# INTEGRATING TRAVEL DEMAND MANAGEMENT STRATEGIES

Michael Replogle, Environmental Defense Fund Transportation Project
and
Hank Dittmar, Surface Transportation Policy Project

## ABSTRACT

Efforts to manage transportation demand in American metropolitan areas have in the past been very limited in scope and poorly integrated with land use and transportation policy, planning, programming, and operations. Although these efforts have frequently been quite cost-effective in reducing congestion and other effects of automobile use, their modest impacts have generally been overwhelmed by the rapid continuing growth in motor vehicle use. Most Transportation Demand Management (TDM) and Transportation System Management (TSM) strategies have had a narrow and short-term focus and have overlooked major opportunities to shape the evolution of longer-term travel demand. Even where growth management and congestion management systems have begun to influence land use policy, there has been a tendency to focus on solely or predominantly on peak period highway system performance. Such systems have given little weight to the quality and availability of transit, walking, and bicycling, or the accessibility these might offer to satisfy daily needs of residents, workers, and visitors.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act Amendments of 1990 (CAA) both give new impetus to TDM. Their successful implementation will require all metropolitan areas over 200,000 to develop effective congestion management systems (CMS) which integrate TDM into transportation planning, programming and operations and include land use management and pricing elements. Under these laws, TDM might finally realize its full potential for boosting the productivity of our transportation system investments and strengthening economic performance. However, this will require several significant changes:

- TDM must be integrated into all aspects of transportation and community planning and development, rather than being treated as an add-on to the current process.

- Local, regional and state agencies involved in transportation and land use need to be held accountable for the impacts of their actions on travel demand and reorganized to better coordinate policies and programs which can manage both short and long term demand growth.

- Much greater resources at the federal, state, regional, and local level must be devoted to transportation and land use data collection, the improvement of analytic tools and monitoring systems, and the use of new types of criteria and benchmarks for measuring transportation system performance, demand changes, and environmental and socio-economic consequences.

- TDM must encompass a broader range of strategies, including those dealing with non-work travel, non-peak period travel, short trips, emerging technologies, pricing, land use development, and urban design.

## LEARNING EXPERIENCE WITH TRANSPORTATION DEMAND MANAGEMENT

Budget constraints, environmental concerns and neighborhood activism have all combined to render new roadway construction increasingly unlikely in many urban areas. All of these factors argue that the freeway building era must give way to the demand and system management era. ISTEA simply acknowledges these forces and begins the process of taking a systematic approach to urban transportation problems via the new congestion management requirement. However, prior attempts at implementing demand and system management approaches have had limited success. How have they worked and why? A look at various attempts at demand management implementation reveals much about implementation barriers.

## U.S. Department of Transportation's 1975 Transportation System Management (TSM) Regulations—"Too Small to Matter?"

In the wake of the environmental and petroleum crises of the early 1970s and rising demands for federal funding of rail transit, US DOT issued regulations requiring systems management as an "element" of long range plans. "TSM" became the buzzword for the notion that "it is better to manage well what you've got than to just keep building more of it." I was a time of pause after several decades of massive highway construction across the nation. The highway revolt and gas lines had raised serious questions about national transportation policy. TSM was a banner for reform in many quarters, but soon enough became established as a label slapped on traffic signalization and a handful of small commuter assistance projects. Some in US DOT and elsewhere saw TSM as a holistic approach to transportation analysis. However, in practice the TSM Regulations failed to promote systems management as an overall approach to transportation planning and programming. Instead they merely attempted to add to existing practice by requiring metropolitan areas to address system management actions including transit, carpooling, park and ride, local traffic management and demand strategies as an element of the plan. The federal guidelines encouraged a systematic approach to the transportation system in this element of the long range plan, but gave little impetus to closer coordination of transportation and land use planning and policy or to consideration of fundamentally different alternative long-range plan options.

TSM was defined as short term in nature, leaving the long range plan to focus on unconstrained demand projection and the expansion of capacity to meet that long range demand. The regulation provided that the long range plan should include a Transportation Systems Management Element, but provided only that the "programming of TSM projects in the annual element of the Transportation Improvement Program represents a commitment for carrying out each action." In the mid term, transportation planners continued the moving bottleneck theory of dealing with congestion problems through programming capacity enhancements in the five year transportation improvement program. This "systems" approach only looked at system and demand management strategies. As a sequential add-on at the tail end of the planning and programming process, thus it was piecemeal in nature. The list of TSM activities did not include capacity enhancement, so systems management of necessity became an adjunct to the plan, not a primary focus.

The 1975 TSM regulations failed to alter transportation planning and practice in a significant way because they were an ad hoc addition to the planning process. There was no need to change institutional structures to implement the regulations, nor to significantly alter the fundamental approach used to evaluate and manage transportation programs, land use decision-making, or transportation pricing strategies. Although some local planners and activists identified more comprehensive transportation management strategies, the only elements moved forward to implementation were those which were supportive of or directly complementary to highway investment—in coordinated or computerized traffic signal systems, intersection widening to boost vehicle capacity, park-and-ride lots to make public transportation more dependent on the automobile, High Occupancy Vehicle (HOV) lanes which usually involved highway capacity expansion, low-budget voluntary ridesharing programs, and parking management programs which brought construction of public parking spaces in or near downtowns. In some communities, bicycle paths or lanes were developed, but frequently these were isolated recreational facilities of poor design which were neither maintained nor integrated into a coherent system. Measures to eliminate parking subsidies, restrict automobile use in central areas, manage land use to limit suburban sprawl were proposed but blocked by powerful political forces in all but a handful of cities.

## California's Congestion Management Program (CMP)

In response to a sharp rise in traffic congestion, a recent California law has created a state Congestion Management Program. This requires designation by county level agencies of a congestion management system consisting of principal arterial roads, requires measurement of Level of Service (LOS) at specific points on that system, and requires the development of a Capital Improvement program to improve LOS at these locations as well as the consideration of demand management approaches and the implementation of trip reduction ordinances. The California CMP provides a new transportation forum for the State Department of Transportation, cities and counties and transit agencies at both elected and technical level for coordination of policies and programs. In addition, it incorporates land use and air quality considerations and elevates consideration of highway system performance to a new level.

However, the California CMP process is modally focused on Level of Service (LOS) measurements at specific points on the county's network of principal arterial roadways. This highway capacity orientated system promotes road construction and widening as the primary strategy for congestion relief. The focus on LOS at specific points in the highway system ignores overall transportation system performance. Moreover, the California system is not regionwide, but only county oriented. For example the San Francisco Bay Area consists of nine counties, between which there is a high degree of inter-county commuting. However, inter-county trips are exempted from consideration. Its many exemptions for types of trips and even for specific trip generators renders its systems analysis component severely flawed.

The California CMP guides resource allocation in three ways: projects must be on the Congestion Management Program network or significantly improve its performance to receive funding, projects must be derived from the CMP's capital improvement program, and if LOS is not improved, a deficiency plan to deal with trip generation and land use must be prepared. This linkage to resource allocation decisions is direct and provides a useful framework for congestion management programs. Unfortunately, the use of LOS as the only performance standard has resulted in Capital Improvement Programs that are almost entirely related to capacity expansion of roadways and have not included meaningful implementation of TDM programs. Despite shortcomings, both the county level congestion management agencies and the programs which they have developed will provide the foundation for the development of the congestion management program under ISTEA.

**Growth Management in Montgomery County, Maryland**

To help respond to the pressures of rapid population and employment growth in recent decades, Montgomery County has developed what is perhaps the most sophisticated growth and congestion management program in the US. Administered under the County's Adequate Public Facilities Ordinance (APFO), this system offers elements of a more robust multi-modal framework for integrating congestion management with land use decision-making, although it too has shortcomings. This system permits new land use development approvals in an area only if the Transportation Improvement Program will provide adequate transportation capacity, but allows a trade-off in LOS between modes. Only a modest level of peak traffic congestion is allowable in areas where people are highly dependent on the automobile for mobility. Higher levels of average highway traffic congestion are allowed where transit, walking, and bicycling provide better alternatives. Rather than measuring congestion at bottlenecks, the Montgomery County system looks at the average level of congestion across all the roads in small sub-areas of the region, giving it more of a system-level focus. Valuable methods for quantitatively assessing the average LOS for different modes which are the choices available to individual travelers have been developed by County planners, including a weighted scoring system which evaluates each of several dozen policy areas for the share of households and jobs within walking distance of transit, the average frequency of bus and rail services, the ratio of sidewalk miles to street miles, availability of bicycle and automobile parking at transit stations, and mode share for work trips and transit access trips. An extension of this approach based on rigorously evaluated peak period transit accessibility of jobs and households is under consideration for use in a total transportation LOS measure.

The Montgomery County APFO multi-modal analysis framework has stimulated increased public-private cooperation in establishing demand management programs, such as employer-based and residential-based rideshare matching, shuttle vans between suburban office campuses and Metro stations, reduction or elimination of employer-provided free parking, and employer subsidies for transit commuting. This has been particularly true in areas where funding for system capacity expansion has been unavailable to support added development approvals. However, the traditional institutional structural bias towards transportation capacity expansion at both the County and state level and the emphasis on peak-hour traffic problems have led demand-management efforts to have a short-term focus on peak-period work travel demand management. Stability of funding for even these demand management programs has been a problem. Less traditional efforts to reduce non-work, non-peak period, and shorter trip travel demand have won little or no support from financially-pressed traditional transportation and planning agencies focused on planning and building roads and operating transit services.

The Montgomery County APFO has had some success in channeling growth into more transit, pedestrian, and bicycle oriented development patterns, but has also sometimes promoted automobile-dependent sprawl. A successful

transfer of development rights program has preserved an agricultural wedge in the County. However, within the growth corridors, automobile dependent sprawl has been encouraged in part by other aspects of the APFO and by the geographically fragmented master planning process. A more traditional and overly uniform APFO intersection-level analysis of the traffic impacts of individual developments has worked against transit-oriented development and was recently modified to allow more congestion near Metro stations. "Local Area Transportation Review," focusing on intersection congestion, has promoted sprawl at the edges of the region, the flaring of arterial intersections (sometimes to 8-lanes or more), a greater use of grade separated arterial intersections, and other actions which have degraded already poor quality environments walking, bicycling, and transit use.

The linkage of the APFO to the County's land use master planning process has been limited by political resistance to the comprehensive revision of County-wide and regional master plans and zoning. A piecemeal master plan amendment process has given excessive power to NIMBY forces seeking to preserve a fast-fading "Ozzie and Harriet" suburban lifestyle in the face of growing urbanization pressures. The resulting compromises have often resulted in development at levels which guarantee enough density to cause traffic problems but not enough density and mix of uses to be truly transit, pedestrian, and bicycle friendly. As in many other metropolitan regions, zoning and growth controls are kept tight in the County's most highly transit accessible areas to limit new infill housing potential, forcing growth to the automobile-dependent metropolitan fringe. For years, political resistance at the senior level of planning agencies has prevented staff from using the county's sophisticated computer transportation models to evaluate the air pollution consequences of significant transportation pricing changes or alternative land use patterns.

**ISTEA's Congestion Management System (CMS)**

The new federal legislation passed in 1991 contained a requirement for six management systems, including one dealing with congestion. There are specific requirements for metropolitan areas over 200,000 in population. Under ISTEA, demand management strategies must be integrated into the transportation planning and programming process and transportation and land use interactions must be accounted for.

ISTEA recognizes the existence of an interdependent, intermodal metropolitan transportation system which affects, and is affected by, many other factors external to the transportation system itself. The management system requirement provides a means for ensuring the physical integrity of that system and for analyzing the performance of the system. The integration of congestion management and ISTEA requirements into transportation planning and programming will require continual efforts to evaluate the impact of alternative strategies to improve transportation performance, including changes in land use and urban design patterns, subsidies, and transportation pricing. These requirements cannot be satisfied by continuing business as usual approaches to transportation planning, with fixed sprawled land use forecasts, the assumption of continued automobile use subsidies, and continued neglect of pedestrian, bicycle, transit, and paratransit options. CMS must become a framework for evaluating metropolitan transportation system performance against goals and benchmarks. It must include a mix of strategies, so that capacity enhancement for highways or transit must be examined in the same context as demand management strategies.

The CMS should serve as a base for developing consensus and a mix or optimization of projects, programs and strategies that moves us beyond narrow debates about transportation and air quality to incorporate demand management strategies as an inherent part of doing business, as electric utilities did in the 1980s. Sound decision-making as part of a congestion management system and ISTEA-compliant transportation planning process will be based on evaluation of the full long-term costs and benefits of alternative investment, pricing, and development patterns, considering secondary effects and induced and latent demand.

Unfortunately, initial US DOT definitions of the new congestion management system appear to perpetuate the sequential approach to the problem and do not provide a clear linkage from the congestion management system to the investment and operational decisions made in the long range plan and short range Transportation Improvement Program (TIP). This approach will perpetuate the marginalization of demand management strategies, contrary to the intent of Congress in passing ISTEA and the CAA. The proposed ISTEA management systems regulations issued in March 1993 provided that in large urban areas the Congestion Management System must first demonstrate that demand management and operational strategies do not solve a congestion problem before proposing the addition of Single Occupant Vehicle

road lanes. This is the obverse of the fallacy of the 1975 TSM Regulations, which added the lanes by right and then iced the cake with systems management strategies. Neither approach represents a comprehensive method of managing transportation system throughput. At this time, it is unclear whether the final regulations will correct this deficiency.

**The Clean Air Act Amendments of 1990**

In the wake of two decades of failure to meet health standards for air quality in American cities Congress passed and President Bush signed the CAA Amendments of 1990. Roughly 150 million people living in dozens of regions are exposed to serious health threats from ozone and other pollutants. Recognizing that uncontrolled growth of motor vehicle use cancels out the benefits increasingly costly technological changes for emission reduction, the law requires steps to slow or cap the growth of vehicle miles of travel, including widespread adoption of TDM strategies in more seriously polluted cities in the 1990s. The CAA requires transportation plans and programs to contribute to annual emission reductions, mandates phased compliance with emission reduction targets, requires setting separate emission budgets for mobile and stationary sources, and promotes emission trading under these budgets. This can create incentives for new political forces to take an interest in mobile source emission reduction through TDM and other strategies if these produce tradable credits at a lower cost than equivalent stationary source emission reductions.

Under the CAA, transportation plans and programs have to conform to State Implementation Plans and their emission budgets. However, until these new budgets are established, interim period rules for transportation conformity are set by the CAA. Instead of issuing the regulations required by law, EPA issued guidance which followed the traditional approach to transportation conformity analysis and air quality planning for transportation: it was designed to affirm business-as-usual rather than to enforce a newly-toughened law. Under this guidance and draft final regulations, as many projects as possible were grandfathered or exempted from evaluation. Second, a "build/no-build" air quality analysis method was established to guarantee that long-established highway construction programs would not suffer excessive disruption, particularly when tested using the old highway planning and emission models, with their lack of policy-sensitivity and ignorance of feedback and secondary effects, such as induced, latent, and suppressed demand.

As a result, transportation plans and programs adopted to date under the CAA and ISTEA have for the most part contributed to further increases in VMT and vehicle trips per household in major metropolitan areas, rather than contributing to healthful air quality. EPA is now finalizing the transportation conformity regulations while states and MPOs struggle to catch up with the challenging requirements of demonstrating how they will attain healthy air. There no doubt that demand management strategies will be a necessary long-term element in providing clean air and healthy communities in many major American cities and suburbs. Hopefully, action by the new administration will send a more consistent message that business-as-usual will no longer suffice and that the law will be enforced.

Conventional strategies for ozone reduction, relying on VOC reduction and measures which increase vehicular capacity, are being revealed as inadequate. In many regions, new strategies are needed to curtail NOx and other emissions, which have been ignored until now. Mobile source NOx emissions increase, rather than decrease, in response to the failed conventional strategies for transportation-related ozone reduction. New transportation strategies need to focus particularly on reducing the number of vehicle trip starts, not just VMT reduction.

While the old approach to ozone reduction relies on models which see speed increases as beneficial, the new approach recognizes the potential for speed changes to modify demand for travel within and across modes. For example, the conventional analysis methods and strategy view traffic calming as something that would increase emissions contributing to ozone while endorsing freeway widening for HOV lanes as an emission reduction strategy. The emerging analysis methods and strategy view traffic calming for its potential to improve pedestrian, bicycle, and transit use while reducing motor vehicle trip starts and the type of vehicle chosen for ownership and use, while questioning whether HOV add-a-lane projects will produce sustainable pollution-reduction benefits. The emerging strategy considers that such HOV project may increase travel demand, especially for longer trips, and induce further low-density automobile-dependent sprawl at the fringe of metropolitan areas, leading to eventual increases in VOC, as well as short and long term increases in NOx emissions.

## LESSONS FROM PAST EXPERIENCE

Prior and ongoing attempts at implementing TDM and congestion management have foundered on six fronts, all of which can be resolved in the U.S. through careful implementation of the 1991 ISTEA legislation.

**1. Past approaches have largely been sequential, not comprehensive in their examination of ways to improve system performance.** A new approach should comprehensively examine the entire range of options including capacity enhancement in an effort to select an optimum mix of demand and supply strategies and actions for inclusion in the plan and program.

**2. Prior efforts have focused on the near term, which has not altered the fundamental approach to congestion—trying to build our way out of it.** A long term commitment to operate and manage both demand and supply on the Metropolitan Transportation System is required. Operations and management commitments and continuing support of TDM must be treated in the same way as pavement maintenance or bus replacement, as regular ongoing features of a management program for the Metropolitan Transportation System.

**3. Attempts to measure congestion have been focused at points on the road network rather than looking at the whole trip from a user perspective.** Congestion management systems should attempt to optimize travel from a system wide perspective by looking at travel corridors or subareas and at travel markets or demand sets rather than at specific bottlenecks. A broader focus will tend to weight decisions not towards optimizing vehicular *mobility*, but toward investments that increase multi-modal *accessibility* and expand the freedom to meet daily activity needs with less forced dependence on the automobile and which benefit the performance of transportation networks as a whole and the general public.

**4. Implementing agencies have traditionally been oriented toward capacity expansion.** Most state DOTs are overwhelmingly oriented to design engineering in terms of resources. New personnel with non-traditional backgrounds, including the social sciences, should be brought into these agencies to strengthen capabilities to identify and implement new and different types of strategies. In addition, implementing agencies have been biased toward capacity solutions on systems that they own. ISTEA's reliance on the Metropolitan Planning Organizations for planning and funding decisions in urban areas helps to resolve these biases as these agencies can broker among options and between competing agencies. MPOs should reach out to agencies and providers such as ridehare agencies and TMAs who have traditionally not been involved in the State DOT project planning process.

**5. Past practice has failed to link demand management options to funding and investment decisions.** This linkage is critical, as the political imperative to get credit for building new facilities is strong among elected officials. The new ISTEA legislation provides the flexibility to invest in demand management options, but there needs to be an explicit linkage between the management system requirement and the fiscal decisions if a continuing commitment to management is to emerge.

**6. Land use, urban design, and transportation pricing policies and decisions have not been considered in light of their effects on transportation demand and transportation system performance, including air quality.** ISTEA requires consideration of such factors as part of both statewide and metropolitan planning. Effective long-term demand management is highly dependent on creating ongoing integration of these factors across many different agencies and actors. This will require major efforts to reform transportation and land use decision-making structures, increase accountability of different agencies to the effects of their decisions, and improve dispute resolution mechanisms between agencies.

## CRITERIA AND BENCHMARKS FOR MULTI-MODAL TRANSPORTATION SYSTEM PERFORMANCE

The integration of TDM strategies into overall transportation and land use decision processes will be most effective if methods are devised for measuring system performance that encompasses the entire multimodal metropolitan transportation system, that focuses upon the needs of the user not the facility, and that allows the evaluation of secondary, tertiary and external impacts of resource allocation decisions. Criteria must be devised for the development of

metropolitan transportation system performance evaluation measures to guide resource allocation decisions: they should be simple enough for a layperson to understand; they should be multivariate in nature as we are trying to model a complex system; they should examine system outputs rather that internal facility characteristics and they should be user oriented.

**1. Cost-effectiveness** should be one factor in evaluating different strategies. It should be measured over the life of the asset. Inclusion of cost-effectiveness into the ranking of projects in the Bay Area has demonstrated that inexpensive operation strategies in the system management arena have tremendously high benefits in congestion relief per dollar invested.

**2. User accessibility and convenience** measured in relative delay or travel time by different modes to different types of destinations could be other factors. While LOS tends only to measure a link, congestion measures which look at the entire trip in terms of time tend to better mirror the user's expectations, although these are challenging to forecast. Accessibility measures which evaluate the potential utility of alternative modes and land use patterns and pricing systems are needed to move away from a narrow modal focus and evaluate the real choices or lack of choices offered to individuals who need to meet their daily activity needs. Criteria for the acceptability of traffic delay or congestion should be related to the availability of other viable modal alternatives and should be established to promote rather than inhibit the development and use of multi-modal alternatives. Accessibility by walking, bicycling, transit, and automobile all need to be considered as elements in the total transportation level of service. The effects of changes in prices and subsidies on the use of different modes should be accounted for in developing composite accessibility measures.

**3. Social and environmental impact** can be measured in an normative plus-minus sense rather than an absolute sense, and a participative model can be developed here. This type of ranking is particularly effective in a public planning process that brings technicians, decision makers, the public and advisors together to evaluate alternative strategies in terms of community values and environmental impacts. Distributional impacts of current patterns and potential changes in transportation prices and subsidies and accessibility should be evaluated to inform public policy-making and participation.

## POTENTIAL EFFECTIVENESS OF COMPREHENSIVE TRANSPORTATION MANAGEMENT

A number of analysts have done analyses of transportation demand management strategies for specific metropolitan areas or as part of generalized studies for US DOT or EPA. Many have concluded that there is only limited potential for demand management strategies to limit future growth of motor vehicle use unless "draconian" steps are taken. Typically, very small potentials have been identified because measures have been considered in isolation, without considering the potential for significant changes in background conditions, such as the widespread substantial hidden subsidies which now encourage Americans to use single occupant automobiles and which encourage suburban sprawl, rather than reinvestment in existing urban areas.

The Environmental Defense Fund (EDF) recently prepared a different type of analysis of the potential for demand management strategies to reduce motor vehicle use.[1] This analysis is based on a review of the literature, examination of the evolution of transportation systems and travel behavior across North America, Europe, and Japan in recent decades, and consideration of the results of several recent long-range strategic planning analyses, using policy-sensitive transportation models. Based on this review, the potential effects of a comprehensive package of demand management strategies on vehicle miles of travel (VMT) in seriously polluted major metropolitan areas have been estimated, employing judgement where rigorous modeling is not yet available for purposes of estimation.

This analysis is compared to the list of Transportation Control Measures (TCMs) evaluated by EPA and DOT. EDF believes that by means of the strategies identified in the attached tables, it will be possible for U.S. metropolitan areas to reduce their VMT to 1990 levels by the year 2000 and to further reduce VMT by 10% below 1990 levels by 2010 while accommodating continued economic and population growth. What is needed to accomplish this end are major changes in the direction of transportation pricing and investment policy, changes in the pattern of real estate development, and new approaches to the management of street space. There are no "magic bullets" which accomplish this transition, although changes in transportation pricing are the foundation of this new direction.

### Context Determines Effect

The context in which transportation demand management strategies are introduced makes all the difference in their effect. Thus, it is not valid to evaluate the effectiveness of a particular measure or strategy without stating the assumed background conditions for its operation. For example, the effect of imposing new parking charges for either work or non-work trips destined to a particular area will depend on the character of the competing available choices. If public transportation is reasonably competitive with the automobile in time and cost, it may attract much greater use for trips to an area in the wake of higher parking charges. On the other hand, if public transportation is very inconvenient for travel to this area, few travelers will switch to it despite new parking charges. Indeed, the new charges may then lead some travelers to choose alternate destinations where they can get free parking, if these are convenient and available.

Evaluation of demand management strategies must include more than just factors of travel time and cost and include consideration of not only alternative destinations, but alternative times of travel, alternative modes including walking, bicycling, carpooling, and telecommuting/teleshopping, and longer-term effects on vehicle ownership and residential location decisions. Moreover, particular strategies will have different effects on different individuals and households, depending on income, household size, and the stage of the household and its members in their life-cycle.

### Current Tools and Data Are Deficient

The transportation planning and analysis tools available today are incapable of considering the full range of these synergistic interactions. Conventional transportation planning models which are in widespread use are generally able to represent only a few of these relationships, and frequently only for work trips. These conventional zone-based aggregate transportation models have usually been calibrated on current conditions and are not structured to be sensitive to changes in real parking costs and subsidies, pedestrian or bicycle friendliness, relative pedestrian proximity of jobs and housing to local retail services and transit stops, the linking of trips into chained itineraries, the potential for influencing the type and number of vehicles used for different household trips, and household life-cycle factors. To encompass these factors which shape travel behavior, most of these models at best rely on crude zonal average indicators of employment density or average parking cost for work trips, average walk access time, and average household size.

Current data collection and transportation monitoring systems are inadequate to support effective TDM and congestion management systems. More investment is needed in longitudinal travel panel surveys, traffic counting and flow monitoring, and the development of inventories of transit, pedestrian, bicycle, and urban design conditions to support truly multi-modal transportation system monitoring and analysis capabilities. These are needed for both short and long range transportation planning and analysis and to evaluate the cost-effectiveness and performance of current TDM and other transportation programs.

The effects of new technologies—ranging from potential new types of vehicles (such as small, lower performance neighborhood vehicles) to new types of information and communications services (such as real-time transit passenger information systems and smart paratransit)—should be evaluated for their potential effects on travel behavior. Efforts to develop more robust and holistic analytic frameworks for travel behavior and transportation system modeling, such as neural network based microsimulation models, should be accelerated.

Meeting these needs will require the "flexing" of transportation construction funds to provide expanded resources for data collection, monitoring, evaluation, analysis, and the development of new analytic tools. ISTEA gives states and MPOs the authority to use federal funds for either construction or planning. Expanding the investment into the latter area can be a key to promoting more cost-effective investment and management strategies as well as the institutional reforms needed to integrate TDM into transportation and land use policy, programming, and operations.

### New Tools Are Being Developed

Adequate analysis of the many types of demand management strategies which need to be considered in implementing the 1990 Clean Air Act (CAA) and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) is prompting development of new models which are sensitive to potential changes in many more types of factors. Several recent

modeling efforts have begun to develop the more holistic frameworks needed to account for these complex interrelationships, using microsimulation to evaluate decisions of individual households (rather than aggregate zones) and geographic information systems to represent the full transportation network and microscale land use pattern (rather than abstracting only major system elements and considering only macro-scale land use).

Notable are the microsimulation analyses developed by Greig Harvey of DHS on several California data sets,[2] the work of Ryuichi Kitamura and Resource Decision Consultants on microsimulation modeling with panel data,[3] refinements of more conventional transportation models in Portland, Oregon,[4] and Montgomery County, Maryland.[5] Caliper Corporation has developed software tools which can support easier manipulation and analysis of comprehensive transportation networks using GIS, while longer range advanced research to simulate real-time highway systems, helpful to developing better evaluation tools for emissions analysis and traffic operations management, is proceeding at Los Alamos National Lab using supercomputers and is being advanced by other researchers such as Hani Mahasanni at the University of Texas. Robert Dial at the Volpe Center in Cambridge, Massachusetts is working on new network assignment techniques sensitive to price as well as travel time.

Some of this work has been drawn upon in estimating the potential for a combination of travel demand management strategies to reduce the growth in vehicle miles of travel (VMT) and vehicle trips from trend forecasts. However, none of this work is yet so fully developed as to provide a framework for estimating the combined effects of all of the travel demand management strategies which might be considered to be a useful and internally coherent package in a given region.

For example, Harvey's work has made a significant contribution to evaluating the potential effects of pricing system changes, but has not incorporated to date the effects of changes in pedestrian and bicycle friendliness, such as widespread application of traffic calming strategies together with encouragement of infill accessory apartments and small-scale infill neighborhood retail services in areas now lacking mixed land uses. Kitamura's work has been similarly limited thus far, but promises to soon explore these interactions. These approaches offer substantial promise for more rigorous policy-sensitive and internally consistent travel demand modeling frameworks when they are combined with microsimulation models which simulate the evolution of individual households using panel survey data, land use models which incorporate price and regulatory effects, and dynamic network simulation models which simulate individual person trips on transportation networks over the course of a full day or week.

Portland's very good conventional models, developed largely by Keith Lawton, with support from Cambridge Systematics, have been limited in considering trip chaining and more complex pricing strategies. While pedestrian friendliness factors have recently been incorporated in Portland's model, improving its ability to simulate spatial variations in travel behavior, this model refinement has been limited by significant undercounting of pedestrian and bicycle trips in the regional travel survey on which the models were estimated and new surveys, now underway, are needed to refine this model's sensitivity to alternative policies. Montgomery County's travel demand and supply models, developed largely by David Levinson, Ajay Kumar, and Michael Replogle, have also faced limitations imposed by available survey data.

In all these cases, efforts are underway by these pioneers to further push the state-of-the-art to better address shortcomings of the existing approaches to evaluating the travel behavior effects of current analysis methods. However, in the meantime, Metropolitan Planning Organizations (MPOs) and others need to estimate now the effects of various demand management and transportation investment strategies on travel demand, transportation system performance, and emissions to meet pressing deadlines under the CAA and ISTEA.

### More Resources Are Needed for Transportation, Land Use, Air Quality Monitoring and Modeling

Unfortunately, there has been little spending in the past decade on transportation and land use data collection and monitoring systems, development of transportation and emissions analysis models, and training related to these. Federal guidance and support, both technical and regulatory, for transportation and emissions analysis has been very limited. MPOs, which are responsible for undertaking many new types of analysis and planning under the CAA and ISTEA, are in many cases small, understaffed, and captive to much more powerful state Departments of Transportation (DOTs).

The staff at many MPOs lack advanced training in how to undertake such analysis and struggle without appropriate models or even appropriate data to begin analysis.

Thus, many MPOs thus hire consultants or turn over analysis responsibilities to the State DOT. The support they obtain is highly variable in quality, given the shortage of appropriate data, models, and individuals who have received advanced training in travel demand analysis. Too often, deficient data and deficient models are used to produce evaluations of demand management strategies which are guaranteed to conclude that the future cannot look like anything other than an enlarged and distorted version of the recent past—i.e. "business as usual." Political pressures on MPOs to resist changes in transportation, pricing, and land use policy frequently converge with the inherent tendency of managers and policy makers to avoid risk, thus leading to acceptance of these deficient analyses as "based on the best techniques available within the time and resources available."

Even useful tools for transportation analysis are subject to misapplication in this process. For example, the Transportation Demand Management (TDM) Model developed Comsis has done a good job of trying to draw from conventional logit mode choice models transferable parameters which can be used to evaluate work-trip related demand management strategies for specific worksites, but this approach is limited by its sensitivity to only work trip mode choice changes. Attempts to apply this model on an area-wide basis and to extend the analysis of strategies to non-work travel through crude factors have not been very satisfactory, leading to conclusions which at times defy common sense.

The shortcomings of existing analysis tools make it essential to introduce more crude estimation techniques for assessing the relative potential of transportation demand management strategies in U.S. metropolitan areas. MPOs and state and local agencies implementing demand management strategies should certainly not limit themselves in their air quality and transportation planning to those strategies which can be rigorously quantified with poor quality models. They should instead apply themselves creatively to developing strategies which make common sense, using the best methods available to estimate the potential impacts of these strategies on emissions, and then ensure both good monitoring systems and contingency measures to evaluate effectiveness and to provide for corrective action in the event of lower than anticipated performance from TCMs.

### Integrating TDM into Long Range Plans and Transportation Improvement Programs

Outputs of data collection, evaluation efforts, and multi-modal analysis are key information inputs into the planning process. The planning process must integrate performance and asset management system decisions, assigning priority to the differing classes of expenditures. The planning process develops the overall goals, policies and objectives of the multimodal system and uses the objectives to evaluate the performance data and through a simple weighting and ranking system, select strategies, programs and projects for implementation. Significant, early, and ongoing public involvement and interagency coordination are essential to the process for developing new plans and transportation improvement programs (TIPs), as well as the supporting elements which are an integral part of these—land use, urban design, pricing, and operating policies. This framework planning and programming process should aid in the effective integration of TDM into all overall transportation policy and operations.

## STEPS TOWARDS COMPREHENSIVE TDM

### Understanding the Limits of Traditional TDM

Recent efforts at TDM and current planning for TDM in many regions have led many to conclude that TDM will provide at best only small reductions in travel demand. A recent US General Accounting Office report which surveyed MPO officials found widespread agreement that traditional TDM measures would produce only small reductions in VMT and emissions, representing on the order of one to two years worth of current VMT growth. Why is this? Traditional TDM has focused on work trips, peak trips, and longer trips, emphasizing VMT reduction, and complemented with traditional TSM measures (such as signalization, intersection widening, etc.) which can be expected in the longer run to actually offset some of the TDM-related VMT reduction because of induced and latent demand and the degradation of the pedestrian environment. This same GAO report found widespread belief among MPO officials that pricing strategies

and non-traditional TDM measures are the most effective ways of affecting travel demand, but these have been little explored since political fear has kept them from even being evaluated in may regions.

### A Comprehensive TDM Action Plan

GAO and MPOs are generally correct about the limits of traditional approaches to TDM. Efforts to reduce growth of travel demand and reverse recent trends towards sharply increased dependence on automobiles will be successful only by considering a wider range of strategies to address non-work travel, non-peak period travel, and shorter trips, and including effective transportation pricing changes. This will require coordination of the actions of many planning and operating agencies to develop truly integrated TDM strategies and programs, with measurable performance benchmarks and the assignment of appropriate responsibilities between various actors.

### Overcoming Entrenched Interests

One of the reasons why there has been little experience with the broad range of effective travel demand management measures in the U.S. is that many of these strategies involve a wide range of different organizations and institutions which often do not see themselves as having anything to do with "transportation." Frequently, implementation of the less traditional TCMs requires these organizations to address new concerns which may go beyond narrowly defined local or state agency missions. Considerable challenges face MPOs and state DOTs as they work to restructure themselves for more effective implementation of ISTEA and the CAA, develop better interagency cooperation and public participation systems, and struggle to resolve sometimes bitter battles over property rights vs. broad community welfare.

Raising concerns about the long-term consequences of local government land use and site design standards will threaten strongly-cherished local autonomy in decision-making at times. However, America can no longer afford to mortgage its future mobility, economic performance, community livability, and public health so that isolationist frontier-spirited defenders of private property rights and exclusive zoning can act against the broad interests the nation, states and the millions who live in increasingly dysfunctional metropolitan areas. Effective regional implementation of ISTEA and the CAA will require providing all the actors in the system and the public with information about costs and benefits and trade-offs between different strategies for managing congestion and ensuring healthful air. This information should become the basis for establishing systems which reward contributions towards metropolitan goals and penalize actions which work against such goal attainment.

### Assigning Responsibility for Results

Governance structures vary widely across the states, making it difficult to generalize about which agency, level of government, or public/private entity should be responsible for implementation of a particular element. However, this assignment of responsibility for implementation and follow-up evaluation is essential if demand management is to be timely and successful. The following discussion is intended as illustrative of what effective short-term travel demand management and mobile source emissions reduction strategies might look like for the U.S. and for a region pursuing expeditious implementation of all reasonably available TCMs.

## A FEDERAL GOVERNMENT ACTION AGENDA

Several actions should be taken as soon as possible at the Federal level to support effective implementation of demand management strategies under ISTEA and the CAA:

### EPA Should Adopt a Revised Transportation Conformity Regulation Consistent with the CAA

EPA should scrap its January 1993 proposed transportation conformity rule and adopt the alternative transportation conformity rule proposed in March 1993 by STAPPA/ALAPCO, the association of state and local air pollution control officials. This alternative rule, while not ideal, is far more consistent with the CAA Amendments than the EPA proposed rule. Among other features, the STAPPA rule would require annual emission reductions from transportation plans and

programs beginning in 1995, although it would not require that nonattainment areas offset emissions growth back to the 1990 level, as Congress originally intended in the CAAA.

### U.S. DOT Should Immediately Issue Revised Interim Conformity Guidance

U.S. DOT should issue revised interim conformity guidance as soon as possible to require a demonstration that transportation plans and programs will produce annual emission reductions, fully offsetting the effects of growth on emissions without taking credit for fleet turnover, technology fixes such as I/M or fuel changes. This is needed to ensure that TIPs prepared as part of the 1993 conformity cycle are subject to appropriate CAA requirements consistent with the intent of Congress.

### U.S. DOT Should Strengthen Management Systems, Statewide Planning, and Metropolitan Planning Regulations to Better Support CAA and ISTEA Implementation

Proposed regulations on these subjects need to set higher standards for data collection and analysis, improve coordination between planning and implementing agencies and between state and local agencies, and to strengthen the role of air pollution related agencies in transportation planning. Growth management systems should be strongly encouraged as a part of congestion management systems in nonattainment areas.

**Congress Should Amend the Internal Revenue Code to Cash-Out Parking Subsidies.** A simple one sentence change in the Internal Revenue Code, proposed in a recent report to the Federal Highway Administration, would make possible widespread cashing out of employer-paid parking. This change could reduce solo driving to work roughly 20%, reduce automobile travel to work by 76 billion moles per year, save 4.5 billion gallons of gasoline per year, reduce air pollution emissions, and increase tax revenues by $1.2 billion per year, according to this recent study for FHWA.

**FHWA Should Accelerate Development and Implementation of IVHS-based Road Pricing.** The introduction of Intelligent Vehicle and Highway Systems (IVHS) should be tightly bundled with road pricing, emphasizing the demand management side of IVHS rather than the supply enhancement potential. Current IVHS operational tests should be modified in appropriate circumstances to demonstrate the utility of using smart cards and other technologies for imposition of trip and VMT based charges to drivers. The same technologies should be extended to enable "electronic traffic calming"—automated vehicle speed limit controls through sensors in the roads or at entrances to areas to prevent excess speeding, improve traffic safety, smooth traffic flows, and protect neighborhoods from high-speed cut-through traffic.

### U.S. DOT Should Support Research and Demonstration of Traffic Calming and Non-Motorized Transportation Strategies

A major gap in U.S. DOT programs until recently has been in the area of pedestrian and bicycle transportation. Federal support for demonstration projects in this area, with appropriate investment in before and after evaluation studies, is essential to making rapid progress in implementing short-trip related TCMs which have been generally overlooked until now as air quality improvement strategies.

### EPA Should Accelerate Research on Modal Emission Factors and Modeling

Widespread evidence suggests that the EPA MOBILE model is based on incorrect assumptions about real-world driving cycles and driver behavior. Incorrect decisions involving billions of dollars in investments are likely being made on the basis of these incorrect model assumptions. Private vehicle scrappage programs implemented under the emissions trading provisions of the CAA might provide a strategy for rapid testing of many more vehicles. However, EPA should complement such testing to fill other gaps and issue revised technical support information and models as soon as possible.

## A STATE GOVERNMENT ACTION AGENDA

State governments have an important role to play in implementing demand management strategies. Short-term action items with the highest priority for CAA implementation related to mobile sources include:

### Legislatures Should Enact Pay-As-You-Drive Automobile Insurance

PAYD insurance, currently under consideration in several state legislatures, would make drivers more sensitive to the marginal costs of using their automobiles. A $.52/gallon insurance premium at the gasoline pump in California has been estimated to likely yield short-term reductions in VMT, fuel use, and emissions of 8%.

### State DOTs Should Introduce IVHS-Based Road Pricing with HOV Take-a-Lane Strategies

Rather than adding new highway capacity in nonattainment areas, even for High Occupancy Vehicles (HOVs), State DOTs should introduce road pricing using automated smart card toll collection in conjunction with HOV take-a-lane strategies on limited access highways and selected major arterials. This kind of combined strategy can ensure efficient use of "Smart/HOV lanes" from opening day, avoiding the experience of the Santa Monica Freeway take-a-lane fiasco. Price levels charged to smart-card SOVs on the reserved lanes can be adjusted as needed over time to keep a satisfactory level of service and to boost HOV incentives. This will minimize the stimulus to latent and induced travel demand which usually accompanies highway expansion whether HOV or general SOV lanes are being added.

### States Should Ensure Full Flexibility of State Transportation Resources and Give Priority to TCM Implementation

Many states still have restrictions on the flexibility of transportation funding sources which contradict the central intent of ISTEA and the requirements of the CAA for priority implementation of TCMs in nonattainment areas. In some states this will require legislative action or constitutional revisions. In most states this will require institutional restructuring and reforms. Funding for pedestrian and bicycle infrastructure projects in nonattainment areas should be substantially expanded beyond ISTEA's requirements for allocation of Surface Transportation Program funds to "Enhancements." Projects benefiting non-motorized modes—such as sidewalk and bicycle path construction, bicycle parking facilities, traffic calming measures—should comprise at least 15% of surface transportation spending in nonattainment areas to help counteract years of neglect.

### Congestion Management Systems Should Incorporate Statewide Growth Management Strategies

Congestion management systems should be primarily focused on demand-side management rather than supply-side strategies. Growth management—implemented through statewide legislation, zoning changes, impact fees, and other measures—should be an integral part of these ISTEA-mandated systems. States have an important role to play in reducing damaging competition between local jurisdictions over attracting growth. In coordination with MPOs and local governments, states should develop supportive frameworks for regional and state-wide growth management, with appropriate participation and delegation of decision-making to local authorities.

## AN ACTION AGENDA FOR MPOs

MPOs vary in their institutional capabilities, styles, and authority, but clearly have an important and expanding role to play in CAA and ISTEA implementation. Among the most important actions MPOs can take to forward effective implementation of the CAA and demand management are:

### MPOs Should Improve Transportation Analysis and Monitoring Capabilities

Implementing CAA conformity will require difficult trade-offs between transportation pricing, investment, and management strategies related to transportation and land use, involving many different organizations, levels of government, and the private sector. More robust and policy-sensitive analysis tools are urgently needed to provide a gaming board for evaluation of alternative scenarios and strategies, as in most cases current MPO tools are quite

deficient. ISTEA funds should be flexed to support expanded investment in data collection, monitoring, analysis, and modeling tools, especially in regions with more serious air quality problems.

### MPOs Should Evaluate Alternative Scenarios for Regional Development and Growth Management

MPOs should cease to use a single land use forecast for TIP and plan evaluation. Instead, alternative land use and transportation scenarios should be developed and evaluated for consideration by state and local decision-makers. Without such analysis, there will be no opportunity to consider how growth management strategies could improve air quality as a reasonably available TCM or contribute towards a congestion management program.

### MPOs Should Invest in Regional Education and Marketing to Create a New Transportation Ethic

MPOs can play an important role in shaping public opinion and attitudes about transportation through education and marketing. These can influence individual driving and travel behavior choices, contributing to air quality.

## A LOCAL GOVERNMENT ACTION AGENDA

Many non-traditional TCMs affect transportation and land use at the level of the neighborhood and local street and hence are best planned and implemented at the lowest possible level of government. Among the more important short-term strategies for CAA implementation related to mobile source emissions affected by local agencies are:

### Local Governments Should Implement Growth Management Strategies as Part of Congestion Management

In coordination with statewide and regional programs, local governments should use zoning, urban design, site planning, permitting, and impact fee systems to promote more efficient growth patterns which will reduce, rather than increase, the number of automobile trips and VMT per capita, per household, and per job in their area. This is perhaps the most effective long-term strategy for demand management, but needs to be implemented if possible in coordination with transportation pricing strategies. Changing ordinances and regulations which discourage or bar accessory apartments from transit-served neighborhoods is a good place to start in encouraging affordable infill housing without cost to the government. Overly restrictive or improper zoning often discourages or bars housing densification and appropriate redevelopment near high transit accessibility locations. Reducing restrictions on home occupations and small neighborhood retail and service businesses can also reduce automobile dependence while creating jobs. Pedestrian and transit friendliness is enhanced by eliminating minimum building setback requirements from zoning and site planning ordinances and replacing these with maximum setback requirements. Blank walls can be prohibited in new development on certain key pedestrian streets of urban, suburban, town, and village centers. Similarly, minimum automobile parking requirements should be replaced with formula automobile parking maximums and area-wide parking caps, along with minimum bicycle parking requirements, and shower requirements at workplaces.

### Local Governments Should Re-examine Transportation Investments and Pricing Policies

The largest source of highway construction expenditures not paid for by road users, but by the general public, is local governments. Local expenditures for transportation should be closely examined for their impact on travel demand and air quality and local strategies for transportation user fees should be developed to favor demand management. Parking excise taxes or other user fees, such as local automobile registration or parking fees, local gasoline taxes, and area pricing, should be used to ensure that local government general revenues do not continue to subsidize and encourage automobile use. Revenues from these new sources can be used to maintain existing roads, improve safety, and expand options for travel within the community.

### Local Governments Should Develop Traffic Calming and Non-Motorized Transportation Programs

The factors that influence whether a street is pedestrian and bicycle friendly tend to be small details of street and urban design. Traffic engineers trained to promote the mobility-oriented objective of faster and more efficient traffic flow should be instructed by local officials to give attention to a new proximity and accessibility-oriented objective—promoting

a balanced transportation and growth management system, with pedestrians, bicycles, and public transportation being given priority on most streets. In areas with serious nonattainment problems, traffic calming, sidewalk and bicycle facility construction, and related measures should be a major element in local capital spending programs.

## AN ACTION AGENDA FOR TRANSIT AGENCIES

Transit agencies have a role to play in CAA implementation as well. Among the most important short-term actions they can take are:

### Transit Agencies Should Work with Other Agencies to Improve Non-Motorized Access to and from Transit

One of the most neglected areas for transit planning and investment is access planning. All further planned investments in park-and-ride lots should be relabeled in capital programs as "Least Cost Transit Access Improvements." These projects should include rapid examination and preliminary engineering and cost estimation for possible strategies for improving pedestrian and bicycle access to transit stops and stations, including substantial expansion of secure bicycle parking, bicycle paths, sidewalks, traffic calming, and marketing, considering the proximity of nearby jobs and residences. This evaluation of alternatives should lead to selection of the long-term least-cost strategy for expanding transit use and reducing emissions in nonattainment areas.

### Transit Operators Should Improve Transit Passenger Information and Security Systems

Investments in real-time transit passenger information systems, especially for areas where services are less frequent, can make a large difference in passenger perceptions of service dependability and user-friendliness. Improved monitoring systems may aid in system security.

### Transit Operators Should Improve Transit Fare Collection Systems

Introduction of more types of pre-paid fare media, particularly linked to employer-commuter subsidy programs, can improve transit attractiveness. These should be complemented by better fare integration between different transit providers.

### Transit Agencies Should Encourage Paratransit Service Development

The days when one type and level of public transportation can meet every need is long gone in most communities. Market-driven paratransit services should be encouraged as supplementary and complementary to a regional transit system, rather than opposed as unfair competition.

## CONCLUSION

In short, effective implementation of demand management in US transportation will come only from learning from past failures and shortcomings and seeking to reinvent institutional structures, planning methods, and the basic framework for viewing and resolving transportation issues and problems. Implementation of ISTEA and the CAA offer major new opportunities to make America's communities more livable and productive by integrating demand and supply side strategies into transportation planning and development.

## REFERENCES

1. For more information, see Michael Replogle, *Transportation Conformity and Demand Management: Vital Strategies for Air Quality,* Environmental Defense Fund, Washington, DC, April 1993, and Michael Replogle, *Motor Vehicle Use and the Clean Air Act: Boosting Efficiency by Reducing Travel,* Environmental Defense Fund, Washington, DC, July 1993.

2. Michael Cameron, *Transportation Efficiency: Tackling Southern California's Air Pollution and Congestion,* Environmental Defense Fund and Regional Institute of Southern California, March 1991.

3. See for example Konstadinos Goulias and Ryuichi Kitamura, *Regional Travel Demand Forecasting with Dynamic Microsimulation Models*, presented at First US Conference on Panels for Transportation Planning, Lake Arrowhead, CA, October 25-27, 1992.

4. Cambridge Systematics, Inc., *Making the Land Use Transportation Air Quality Connection: Volume 4—Model Modifications*, 1000 Friends of Oregon, Portland, Oregon, 1992.

5. Montgomery County Planning Department, *TRAVEL2 Model*, Maryland-National Capital Park and Planning Commission, Silver Spring, MD, 1992.