required by the new requirements of the CAAA of 1990 and the ISTEA of 1991. A good example is urban vehicle counting and vehicle classification on high volume congested facilities.

- Determine the type and amount of goods movement data required for appropriate analytical and planning purposes, and develop the appropriate data collection methods to obtain data that can be used for analyzing the movement. The area of goods movement measurement has been a problem area for some time and currently requires priority attention.

- Research is required to define the data needs and methodologies of collecting data for intermodal planning purposes as recently highlighted in the ISTEA of 1991.

- An initiative is required to promote consistency in various data collection efforts and provide replicable information from multiple sources such as the federal efforts with the Census and NPTS data, MPO data with local travel survey, and state data with counts and classification.

- Research is needed to determine the measurements and analysis required to determine the land use impacts and changes resulting from increasing facility capacity and reducing travel time in a corridor.

- Identify the types and amounts of data needed to determine with a reasonable degree of certainty the degree of impact of various transportation control measures.

Education, Training and Technical Assistance

- Consideration should be given to developing a new set of manuals that were previously developed in the 1950s by the National Committee on Urban Transportation, and in the 1970s by the Highway Users Federation "The Planning Process for Smaller Cities." These manuals provided considerable guidance to the professionals of the time, especially with regard to data and collection methods. This material would provide the best practices with regard to data collection.

- State and MPO work programs should be widely distributed which would provide useful information to agencies to upgrade their own activities. These work programs could be collated by subject and would be a resource for others in the development of their own programs of work.

- Training courses should be developed to provide agency personnel with the current state-of-the-art in survey design, collection, and analyses methods. These courses should be developed in the various media available and should be made available for various audiences in a variety of ways.

- A national conference should be undertaken by the Transportation Research Board every other year in which various state and MPO staffs could highlight their procedures for collecting different types of data. This conference would be developed by the states and MPOs jointly and would illustrate the latest methods and procedures used in their data collection program.

KEYNOTE PAPER
DATA, DATA, AND MORE DATA: THE FOUNDATION TO PERFORMANCE-BASED PLANNING

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"Without a store of basic data, urban transportation problems cannot be accurately defined or measured. Without facts, it is hard to determine the potential solutions; it is even more difficult to select the most practical ones. Moreover, it is virtually impossible to present to legislative bodies and to the general public a clear picture of needs--or to create public understanding of the benefits that will accrue from improvements."

— National Committee on Urban Transportation, Better Transportation For Your City, 1958

How little things have changed over the past 34 years. Just as engineers and planners at the beginning of the highway construction era in this country argued for a decision-making process based on fact, so too we, 34 years later, have gathered to argue for better and higher quality data to support the transportation decisions that must be made over the next several decades. And yet, a great deal has changed since 1958. Certainly, the technology of transportation planning (for example, the widespread use of the microcomputer) provides data handling capabilities that the planners and engineers in 1958 could only dream of. We presumably know more about the fundamental characteristics of transportation systems and their relationships to the such things as the economy, natural environment, and travel behavior. And importantly, the types of decisions that must be made

are very different than those facing decision makers 34 years ago. It is this last point that I want to use as a theme throughout my remarks. I have for many years argued that a major purpose (if not the major purpose) of planning is to inform the decision-making process. If you accept this, then an excellent point of departure for any discussion on data and on the changing needs of data collection will be to first look at what types of decisions, and what types of decision-making processes, will likely occur over the next several years. I will do this in the first half of my discussion. The second half of my presentation will focus on some key data challenges and opportunities that will present themselves to planners and engineers over the next decade. If these challenges and opportunities can be met, transportation planning ten years hence will be a much more effective and important part of decisionmaking. Hopefully, this conference will be an excellent starting point for accomplishing just that.

THE CHANGING DECISION-MAKING ENVIRONMENT

The form and substance of transportation planning is very much influenced by the political and institutional environment within which it occurs. It is not surprising then that the evolution of transportation planning and thus of the types of data that needed to be collected reflects the changes occurring in this environment. Clearly, goals, decision-making processes, available resources, and political commitment and leadership will vary from one community to the next.

Instead of deciding on massive new facility construction (which was the decision-making context for Better Transportation For Your City), many decisions will now be oriented toward improving the performance or lessening the impacts of the existing transportation system. I call this *performance-based planning*. One of the most important characteristics of such planning is that it is based on a comprehensive and high quality data base.

A simple look at the recent Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the Clean Air Act Amendments (CAAA) of 1990 shows how the decision-making, and thus the planning, environment has changed. Not only did the ISTEA mark the end of the Interstate Highway program begun in 1956, but it greatly loosened the institutional, financial, and thus political, framework within which decisions on transportation investment had been made over the past 40 years. Over $150 billion was provided by Congress to carry on the important work of building, operating and maintaining the transportation infrastructure so critical to the U.S. economy and the quality of American life. Of this sum, significant amounts were allocated to support mass transit, to fund actions that will improve air quality and enhance the environment surrounding transportation facilities, and to provide seed money for research and demonstration of advanced technology applications to the transportation system. More importantly, however, the ISTEA established a new program structure for investing transportation dollars.

Where federal funds once had to be spent only on projects that were eligible in specific program categories, now many of the funds can be used for any transportation project. Where the federal program was once designed to provide uniformity of transportation investment from one state to the next, a necessity for a program like the Interstate Highway System, the ISTEA now encourages states and localities to seek solutions to transportation problems appropriate to their needs and desires. Where the federal program historically emphasized transportation investment as an end in itself, the ISTEA provides transportation funds to meet other societal goals, thus viewing transportation as a means of achieving some greater aim. Where the federal program separated transportation investment into highway and transit pots of money, the ISTEA now encourages transportation decisions that are undertaken from a multimodal perspective (known in Washington, DC as "flexibility"). Lastly, the federal program once emphasized the construction of new facilities, now the ISTEA encourages better management and operational improvements of existing facilities with such things as incident management programs and the application of advanced technologies.

The Clean Air Act Amendments also provide a strong basis for a changing transportation planning focus in those metropolitan areas in non-attainment of air quality goals. There has been a long history of linkage between transportation planning/decision-making and air quality planning. However, never before has Congress made the linkage stronger. Certainly, the transportation portions of the CAAA will greatly influence the focus and scope of many transportation decisions during the next decade. With a stringent schedule of anticipated emission reductions from stationary and mobile source controls, a significant number of areas will have to consider, and possibly implement, transportation control measures (TCMs) to demonstrate attainment. In addition, because of concerns about both attainment and maintenance, Congress has supplemented or reinforced the SIP revision process with specific requirements for non-attainment areas to periodically assess and mitigate on a continuing basis increases in VMT, congestion, and vehicle trips.

Importantly, the CAAA reflects Congress's concern with past and anticipated growth in VMT and congestion as a primary cause of non-attainment. Congress viewed past failures to accurately predict/monitor these travel indicators as a main reason for overly optimistic attainment demonstrations following the 1970 and 1977 Clean Air Act Amendments. Regular determinations that transportation plans, programs, and projects conform to the state implementation plan (SIP), and this means a lot of data collection, could be the greatest cause of change to how transportation agencies conduct their business.

A simple example of the new decision-making context for transportation illustrates the challenges facing the transportation planning profession. I was reading a newspaper from one of our larger cities and came across an article that described a major transportation decision that was facing the region. The transit agency, strapped for funds, was going to ask the MPO to adopt the flexible approach to resource allocation that was inherent in ISTEA and approve the use of $6 million of Surface Transportation Program (STP) funds to retrofit its buses with wheelchair lifts. It seems the state department of transportation had been counting on these funds to construct and improve the area's road system, and had warned local officials that such a use of funds would reduce the number of road projects in the region. What data are necessary to provide local officials with some sense of trade-offs associated with such decisions? Do we even have the technical methodology to analyze such trade-offs? Or do we simply throw our hands in the air and say that such decisions are political and thus it is useless to attempt a trade-off analysis? My guess is that more and more metropolitan areas are going to face such decisions in the very near future.

CHALLENGES/OPPORTUNITIES FOR TRANSPORTATION PLANNING

There are many challenges/opportunities that face the transportation planning profession over the next decade, and which should guide your discussions over the next several days.

Decision-Making Flexibility

It has been estimated that if state and local officials chose to do so, $103 billion of the $151 billion provided by ISTEA could be spent on transit. How will the decision of how to spend federal dollars be made in our metropolitan areas? What criteria will be used to determine the trade-offs between different transportation alternatives? What data are necessary to support these types of decisions? It seems to me that what we need to support this type of decision-making is a set of criteria that is generic enough that will allow some sense of cost effectiveness across the options being considered. This will not be easy. In the above wheelchair lift example, it is hard to develop a measure of benefit for bus retrofit (cost per non-ambulatory person served) that is easily compared to benefits associated with road improvements (usually time savings, lives saved, and reductions in vehicle operating costs). And yet, a way of doing just that is needed.

Multimodal Transportation Planning

This requires, for the first time, that state departments of transportation develop a statewide multimodal transportation plan. These plans are not simply to be a document which examines highway, transit, rail, aviation, and port issues separately, but rather a process and a plan that looks at transportation as an integrated system, related to multiple societal goals, and, in particular, emphasizing efficient and productive people and goods transfer from one mode to another. This requirement will be a particular challenge to those states which have traditionally emphasized highway planning at the expense of other modes. This multimodal planning approach could, and probably should, characterize planning at other levels of application.

The implications for data collection are similar to those described above for decision-making flexibility—the data needed relates directly to the types of evaluation criteria that are in place. In those cases where the types of projects under consideration are trying to serve the same function, such criteria are not difficult to envision. For example, in a corridor analysis, the impact of a highway widening project versus an HOV lane versus a strong incident management program versus light rail could all be evaluated with criteria such as time savings for targeted markets, impacts on existing freeway users, air quality changes, etc.

Management Systems

The ISTEA requires state departments of transportation to develop management systems in six areas: congestion, pavements, bridges, safety, intermodal activities, and public transit. It is too soon to say what many of these systems will look like. However, Congress is clearly telling transportation officials to develop the capability to better manage the transportation facilities and systems that currently exist. For congestion management systems, this will likely entail the consideration and implementation of regional

incident management programs, coordinated traffic signal control systems, preferential lanes and/or other incentives for multioccupant vehicles, and the like. For many highway agencies that have reputations for high quality freeway construction, the question becomes can they also become leaders in managing the road system that they have so effectively constructed? An obvious challenge for all of these management systems is to provide an overall framework in which they preferably are all part of the same system, but at a minimum all coordinated.

With respect to data base management, the required management systems provide a unique opportunity to develop a coordinated and common data base for all of the transportation decisions to be made in a metropolitan area, as well as serving the reporting functions that will be required from the federal government. There is little doubt that data requirements for each management system will vary, with some data items (e.g., volumes) common to all systems and others (e.g., pavement conditions) specific to one. The coordination among the management systems can be provided by an overarching management system, or the coordination could be achieved through a common database. Of particular importance in this regard is the use of geographic information systems. The "layering" of data in such systems will allow a common data base to be developed around a common base map which will allow the user to locate the specific facility or part of facility that is of interest, and to also define the attributes associated with these facilities. I would strongly urge MPO and state DOT planners/engineers to consider the use of GIS in developing their management systems.

Performance-Based Planning

The ISTEA and CAAA provide an impetus for state and metropolitan agencies to establish more systematic approaches to managing system performance. The management systems that are required by ISTEA are inherently a performance-based approach to decision-making. A key issue for metropolitan planning organizations and state transportation agencies over the next several years will be the development of comprehensive strategies for the collection and analysis of system performance data. One note of caution. Transportation planners and engineers tend to focus on performance of the transportation system, certainty something that is definable and measurable. I suspect that political decision makers will not respond well to single indices of system performance, but rather will be much more interested in metropolitan or regional indices of economic performance, or quality of life measures, or other important variables to political leaders. Instead of transportation system indicators, perhaps we should be looking at much broader social and economic well-being indicators within which transportation plays a role.

Goods Movement

The requirement for an intermodal facility management system underscores the importance that goods movement should play in transportation planning. Although this management system is not focused exclusively on goods movement, certainly one of its major emphasis areas will be on the interchange of freight from one mode to another. This is one of those topics that only a few states and metropolitan areas have spent much time in investigating, and yet freight movers are major customers of the transportation system. The intermodal facility management system will likely be the most difficult one to develop because of very little understanding of what "intermodal" means and of the types of data that are necessary to collect. Clearly, however, the most important purpose of this management system, as it is with the other systems, is to provide information to those allocating resources where the most cost effective investments will be in improving goods movement and passenger interchanges.

New Techniques for Collecting Data

We need to be "smarter" about collecting data. One of more intriguing experiments in this area is the ADVANCE demonstration in Chicago where instrumented vehicles themselves will be used as traffic probes to provide real time monitoring of system conditions. With the many opportunities that IVHS will provide for enhanced vehicle guidance and information, why not also look carefully at how such technologies can be used for the collection of data that might be useful for transportation planning purposes.

Another area in the technology of data collection merits some attention. Transportation agencies are not unfamiliar with remote sensing technologies. Traditional air photos have been used in the planning and engineering of transportation facilities for well over fifty years. Over the past 20 years, however, the use of satellites for remote sensing has expanded dramatically, although much of this use was in the natural resources planning area. Newer remote sensing technologies have increased both the spatial and spectral resolution over that of their predecessors. Today, we have the ability to integrate and use remotely sensed digital data that only a few years ago was impossible. I can imagine in the not

too distant future the widespread use of such technology for urban growth pattern modeling, environmental assessment along transportation corridors, and area-wide traffic volume counts.

Coordinated Data Collection and Use

Because the effectiveness of planning and, thus hopefully of decision making, depends so strongly on the existence of a good data base, designing a data collection and management plan for an urban area becomes an important task in transportation planning. Indeed, I would argue, just as our predecessors did in 1958, that you really cannot make good decisions without the facts. Therefore, I would recommend that just as the transportation improvement program (TIP) outlines the projects, agency responsibilities, funding sources, and timing of the key projects in a region, so too should there be a data improvement program (DIP). This program would provide a schedule of data collection activities over a specified period, identify likely unmet data needs, establish priorities among these needs, determine the level of resources to be devoted to each of these needs, and estimate the cost of the data collection efforts on an annual basis. Of great importance in this exercise would be the required interagency and intergovernmental coordination that would be required for such a program to be successfully implemented.

Before ending, I would like to add a personal note. I have been a participant and observer of transportation planning over the past 18 years. I have held positions where I was the producer of information for decision makers and also held positions where I was the end user of information produced by the planning process. I have participated in several expert review panels for transit investment where billions of dollars worth of public funds were going to be spent on systems or facilities for which the data base and planning tools were totally inadequate to answer some of the most basic questions. I have participated in debates over system performance monitoring (primarily for air quality purposes) where the level of precision and accuracy of data collection demanded by some far out-stretched even the best capabilities in the country. I worry that many of our public policies and subsequent policy requirements have gone far beyond the data base and technical modeling capabilities that exist in our profession. There is little doubt in my mind that we are about to play a catch-up game, due in part to many years of neglect and limited resources. However, I hope that our profession, and this conference, goes beyond simply looking at what is necessary to support the decisions of today. Because if we do, my fear is that once we finally have in place the data base and analysis methods that are needed for today, the decision-making environment will have changed again. In all of our discussions, the importance of data and of the analytical we need to provide some strategic perspective on capability it supports. Will they be useful 10 years from now? 20 years from now? 50 years from now? I know the answers to these questions are not easily forthcoming. However, by simply asking them, we might be able to put in place a data base that truly can support the decision-making process of the 21st century.

PANEL ON ENVIRONMENTAL ISSUES AND IMPLICATIONS FOR DATA COLLECTION PROCEDURES

Gary Hawthorn, Gary Hawthorn Associates, Ltd., moderator

OPENING COMMENTS

Gary Hawthorn

The Clean Air Act Amendment (CAAA), in advance of ISTEA, first spotlighted concerns about the adequacy of existing analytical tools and data needed to carry out the clean air requirements.

A NARC conference in November 1991 focused on these concerns, emphasizing data problems as major obstacles to improved emission estimates--in particular: no data, data of uncertain quality/precision, bad data, and the expense/time to collect new data.

In an eye-opening/overwhelming exercise, a workshop at that NARC conference demonstrated the wide range of data needed to determine accurately the emission reductions resulting from employer trip reduction programs. (The CAAA specifies only that required employer programs achieve a 25% increase in AVO above the area-wide average--which, if achieved, reveals little about the emission reductions from such programs.)

Compatibility and cultural gaps exist between transportation and air quality professionals and their data/models. Accuracy needs are also significantly different.

Sometimes the data in hand may not represent the truth. Employer trip reduction plans, submitted in response to Regulation XV, may feature preferential parking as a major incentive for carpoolers. But a site