than is generally accepted at present and further assuming that, for most TSM actions, only partial implementation has so far been achieved. (One can, for example, upgrade the signal system by using current technology only once; after that, that TSM action is no longer available to a given area.)

The first thing to be said about the results shown for worktrips in Table 2 is that the potential effects of combined actions are very large. Travel-time reductions on a regional basis of the order of 20 percent are simply enormous. Class B actions alone (e.g., traffic engineering improvements, freeway traffic management) have the potential for almost 10 percent travel-time reductions, while class C and class A actions have the potential for about 5 percent reductions.

The potential effects on VT are not as great, but are still large—a total of more than 10 percent VT reduction appears possible. About half of this comes from efforts to encourage HOV use through ride-sharing programs and transit improvements, while the other half comes from actions affecting HOV use through restrictions on regular automobile use (e.g., take-a-lane HOV priority schemes, automobile-restricted zones).

Class A actions tend to favorably affect mobility goals as well as energy-conservation and emission-reduction goals and are being implemented in many areas throughout the country with little controversy. Their use is limited largely by the extent to which improvements can be affected without unreasonably large financial costs (thus unfavorably affecting economic-efficiency goals). Class B strategies, on the other hand, tend to achieve mobility goals (by reducing travel time), while adversely affecting energy-conservation and emission-reduction goals (by increasing VT). It is interesting to note that class B actions are also being implemented in many locations, giving further weight to the contention that mobility goals are generally dominant at the local decision-making level. In addition to class A actions (which also improve mobility), the most favorable effects on VT are achieved by road-user pricing and class C actions. Both of these actions, however, are perceived as having adverse effects on mobility and thus tend to be the most difficult to implement. (Pricing actions can be shown to reduce travel time and thus improve mobility for those willing to pay the price, but are perceived to reduce the mobility of those unwilling to pay the price.)

Table 2. Effects of TSM strategies: prototypical city of one million population.

Type of TSM Strategy		Change (%)					
		Work Trips		Nonwork Trips		All Trips	
Description	Class	Travel Time	VT	Travel Time	VT	Travel Time	VT
Actions that reduce demand for vehicle travel							
Ride-sharing programs, transit marketing, express bus services, park-and-ride lots, local transit route and schedule improvements, paratransit services, bicycle and pedestrian facility improvements	A	-5.1 to -5.5	-5.1 to -5.5	0.2	1.1	-2.0	-1.5
Road-use pricing	A′	-2.3 to -2.4	-2.3 to -2.4	-1.2	-6.1	-1.7	-4.6
Actions that enhance highway supply: traffic engineering improvements, freeway traffic management, truck restrictions	B	-9.1 to -9.7	+0.2 to +0.9	-7.0	1.0 to 3.4	-8.0	0.7 to 2.4
Actions that reduce demand for vehicle travel and degrade highway supply: preferential treatment for HOVs, automobile-restricted zones, reductions in off-street parking	C	-4.7 to -5.1	-5.8 to -6.2	0.4	1.9	-1.7	-1.3
Actions that reduce demand for vehicle travel and enhance highway supply: preferential treatment for HOVs, on-street parking restrictions	D	-1.3 to -1.5	-0.6	0	0.2	-0.6	-0.1
Actions that improve mobility	A + B + D	-15.5 to -16.7	-4.8 to -5.9	-6.8	2.4 to 4.7	-10.6	-0.9 to +0.9
Actions that favorably affect energy-conservation and emission-reduction goals	A + C + D	-11.1 to -12.1	-11.5 to -12.3	0.6	3.3	-3.8	-2.7
All actions (except road-use pricing) combined	A + B + C + D	-20.2 to -21.8	-10.6 to -12.3	-6.7	4.4 to 6.6	-12.1	-0.3 to -2.2

The potential effects of these same strategy classes on nonwork trips are much less than those for work trips. This is due to the fact that most TSM strategies are directed toward relieving congestion (and thus primarily affect work trips) or apply only to daily or highly repetitive travel (e.g., ride sharing). Thus, travel-time reductions approaching only 7 percent appear possible. The real problem is the adverse effect on VT. All strategies except pricing actually increase VT. This is explained by the increased use of the family automobile that is now available at home. This extra VT also adversely affects fulfillment of energy-conservation and environmental goals. Overall travel-time improvements of about 10 percent seem possible for TSM strategies for work and nonwork trips, surprisingly high considering that potential travel-time reductions for nonwork travel are intrinsically limited because most such travel occurs at noncongested periods.

Our ability to reduce VT appears very limited unless we are prepared to use pricing strategies. Without the use of pricing strategies, VT reductions of about 3 percent appear to be the upper limit. As urban transportation is responsible for about 25 percent of all petroleum consumed in the United States, this means that nonpricing TSM strategies have the potential for saving less than 1 percent of U.S. oil use. This, however, may understate the longer-term effects of families selling the car released from travel to work when HOV strategies are employed. Little is known about this type of effect.

All of the results shown above are for a prototypical city of one million within the current goals-acceptance context. Smaller cities could expect results of less magnitude, and larger cities could expect greater results; many priority HOV treatments, carpool and vanpool encouragement programs, and transit improvements have larger effects where trips are longer, congestion is greater, and costs are higher. In a rationing or fuel-supply-interruption context, however, the effects among different types of cities might be more equally distributed.

We should agree that effects of 3-5 percent are significant. Even very large, expensive, and highly visible transportation projects in urban areas rarely affect more than 5 percent of all urban travel. For example, a 16-km (10-mile), eight-lane section of urban freeway carrying 100 000 vehicles/day in a city of two million population will likely carry less than 5 percent of the VT for that area. The Bay Area Rapid Transit System carries less than 2 percent of all trips in the Bay Area. Because of the ubiquitous use of energy in all aspects of human activity, reductions in any single area will likely have only a small effect on overall energy use. Success must necessarily be achieved by small reductions in a large number of different types of activities. Part of our problem may be that we as professionals do not ourselves understand the importance of changes of these dimensions. The larger capital-intensive systems tend to be oversold and have popular perceptions of effects larger than warranted. Our own perceptions may be similarly distorted.

TSM IN AN ALTERED GOALS CONTEXT

As a group, we have grown accustomed to the evaluation of transportation improvement projects not only for their effectiveness in improving mobility, but also in terms of their effects on other national (and related local) goals. Although mobility is still considered of highest priority, we are at least comfortable with the concept of trading off among conflicting values associated with many of the potential improvements developed for any particular problem. Such evaluations are almost always at the local neighborhood or metropolitan scale, and it is accepted that the total of projects that survive such local evaluations will, in the aggregate, move us in the direction of goals satisfaction. Such notions, although satisfactory to most in the past, may be quite insufficient in the coming years, when energy conservation or other social goals may justify a much more rigorous system intervention. This insufficiency springs from the very dominance of mobility, its impact on the American lifestyle, and its supporting economic and social structure. Any serious manipulation that has adverse impacts on mobility will likely have social and economic impacts so pervasive that they can be evaluated only at the level of national policy and long-range planning (rather than at the local or short-range level that is our custom).

Wachs (10) describes these impacts as follows:

> In the U.S., employment related in some way to vehicles and highways totals almost 15 million jobs. This means that about one-fifth of all jobs held by Americans in all fields are related to building, repairing, driving, or selling vehicles, roads, and related facilities. Just the retailing of automobiles and auto equipment and supplies required nearly two million employees and produced annual receipts exceeding 119 billion dollars. Industries other than motor vehicle manufacturers themselves produce more than 16 billion dollars annually in auto parts. Vehicle rental, parking, repair, and related services generated annual receipts of more than 12 billion dollars and payrolls of more than 2.5 billion dollars. Nationally, 70 percent of all fruits and vegetables travel by truck, and virtually 100 percent of all livestock reaches major markets in trucks. Given this setting, it is clear that any national policies or cumulation of local policies impacting mobility will have pervasive social and economic impacts.
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> Among the most dramatic of social changes which have been facilitated by the evolution of personal mobility are those related to recreational travel. Tourism is now considered to be the second ranking source of retail expenditure within the U.S., surpassed only by the marketing of food. In 1974, the U.S. Travel Service reported that expenditures for travel within the United States were 61 billion dollars annually and that more than ninety percent of this total was automobile oriented. Only two years later, by 1976, this annual total had grown to more than 72 billion dollars. There are now more than 55,000 motels in the United States, grossing 7.5 billion dollars per year and all depending upon continued freedom of personal mobility.
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> Mobility and expectations regarding mobility are such an intrinsic part of American social life, that changes in national policies regarding the economy, energy, environment, and transportation can and will have major social impacts related to mobility. It has been estimated, for example, that the national decision to close gas stations on Sundays during the fuel shortage of 1973-74 caused a temporary loss of jobs to 90,000 people, and that losses to the tourism and travel businesses over a four month period amounted to three-quarters of a billion dollars. In the last full year before the oil embargo, Americans purchased 752,000 campers, pickup truck covers, travel trailers, camping trailers, and motor homes. In response to the oil embargo and the recession, this annual total dropped by one-third. After the embargo was lifted and the supply of fuel returned to the more usual levels, sales in this area climbed upward again. Such trends indicate more than the economic dependence of certain industries upon expectations of continued mobility. The economic facts, of course, mirror choices which have been made by a hundred million families and are indicators of the role of mobility in modern America. These facts and figures also imply the kind of readjustment which would be required to cope with major changes in policy which might lead to reductions in mobility during the coming decade.

Consideration of such broad impacts has been beyond the range of all but a few national policy planners. However, it is clear from recent events that decisions being made at the state and local levels also have impacts beyond those we normally evaluate. Odd-even gasoline sales, intrastate fuel-allocation decisions, gasoline-less weekends, and other conservation measures depending on site-specific contexts can spell economic ruin (or windfall) for thousands of Americans and social readjustment for millions. To discuss the relationships between TSM actions and national goals thus requires considering these broader implications under conditions where radical system manipulation is required.

SUMMARY

It has been noted that one of the major criticisms of TSM has been its failure to develop action strategies that are appropriately responsive to specified goals. Many TSM actions have favorable effects on some goals while unfavorably affecting others. The need for analysis and evaluation of the trade-offs of these effects is particularly important if major goals are viewed as having equal or nearly equal value. The fact that such evaluation and analysis does not occur appears to be a natural result of a goals hierarchy that strongly and rather consistently favors mobility over other goals. Fuel rationing, energy supply interruptions, or national economic difficulty, however, have the potential to alter this hierarchy and introduce an era where TSM can function in its originally conceived manner.

TSM strategies, if applied without reservation (but excluding fuel rationing or pricing strategies), can have significant effects on major goals. Travel-time reductions for work travel of 15-20 percent are possible. Favorable effects on energy-conservation and emissions-reduction goals are more limited—probably not more than 3 percent VT reduction for all trips (but more than 10 percent VT reductions for work travel). Pricing seems to be the only significant TSM strategy that reduces VT for nonwork trips; thus, the need for acceptable TSM strategies that could accomplish this goal is a crucial weakness in TSM as currently practiced. However, effects of even 3-5 percent are significant when compared with the effects of some highly visible and costly transportation improvements.

The strategies that include more radical conservation measures (such as fuel allocation, rationing, and pricing) have, because of the pervasiveness of personal mobility and its influence on the American life-style, more far-reaching impacts than those usually considered by planners. Under such conditions, the cumulative effects of local TSM actions could have a significant impact on the satisfaction of national goals such as economic growth, economic equity, and social diversity and choice.

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