

8TH
International Conference on
High-Occupancy Vehicle Systems

1996
Conference
Proceedings

August 25-28, 1996
Pittsburgh, Pennsylvania



*TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL*



Eight International Conference on High-Occupancy Vehicle Systems

August 25-28, 1996
Sheraton Station Square Hotel
Pittsburgh, Pennsylvania

Presented By

Transportation Research Board
National Research Council

In Cooperation With

Federal Highway Administration
and
Federal Transit Administration

Conference Proceedings

Editor

Katherine F. Turnbull

Texas Transportation Institute
The Texas A&M University System

Typing, Graphics, and Editorial Assistance

Bonnie Duke
Stephen Farnsworth

Texas Transportation Institute
The Texas A&M University System

The preparation of these proceedings was funded in part through a grant from the Federal Highway Administration, United States Department of Transportation.

Eight International Conference on High-Occupancy Vehicle Systems

Conference Hosts

Port Authority of Allegheny County
Pennsylvania Department of Transportation
City of Pittsburgh
and
Southwestern Pennsylvania Regional Planning Commission

Conference Planning Committee

TRB Committee on High-Occupancy Vehicle Systems Chair

Katherine F. Turnbull
Texas Transportation Institute

Local Arrangements Committee

Allen Biehler, Port Authority of Allegheny County
Terry Schneider, Port Authority of Allegheny County
Gary Runco, Parsons Brinckerhoff
Tom Fox, Pennsylvania Department of Transportation
Darryl Phillips, City of Pittsburgh Engineering and Construction Department
Patrick Hassett, City of Pittsburgh Planning Department
Jim Moorcroft, Michael Baker, Jr., Inc.
Chuck DiPietro, Southwestern Pennsylvania Regional Planning Commission

TRB Staff

Rich Cunard
Linda Karson
Reggie Gillum
Anita Brown

Eight International HOV Conference

TRB Committee on High-Occupancy Vehicle Systems

Dr. Katherine F. Turnbull
Texas Transportation Institute

Mr. Alan T. Gonseth
Gonseth Associates, Inc.

Mr. Leslie L. Jacobson
Washington State Department of Transportation

Mr. Tom Lambert
Metropolitan Transit Authority of Harris County

Mr. Richard Cunard
TRB Staff

Dr. Timothy Lomax
Texas Transportation Institute

Mr. Paul Bay
BRW, Inc.

Mr. Carlos A. Lopez
Texas Department of Transportation

Mr. John W. Billheimer
SYSTAN, Inc.

Dr. Adolf May, Jr.
University of California, Berkeley

Dr. Donald G. Capelle
Parsons Brinckerhoff

Mr. Thomas W. Mulligan
Municipality of Toronto

Dr. Dennis L. Christiansen
Texas Transportation Institute

Mr. Andres Ocon
Los Angeles MTA

Mr. Don Emerson
Federal Transit Administration

Ms. Luisa B. Paiewonsky
Massachusetts Highway Department

Mr. William B. Finger
City of Charlotte Department of Transportation

Mr. Donald R. Samdahl
BRW, Inc.

Ms. Barbara L. Fischer
State of New Jersey Department of Transportation

Mr. Dave Schumacher
San Diego Metropolitan Transit Development Board

Mr. Charles Fuhs
Parsons Brinckerhoff

Ms. Heidi Stamm
Pacific Rim Resources

The Eighth International High-Occupancy Vehicle (HOV) Systems Conference was held in Pittsburgh, Pennsylvania on August 25-28, 1996. The Conference brought together transportation professionals from throughout North America and the world. The keynote speeches and concurrent session presentations are summarized in these proceedings.

The Pittsburgh meeting was the eighth international HOV conference sponsored by the Transportation Research Board (TRB). Building on past efforts, the Conference provided the opportunity for transportation professionals to share ideas on different topics and to discuss current issues and opportunities. A wealth of information was presented on new HOV projects, innovative transit services, ITS, priority pricing, arterial street projects, and marketing and public information programs. Participants also had the opportunity to tour the busways, freeway HOV lanes, arterial street bus lanes, LRT, and other facilities in the Pittsburgh area.

A number of people helped ensure the success of the 1996 HOV Conference. The local planning group did an excellent job organizing the tours and other activities. The TRB HOV Committee developed an excellent technical program. Rich Cunard and the TRB staff did their always exceptional job with the arrangements and overall organization. The Federal Highway Administration provided support for the preparation of Conference proceedings.

The TRB HOV Systems Committee continues to be involved in a number of activities. The Committee is updating its strategic plan and the research program published in 1995 to better reflect current needs. The Committee publishes a regular newsletter and sponsors technical sessions at the TRB Annual Meeting.

The next HOV Conference is scheduled for the Fall of 1997 and will be held in conjunction with the Institute of Transportation Engineers International Meeting in Toronto. I encourage you to plan now to attend this Conference and to become involved with the activities of the TRB HOV Committee. The Committee is committed to providing ongoing leadership in addressing today's transportation problems through innovative approaches.

Sincerely,

Katherine F. Turnbull
Chair
TRB HOV Systems Committee

Table of Contents

PLENARY SESSIONS	
Opening Session — HOV Facilities in the 1990s	
Welcome and Keynote Address — Bradley Mallory	5
Update on HOV Projects and Activities — Katherine F. Turnbull	6
Federal Update — Jon Obenberger	7
General Session — HOV Facilities in the Pittsburgh Area	10
Downtown Pittsburgh Contraflow Bus Lanes — Darryl Phillips and Patrick Hassett	10
I-279 Reversible HOV Lanes — Tom Fox	12
The Pittsburgh Busways — Allen Biehler	13
Regional HOV Incentives — Chuck DiPietro	14
Luncheon	
Public Transportation in Pittsburgh, William Millar	
General Session — A Look to The Future — Priority Pricing on HOV Lanes	
SR 91 — Jerry Porter	18
I-10 West Houston — Bill Stockton	19
I-15 San Diego — Mario Oropeza	20
General Session — A Look to The Future — ITS And HOV Facilities	
Role of HOV, Transit, and ITS at the Atlanta Olympics — Shelley Lynch	22
Automated Vehicle Research at Carnegie Mellon University — Dean Pomerleau	22
CONCURRENT BREAKOUT SESSIONS	
Innovative Marketing and Public Information Programs	24
Planning and Regional HOV Systems	36
ITS and HOV Facilities	39
Recent HOV Project Experience	
Innovative Transit Services	29
Hot Topics with HOV Facilities	30
International HOV Experience	46
Arterial Street HOV Applications	49
NCHRP HOV Manual	56
FHWA HOV Demand Estimation Project	57
CONFERENCE REGISTRATION LIST	
LISTING OF HOV PROJECTS IN NORTH AMERICA	

Opening Session — HOV Facilities in the 1990s

Don Capelle, Parsons Brinckerhoff — Presiding

Welcome and Keynote Address

Bradley Mallory

Pennsylvania Department of Transportation

It is a pleasure to welcome you to Pittsburgh and the Commonwealth of Pennsylvania. The *New York Times* has referred to Pittsburgh as the only American city with a grand entrance. If you come through the Fort Pitt Tunnel at the right time of the day, you will understand this statement. The view of the city at sunset as you emerge from the Tunnel is an impressive sight.

Pittsburgh is also an accommodating, adaptable, and resilient city. Pittsburgh has gone through a dramatic change, both economically and socially, over the past 20 years. I am sure you are all aware that the steel industry used to be the major employer in Pittsburgh. When the economy of the steel industry changed in the 1970s, the city also had to change. Pittsburgh is now the home of advanced technology companies, banks, medical facilities, and other businesses.

Pittsburgh is also the city of champions with the Stanley Cup Penguins hockey team, the Super Bowl Champion Steelers football team, and the World Series Champion Pirates baseball team. The University of Pittsburgh is noted for its pioneering medical work in transplants. More recently, the city has become the movie making capital of Pennsylvania.

From a transportation perspective, Pittsburgh is also unique. The City is the intermodal capital of Pennsylvania. As you are well aware, Pittsburgh is known for its busways and HOV facilities. These include the HOV lanes on the I-279 Freeway, the South Busway, and the Martin Luther King, Jr. East Busway. Other projects underway include a new bridge across the Monongahela River, the Airport Busway/Washbash HOV facility, and an extension to East Busway.

These projects represent the coordinated efforts of the Pennsylvania Department of Transportation (PennDOT), the Port Authority of Allegheny County (PAT), the City of Pittsburgh, Allegheny County, and other cities and counties

in the region. Planning, designing, funding, and operating these facilities is truly a team effort. You will be hearing more about the various HOV facilities in the area and other related activities from speakers during the next session.

I would like to thank the Transportation Research Board (TRB) for the opportunity to welcome you today. Traditionally, less research has been done in transportation than in many other fields. Unfortunately, this fact is reflected in some of our transportation facilities. I applaud the efforts of TRB, the American Association of State Highway and Transportation Officials (AASHTO), and other organizations that are conducting and promoting a wide-range of transportation research.

Transportation will continue to play a critical role in Pittsburgh and throughout the country and world as we look ahead into the next Century. Many elements of the nation's transportation system are in need of repair. We must continue to explore ways to do things better. At PennDOT, we want to be known for excellence as a transportation service provider. More funding will be needed for all modes of transportation. To accomplish this goal, we must raise the visibility of transportation needs among local, state, and federal policy makers.

PennDOT and other transportation agencies must also reach out to our customers and better understand their needs. We must raise the awareness of the public and policy makers about current problems, and clearly articulate the benefits of an efficient intermodal transportation system. We need to return transportation to the national spotlight to ensure that adequate investments are made to meet future needs.

1997 will be a critical year for transportation, as Congress will be considering the reauthorization of the Intermodal Surface Transportation Efficiency Act (ISTEA). Ensuring that the reauthorization is completed in a timely fashion and that the new Act adequately provides for all modes will be important.

Welcome again to Pittsburgh and enjoy your stay. I hope you have a very productive conference over the next three days.

Overview of HOV Facilities in North America

Katherine F. Turnbull

Texas Transportation Institute

It is a pleasure to have the opportunity to provide an overview of HOV facilities in North America. A great deal has happened in the two years since the last International HOV Facilities Conference in Los Angeles. New HOV lanes have been opened, existing projects have been extended, and additional supporting services and facilities have been implemented. We have also seen continued interest in ITS applications with HOV projects and priority pricing on HOV lanes.

A number of new HOV facilities have been implemented throughout the country over the last two years. Extensions and enhancements have also occurred on many existing HOV facilities. Further, a wide-range of research projects, technology transfer activities, and new initiatives are underway.

A quick trip around North America provides an idea of the number and the nature of new HOV facilities. Starting on the east coast, concurrent flow HOV lanes have been implemented on I-80 in Morris County, New Jersey, and on I-495 (Long Island Expressway) in Suffolk County in New York. The contraflow HOV lane on I-93 (Southeast Expressway) in Boston represents the second HOV project using the moveable barrier technology.

Moving across the country, concurrent flow HOV lanes opened on I-75 and I-85 in Atlanta over the past year. The reversible barrier separated HOV lanes on I-25 in Denver represent another relatively new project.

A number of new HOV facilities have opened in Southern California, including the Harbor Transitway. This facility has on-line bus stations and connections to the Metro rail system. Other new HOV lanes have been implemented, along with extensions to existing facilities. With these additions, there are almost 2,000 lane miles of HOV facilities in Southern California.

HOV facilities also continue to be implemented in countries around the world. The experience with HOV projects in Cape Town, South Africa; Madrid, Spain; Taipei, Taiwan; and Zurich, Switzerland will all be discussed in one of the concurrent sessions.

Extensions and enhancements have been completed on a number of HOV projects throughout North America. For example, a new two level transit station has been developed at the Kuykendahl park-and-ride lot adjacent to the North HOV lane in Houston. The station includes an enhanced passenger waiting area and has improved bus operations.

METRO has also experimented with leasing and concessionaire arrangements at Houston park-and-ride lots. METRO's concessionaire program focuses on leasing space at the park-and-ride lots for various services. For example, you can have your car covered, drop-off and pick-up your dry cleaning, and buy dinner on your way home at some lots.

Interest in arterial street HOV facilities continues to be high in many areas. Major studies focusing on arterial street applications have been conducted in the Seattle and Toronto areas, and projects are being implemented in these and other locations. More information on arterial streets and projects will be presented in one of the concurrent sessions.

Priority pricing on HOV lanes represents another topic of interest throughout the country. The Route 91 Express Lanes in Southern California, which allow 3+ carpools to use the toll lanes for free, is the first real example of this approach. Possible demonstration projects allowing lower or single-occupant vehicles to use HOV facilities are being considered in Houston and San Diego. Presentations on all three of these projects will be given at the closing session on Wednesday.

The application of ITS and advanced technologies with HOV facilities represents still another topic of current interest. Many areas are exploring ways to use ITS to improve the operation and enforcement of HOV lanes. Further, ITS may enhance the convenience of using buses, carpools, and vanpools, making them more attractive options to commuters.

The Houston *Smart Commuter* Operational Test represents one example of deploying ITS to encourage greater use of the HOV lanes. The project will provide real-time traffic and transit information to commuters in the I-45 North Freeway corridor through a hand-held information device and a telephone information system.

The *Smart Commuter* demonstration, which will be implemented this fall, will monitor and evaluate commuter's use of these systems and any changes in travel behavior. Commuters may choose to take the bus or carpool in the HOV lane, to take an alternative routes, to change their departure time, or to telecommute based on the real-time traffic and transit information.

Other ITS projects are being developed with HOV facilities around the country. For example, the provision of real-time bus arrival information was tested at transit stations along the I-394 HOV lane in Minneapolis. Further, most freeway HOV lanes are included in existing or planned advanced transportation management systems (ATMS).

Bus and HOV facilities are being incorporated into various aspects of the Automated Highway System (AHS). A representative from Carnegie Mellon University will be speaking on Wednesday about the Smart Vehicle research currently underway. An AHS demonstration on the I-15 HOV lanes in San Diego is scheduled for next summer. Two Houston METRO buses will be part of this demonstration.

A number of HOV studies, research projects, and other activities have also taken place over the last two years. An *HOV Marketing Manual* was developed through the sponsorship of FHWA. The Manual highlights examples of marketing programs used with HOV facilities. It provides a discussion of the steps involved in developing and implementing a comprehensive marketing program for an HOV project.

The FHWA also sponsored a recently completed study examining techniques for predicting HOV facility demand. Assessing the potential demand for an HOV lane at different vehicle-occupancy levels is a critical part of the planning process. The results of this study, which included the development of a computer model for estimating the use of an HOV facility, will be presented during one of the concurrent sessions on Tuesday.

The development of a comprehensive HOV Systems Manual is being sponsored through the National Cooperative Highway Research Program (NCHRP). The manual will address planning, designing, implementing, marketing, operating, enforcing, and evaluating HOV facilities on freeways, in separate rights-of-way, and on arterial streets. The Manual will be discussed in two of the concurrent sessions on Tuesday and you will have the opportunity to identify issues to be included in the various chapters.

The FHWA is also sponsoring the development of HOV training courses that will be offered throughout the country. Three different courses are being prepared. These include a one-day session for policy makers and management personnel and more detailed two-day and three-day courses for technical staff. The courses will be available next year.

A great deal has been accomplished in the ten years since the first HOV Conference in Irvine, California. The TRB Committee has sponsored eight conferences over this time period. In addition to Irvine, conferences have been held in Houston, Minneapolis, Washington, D.C., Seattle, Ottawa, and Los Angeles. This conference in Pittsburgh continues to build on the success of past efforts.

Each conference has provided the opportunity to see the HOV facilities in the area, to learn from the local experience with HOV projects and related activities, and to share information with other professionals from around the world. These conferences, and other activities sponsored by the

TRB HOV Committee, FHWA, FTA, NCHRP, and other groups have helped advance the state-of-the-practice.

Many of the current topics of interest will be discussed in the concurrent sessions over the next two days. These include converting general-purpose lanes to HOV lanes, vehicle-occupancy levels, priority pricing, ITS, enforcement techniques, and the reauthorization of the ISTEA. Building on the success of past conferences, I hope you will have the opportunity to exchange ideas and learn from other transportation professionals from throughout the World. I also hope you will participate in the field trips and see the HOV, LRT, and bus facilities here in Pittsburgh. Finally, I hope you will share what you learn here with others in your area.

The last ten years have been a very challenging, successful, and enjoyable period. I look forward to working with you to continue to address the mobility, congestion, and environmental issues that face most urban areas in North America and throughout the world. By working cooperatively and collectively, we can continue to make progress in overcoming these issues. Again, welcome to the Eight International HOV Conferences. I hope you enjoy your stay in Pittsburgh and find the Conference informative and stimulating.

Federal Update

Jon Obenberger

Federal Highway Administration

It is a pleasure to have the opportunity to provide an update on several initiatives that the Federal Highway Administration (FHWA) is developing in partnership with the Federal Transit Administration (FTA). I would like to provide an overview of three Intelligent Transportation System (ITS) activities underway focusing on the ITS Metropolitan Area Model Deployment Initiative, the ITS Professional Capacity Building initiative, and the ITS Standards initiative. These represent three key programs the Department will be pursuing over the next few years.

These programs will play a major part in the implementation of Operation Time Saver, which was announced by Secretary Pena at the TRB Annual Meeting in January of 1996. The goal of Operation Time Saver is to deploy ITS and Intelligent Transportation Infrastructure

(ITI) in the 75 largest metropolitan areas as well as rural areas over the next 10 years.

ITI is comprised of a number of different technologies, when deployed as system components in an integrated manner, can improve all facets of the transportation system. This goal will require all groups, both public and private, to work together to manage travel demand in a safe and efficient manner. One key need is to better integrate planning and operating ITI into all applicable aspects of the metropolitan transportation planning process.

The Model Deployment program is currently one of the most visible federal ITS initiatives. The program focuses on deploying ITI in a test bed urban environment. Funding for the two year initiative is anticipated to be approximately \$40 million. The purpose of the Model Deployment Initiative is to assess the benefits of region-wide, integrated multimodal transportation management and traveler information systems. The benefits and experiences from the Model Deployment Initiatives will be documented and the knowledge gained from specific projects will be available to be transferred to other areas.

A total of 23 proposals were submitted to the Department in response to a request for proposals on the Model Deployment Initiative. All of the proposals were well done, and it was a difficult job to select the metropolitan areas to participate in the program. Proposals from four areas were identified to proceed to the next stage in the selection process. Contract negotiations are underway and it is anticipated that cooperative agreements will be signed by the end of September, with an official announcement of the sites in October. Projects in the four areas should remain on schedule as proposed and be in operation by December of 1997.

The second initiative is the Professional Capacity Building program, which represents a combination of training, education, and outreach. The Professional Capacity Building initiative focuses on existing and new personnel within the U.S. Department of Transportation, as well as at the State and local agencies. Targeted audiences include elected officials, agency staff, and private sector representatives, as well as in the long term, graduate, undergraduate, and other students.

A five year strategic plan is being developed to help guide the Professional Capacity Building program. An example of an activity over the next two years Executive Scannint Tours to introduce elected officials, policy makers, and managers to ITS.

Courses presenting an overview of ITS and ITI, for personnel in traffic and freeway operations, as well as design, construction, and maintenance are being developed. A series of these seminars will be offered in each FHWA region starting next year. The HOV System course, is an example of a Technical Training course being updated and will be available next year. Other courses will be developed

and offered in the future as part of the ongoing training and outreach efforts. The ITS Technical Assistance Program (ITAP) is another component of the Professional Capacity Building initiative. This program, which is jointly sponsored by FHWA and FTA, will provide peer-to-peer assistance to help meet some of the immediate technical needs of agencies throughout the country. Examples of support that could be provided through this program include assistance in developing plans, reviewing technical documents, providing resource materials, and documenting best practice case studies. The ITAP program will utilize professionals with expertise in specific areas to foster state-of-the-art transfer of information to address unique ITS challenges which may exist.

Finally, I would like to provide an update on the ITS National Architecture initiative, which was completed in the Spring of 1996. The Architecture report is intended to provide framework of how all of the system components fit together in an integrated manner and to help ensure investments made in ITI. The next steps in the ITS Architecture development process includes working with the various standard setting and professional organizations.

The National Transportation Communications for ITS Protocol (NTCIP) is a high priority for FHWA. You can find the most recent information on the development of the NTCIP is available through the FHWA Home Page on the World Wide Web. Awareness Sessions on the NTCIP are also being held throughout the country.

These programs represent just some of the more higher profile ITS efforts currently underway at the Department. There will continue to be a great deal of interest in ITS at the federal, state, and local levels in the future. The Department is committed to continuing advancement of the deployment of ITS through these and other programs by working in partnership with all potential stakeholder groups.

General Session — HOV Facilities in the Pittsburgh Area

Les Jacobson, Washington State Department of Transportation — Presiding

Overview of Pittsburgh Transportation System

Patrick Hassett

City of Pittsburgh

It is a pleasure to have the opportunity to provide an overview of the transportation system in Pittsburgh, including the HOV facilities. As the Principle Transportation Planner for the City, I am involved in most of the transportation planning activities in the area. I also have responsibility for the development of policy relating to transportation and infrastructure investments.

The population of the Pittsburgh metropolitan area is approximately 2.3 million, and there are about 1.2 million jobs. Approximately 16 percent of the region's population lives in Pittsburgh, but the City accounts for almost one-third of the employment base. Downtown Pittsburgh accounts for about a half of these workers. As a result, approximately 130,000 commuters enter and leave downtown Pittsburgh on a daily basis. There are also 25,000 students enrolled in various colleges and universities located in the downtown area, along with 3,800 residences and 15,000 to 20,000 daily visitors and shoppers.

The total daytime population of downtown Pittsburgh is between 175,000 to 200,000 people, two-thirds of whom come from outside of the City. The roadway and transit system in Pittsburgh has been developed primarily as a radial network focusing on the downtown area. The transportation system can be characterized as a paired network of radial highways and high capacity transit lines.

The I-376 Freeway and the Martin Luther King, Jr. East Busway serve the eastern part of the area. The I-279 Freeway and the I-279 HOV lane serve the area to the north. The Airport Busway, which is currently under construction will provide access from the west. There is no freeway serving the southern portion of the metropolitan area, but there are two major high capacity transit facilities located in this corridor. These are the light rail line serving the South Hills area and the South Busway serving the southern communities. Other projects under consideration include a toll road in the southeast part of the metropolitan area and an extension to the Martin Luther King, Jr. Busway.

In addition to the busways, HOV lanes, and LRT lines, we also have a number of supporting programs to encourage the use of all types of alternative commute modes. These include transit and rideshare marketing programs, parking strategies, and other activities. These programs focus on supporting the infrastructure and related investments that have been made to accommodate HOV traffic.

The HOV facilities in Pittsburgh can be examined on three different levels. At the basic level, HOVs operate in mixed traffic with some special considerations. These

include bus pull-ins at major boarding points and priority for buses at some traffic signals. For example, the green time at selected intersections can be extended for buses along specific routes.

The second level is a dedicated lane. In this case, a lane is reserved specifically for HOV vehicles, which could include buses, Light Rail Vehicles (LRVs), and carpools and vanpools. These facilities still require HOVs to pass through controlled intersections, although priority treatment may be provided at some signals.

Exclusive facilities represent the third level of HOV facilities found in Pittsburgh. These provide HOVs with exclusive lanes for a major portion of the trip. The busways, LRT lines, and the I-279 HOV lane represent exclusive facilities. In some cases, like the Mount Washington Tunnel, buses and LRVs share an exclusive right-of-way.

The HOV facilities have been developed for three main reasons. First, we hope to provide HOVs with a safe and free flowing environment to encourage commuters to change from driving alone. The busways and LRT lines provide a convenient and effective system of high capacity public transit services. Second, the HOV facilities help address issues related to the environment, traffic congestion, and parking demand. Third, the HOV facilities help improve traffic flow and traffic control, especially in the downtown area.

Downtown Pittsburgh Contraflow Bus Lanes

Darryl Phillips

City of Pittsburgh

It is a pleasure to have the opportunity to tell you about the contraflow bus lanes in downtown Pittsburgh and the surrounding area. Although the bus lanes have been developed over the years in response to specific constraints and opportunities, they provide a comprehensive system of priority treatment for buses in downtown Pittsburgh and in the Oakland area.

If you have had a chance to look around the downtown area, you know that traffic congestion is a problem. Approximately 175,000 to 200,000 workers, shoppers, students, and visitors enter and leave the downtown area each day. As a result, bus, automobile, and pedestrian volumes are high in the downtown area. The street capacity downtown is limited. Most streets are 36 feet wide, but some are narrower.

The first attempt to provide priority treatment for buses occurred in the mid-1970s when the curb lane on Stanwick Street was converted into a bus-only lane. Stanwick Street

is one of the widest streets in downtown Pittsburgh, but it is also very short. Due to a number of operational problems, this project was terminated. These included conflicts with vehicles stopping in the lane to drop off and pick-up passengers and goods, as well as vehicles using the lane for right turns.

To address these problems, a second project was implemented using a contraflow bus lane on Fifth Avenue. Based on recommendations from a study, Fifth Avenue was changed from a two-way street to a one-way street with a contraflow bus lane. Bus routes in the downtown area were consolidated to operate along Fifth Avenue. The facility proved to be successful and led to the implementation of a number of other bus lanes.

A study was also conducted in the mid-1970s on traffic flow along Forbes Avenue and Fifth Avenue connecting downtown with the Oakland area. As a result of this study, both avenues were converted into one-way pairs. Forbes Avenue, which serves east bound traffic, is very congested due to a bridge crossing and a freeway exit point. To provide buses with priority around this bottleneck, a contraflow bus lane was implemented on Fifth Avenue. This facility has been very successful and seems to have been accepted by the community.

Major redevelopment activities during the early 1980s lead to the implementation of additional downtown bus lanes. Major traffic disruptions were anticipated during the "Renaissance Two" redevelopment, which included the construction of new office buildings and the subway. Wood Street and Smithville Street, which were one-way pairs with streetcars lines were converted to operate with a contraflow bus lane. The downtown construction activities did not impact these streets, and the contraflow bus lanes provided the opportunity to consolidate bus routes and to provide buses with significant travel time savings. The project did require the relocation of loading zones and on-site parking spaces, but it proved to be very successful. The contraflow bus lane was recently extended an additional block. This extension has provided better routing for buses circling back through the downtown.

Shortly after the contraflow bus lanes on Smithville and Wood Streets were implemented, the Fifth Avenue bus lane in the Oakland area was extended through the Oakland business district and the University of Pittsburgh. This extension has been successful, although there have been conflicts between buses and pedestrians. These problems are partly the result of narrow sidewalks, heavy traffic volumes, and jaywalking pedestrians.

The Penn Avenue bus lane is the most recent addition to the downtown network. A bus lane was operated on Penn Avenue in the early 1980s when Liberty Avenue was closed for construction of the subway. This facility was successful, but when Liberty Avenue was reopened, buses were shifted

back to their previous routes and the contraflow lane was opened to general traffic.

The operations of the bus lanes have been modified over time. For example, portions of some of the bus lanes have been opened to general traffic to provide for turning movements at selected intersections. The experience in Pittsburgh indicates that contraflow bus lanes can be used successfully in downtown areas and other neighborhoods. Bus lanes provide a flexible alternative to enhancing bus operations and general-purpose traffic flow.

The experience in Pittsburgh also indicates that as a general guideline, a contraflow bus lane may be justified if at least 70 buses an hour operate on a street. A facility becomes congested if there are over 100 buses an hour. Although the capacity is available to accommodate over 100 buses, operation of the lane may break down when buses stop to drop off and pick up passengers. Providing adequate space for passenger waiting areas on the sidewalk may also be a problem.

Some safety issues have been experienced with the bus lanes. Pedestrian conflicts have been a problem at a few intersections with high volumes of turning buses. The removal of on-street parking spaces caused concerns among businesses, but in most cases we were able to provide alternative parking close by. There was some opposition from the public when the first lanes were implemented, but in general the facilities have been well received.

The Port Authority and the City are currently examining the bus lanes and bus operations in the downtown area. This study is being conducted to determine if any changes should be made in the facilities or in bus operations, and to ensure that the lanes continue to provide safe and effective service.

I-279 Freeway HOV Facility

Tom Fox

Pennsylvania Department of Transportation

It is a pleasure to talk about the only freeway HOV facility in operation in the Commonwealth of Pennsylvania; the HOV lane on the I-297 Freeway on the north side of Pittsburgh. When planning for the I-279 Freeway started in the 1970s it was realized that the facility, which was to connect the rapidly growing area of North Hills to downtown Pittsburgh, would not be able to meet projected demand levels. Including an HOV lane in the freeway design was determined to be the best approach to meet future travel demands in the corridor. The freeway and HOV facility were opened in the fall of 1989.

The I-279 HOV lane connects downtown Pittsburgh with the North Hills area. There are three access points for the facility in downtown Pittsburgh. One entrance and exit point is at Three Rivers Stadium, home of the Pittsburgh Pirates and the Pittsburgh Steelers. This access point allows people going to and leaving the stadium to use the HOV facility. A second access point is at the Civic Arena on the edge of the downtown area, which is the home of the Pittsburgh Penguins hockey team. The third access point is at the Ninth Street Bridge on the north side of Pittsburgh. There is also a slip ramp that connects the I-279 HOV lane to the freeway general-purpose lanes. There are three access points in the North Hills area. These are a slip ramp at the start of the HOV lane, a ramp at the Perrysville park-and-ride lot, and a ramp at McKnight Road.

The I-279 HOV facility is a single-lane reversible barrier separated lane. It operates in the inbound direction, toward downtown Pittsburgh in the morning and in the outbound direction away from downtown in the afternoon. The access points are manually opened and closed at the start and end of each operating period. There is an operations cabinet located at each entrance and exit point. The individual responsible for opening and closing the facility must stop at each cabinet. Inside the cabinet are three buttons for inbound, outbound, and closed. The operator pushes the appropriate button which starts the sequence of gates and changeable message signs to open or close the facility. The operator is able to monitor the lights for each gate to make sure they open or close and to ensure that the changeable message signs contain the correct information.

The changeable message signs and traffic signals located at each entrance point provide information to motorists on the status of the facility. If you were approaching an entrance during the correct operating period, the changeable message sign would read open and the traffic signal would be green. If you were approaching the same entrance when the facility was closed or when it was operating in the other direction, the traffic signal would

be red and the changeable message sign would read closed or wrong-way.

The I-279 HOV lane was opened in the fall of 1989, with a vehicle-occupancy requirement of three or more persons (3+). Initially about 180 vehicles were using the lane during the peak-period. This figure increased to about 300 vehicles over the first few years of operation. In 1992 the vehicle occupancy level was lowered to two or more persons (2+) due to a construction project in the corridor. During this period use of the facility increased to approximately 1,100 vehicles during the peak-period.

The use of the Perrysville park-and-ride lot has also increased over the years. When the HOV lane was first opened, only about 20 cars were using this facility. There has been a steady increase in use, and the lot has been expanded. Today, the facility is filled on most days.

In the first six years of operation, only one reported accident occurred. This accident occurred when a woman who normally used the HOV lane left work in the morning because of a sick child. She took her normal route, which included turning into the entrance of the HOV lane at one of the downtown access points. Obviously, the lane was still operating in the inbound direction at that time of the morning. The woman apparently missed all of the warning signs, and a minor accident with a vehicle traveling in the correct direction resulted. There were no injuries associated with the accident.

On August 25, 1995 a major accident did occur on the facility, which included fatalities. At about 11:50 a.m., the operator went out to reverse the HOV lane, which was working in the in-bound direction. The normal sequence to reverse use of the facility is to close the access points from the north to the south and then reopen the lane from the south to the north. For some reason, that only the operator knows, he mistakenly opened the southbound gate at Three Rivers Stadium at about 11:50 a.m. At that moment, a two direction flow was in operation on a single lane. The individual realized his mistake and speed northbound in hopes of closing the other access points.

An automobile with six people entered the lane at the Three Rivers Stadium access point in the northbound direction shortly after the operator had mistakenly opened this gate. The irony of the situation is that the driver and passengers, which were going to lunch, did not want to enter the HOV lane. They had become lost looking for a restaurant, and at about 11:50 a.m. followed the operator onto the HOV lane heading northbound. At the same time a pickup truck had entered the HOV lane in the southbound direction at North Hills. Witnesses report that the pickup truck was traveling at a high rate of speed. These two vehicles collided head-on at about mid-point of the HOV lane. Four people lost their lives at the accident scene, and two others died later from injuries. The individual that opened the HOV lane has pleaded guilty to six counts of

involuntary manslaughter and two counts of reckless endangerment. He will be sentenced later this year.

As a result of this tragic accident and other unconfirmed reports of motorists entering the HOV lane in the wrong direction, the Pennsylvania Department of Transportation (PennDOT) closed the facility for a period of time in early 1996 to reevaluate the operating procedures. A number of changes were made to safeguard the facility to prevent wrong-way movements as a result of this reevaluation. After users of the facility complained when the lane was closed for the two week reevaluation, the changes were implemented and the lane was reopened to traffic.

A number of changes were made as the result of the accident and the reevaluation. First, the hours of operation were reduced, since many of the wrong way movements were reported in off-peak times of the day. The facility is now open from 6:00 a.m. to 9:00 a.m. in the inbound direction. The lane is closed between 9:00 a.m. and 4:00 p.m. The lane is reopened in the outbound direction at 4:00 p.m. and operates until 7:00 p.m. A 2+ vehicle-occupancy requirement is used.

The one variation to this procedure is if there is a sporting event or other major activity at Three Rivers Stadium. In these cases the HOV lane remains open longer in the evening to allow people leaving the stadium to use the facility. The lane is also open on weekends in the outbound direction. Thus the only time the lane operates in the inbound direction is weekdays from 6:00 am to 9:00 am.

Additional changeable message signs were installed along the facility, and red flashing lights were added at the North Hills access point to advise people when the lane is closed to inbound traffic. Message signs were added at other access points, including no right-turn or no left-turn signs at key entrances. An educational campaign was undertaken to inform users about the new safety features.

Additional procedures were implemented for the operators responsible for opening and closing the lane. Two operators are now used to close the lane, and they are required to call-in from the cabinets at each of the 6 access points to verify their location to the supervisor. The call-in time is recorded to help ensure that the correct procedures are being followed. Security guards, under contract to PennDOT, were also hired to monitor the three entrance and exit points in downtown Pittsburgh. These personnel are stationed at the access points in the morning when the facility is operating in the inbound direction to help provide extra insurance against possible wrong way movements.

Finally, a plan to monitor the entire facility by a closed-circuit television system is being implemented. Monitoring the control cabinets and the lane opening and closing procedures will be centralized at PennDOT District office. A wrong-way vehicle detection system will be installed, and

a series of overhead lane control signs will be added along the entire length of the HOV lane.

Until last August, the I-279 HOV lane had a safe operating history. In response to the accident, additional safeguards are being added to the facility. With these enhancements, we hope the facility will continue to operate in a safe and effective manner.

The Pittsburgh Busways

Allen Beihler

Port Authority of Allegheny County

It is a pleasure to provide an overview of the busways in the Pittsburgh area. The approach taken in Pittsburgh is somewhat unique in the United States. We have two busway facilities currently in operation and a third in the development stage. The East or Martin Luther King, Jr. Busway and the South Busway have been in operation since the 1970s and 1980s. The Airport Busway/Wabash HOV facility is currently under construction.

The Port Authority of Allegheny County (PAT) provides transit service in a 700 square mile region. PAT operates four basic types of services; regular route buses, light-rail transit (LRT), two inclines, and paratransit services. The bus system represents the major focus of the system. The LRT system is relatively small, but it is an important part of the overall system. Currently, 19 miles of the 25 mile LRT system are in operation, with a portion still under rehabilitation. The two inclines, which were rebuilt a few years ago, operate on Mount Washington. The final element of the system is the paratransit service which carries almost 2 million riders a year. Ridership levels on the paratransit system are the highest of any system in the United States.

Bus service represents the major element of the system, accounting for almost 85 percent of the total system ridership. Operating reliable bus service in an area that is restricted by narrow streets, limited river crossings, hilly terrain and tunnels, and winter weather with a good deal of snow, is difficult. In response to these challenges, PAT has developed a system of exclusive rights-of-way for buses over the years. This approach provides much more reliable service for customers and is more cost-effective for PAT.

The contraflow bus lanes in downtown Pittsburgh and in the Oakland area were the first bus-lanes in the area. Currently, some 60,000 riders a day are carried on these facilities. The total daily system ridership is about 260,000 passengers. Thus the lanes have improved service to a significant number of riders. They have also enhanced PAT's operating efficiency. The lanes help ensure that our buses provide quick and reliable service.

The South and the Martin Luther King, Jr. East Busways provide good examples of the concept of bus rapid

transit. The busways have made significant improvements in bus travel times and travel time reliability. They also provide transit with a competitive advantage over the automobile, especially during the congested peak-periods.

The South Busway was opened in 1977. Although it is only four miles long, it allows buses to bypass major congestion points. The busway is an exclusive two lane facility. A number of bus routes were reoriented to the busway when it was opened to provide travel time savings and travel time reliability to additional riders.

Commuters have responded favorably to the busway, and ridership has increased on buses using the facility. Currently some 10,000 to 11,000 passengers are carried on a daily basis. Ridership has been as high as 19,000 passengers a day. Ridership declined when a critical bridge into downtown Pittsburgh was restricted, but ridership has been increasing since the bridge was reopened to buses.

Both on-line and off-line stations are provided along the South Busway. Off-line stations include space for buses to pull over to pick-up and drop-off passengers, allowing other buses to pass, while other stops are directly on-line. A segment of the busway right-of-way, including the Mount Washing Tunnel, is shared with the LRT line. This joint operation has worked well.

The Martin Luther King, Jr. Busway is located in the eastern part of the City. The busway is 6.8 miles long and was opened in 1983. It is located adjacent to a Conrail railroad line. At one point, four railroad tracks were in operation in the corridor. Two tracks were consolidated and the remaining two tracks were relocated to one side of the corridor, providing room for the construction of a two lane busway.

The East Busway provides significant travel time savings for buses operating in the corridor. Previously, it took buses an average of 35 to 40 minutes to travel from the end of the busway to downtown Pittsburgh. With the busway, this same trip now takes 15 minutes or less. Ridership on the busway grew from some 20,000 daily passengers to 30,000 as a result of these travel time savings.

The stations along the East Busway are relatively simple. Pedestrians are allowed to cross the busway at stations. Although the busway is well used, bus volumes are lower than vehicle volumes on most arterial streets. As a result, passengers are allowed to use designated crosswalks at stations.

The longest route using the East Busway is approximately 36 miles. This route services one of the further out areas. In general, most buses serve the neighborhoods directly along the route or in a 10 mile area around the last station. No park-and-ride lots were built with either the East or South Busways, but future plans call for the addition of park-and-ride facilities.

The I-279 HOV lane also represents an important component in the bus rapid transit system in Pittsburgh.

Routes serving the North Hills area have been reoriented to use the HOV facility. Ridership increases of between 30 and 50 percent were experienced when the service was changed to the HOV lane.

The Airport Busway/Wabash HOV facility is currently under construction. This project was initiated as a result of the new airport, the heavy development in the Parkway West corridor, and the major reconstruction project on the Fort Pitt Bridge. This bridge carries some 145,000 vehicles a day into and out of the downtown area. There was a push to build the first phase of the Airport Busway/Wabash HOV facility to help manage traffic during the reconstruction of the bridge. This section of the facility is approximately 7 miles in length from downtown Pittsburgh to the Parkway West corridor. The section includes a new bridge and use of an abandoned railroad line for an HOV facility.

When the project was first discussed, it was proposed as a bus-only facility. During the project development stage, the use of the abandoned railroad tunnel and allowing vanpools and carpools to use the facility were added. Thus, the project now includes a bus-only portion in the Parkway West corridor and an HOV segment closer to downtown. The project will also include park-and-ride lots and other supporting components.

An extension to the East Busway is also being developed. The first phase of the extension is a little over 2 miles in length. The project also includes new park-and-ride facilities and on-line stations.

All of these components are important parts of the overall transportation system in the Pittsburgh area. The busways, HOV lanes, LRT lines, and supporting elements provide travel time savings to transit passengers, carpools, and vanpools. They represent successful approaches to providing travel options to commuters and help manage traffic congestion in the area.

Regional HOV Incentives

Chuck DiPietro

Southwestern Pennsylvania Regional Planning Commission

I would like to welcome you to Pittsburgh. As you have heard from the previous speakers, there are a number of different HOV facilities operating in the area, and more are in various stages of planning, design, and construction. Like other areas, we face the ongoing challenge of promoting bus use, vanpooling, and carpooling.

Commuting patterns in Pittsburgh reflect the nation's trends of reliance on the automobile and increases in suburb-to-suburb travel. While transit ridership has remained stable, transit's share of all commute trips is eroding. Transit ridership is very strong in the core areas of the city, but not in suburban areas.

On a national level, work trips by carpool have declined by some 17 percent over the last decade. Using transit for work trips has declined by 12 percent. Commute trips by walking have declined from 6 percent to 4 percent. On the other hand, commute trips made by driving alone have increased from 64 percent to 73 percent, a growth of 14 percent.

The challenge we face is how to reverse these trends and attract commuters back to all forms of high-occupancy vehicles. Experience in the Pittsburgh area indicates that travelers will use transit and ridesharing when services are targeted to their commute needs and patterns. Creative approaches will be needed to provide services to new markets.

The partial closing and two-year reconstruction of the Fort Pitt Bridge, which will also involve four years of related advanced construction projects provides the opportunity to develop and implement a comprehensive program to promote HOV use. Thirty different projects are part of the Fort Pitt Bridge reconstruction. These projects will impact commuters and travelers in many corridors.

The Commuter Connection Program was developed by the Southeastern Pennsylvania Regional Planning Commission in conjunction with PennDOT, Port Authority Transit, the City, and other jurisdictions and groups. The purpose of Commuter Connection is to provide travelers with reasonable alternatives to driving alone. The program provides a comprehensive set of TDM strategies. Program elements include transit services, ridematching services, guaranteed ride home programs, park-and-ride promotions, third party vanpool subsidies, transit check and bus pass subsidies, bicycling and walking promotions, alternative work schedules, and telecommuting.

The ridesharing program in Southwestern Pennsylvania was initiated in 1974 during the gasoline crisis. The vanpool program was also started at that time, with promotions and marketing continuing today. Currently, there are some 70 vanpools operating in the program. The rideshare database currently has approximately 2,500 active commuters. A new ridematching computer system, which includes both hardware and software, is being purchased. We hope to increase the rideshare database to over 20,000 active commuters with this new system and the additional marketing activities.

Specific program elements are being tailored to individual employers, major employment areas, and activity centers within the City of Pittsburgh. We realize that no one approach will work for all areas or all commuters. Thus, the program tries to match commuters with the services and strategies that best meet their needs.

Luncheon

Dennis Christiansen, Texas Transportation Institute — Presiding

William Millar
General Manager
Port Authority of Allegheny County

It is a privilege to join you today. I am glad that the TRB HOV Systems Conference is in Pittsburgh this year. We are always happy to have visitors, and it is a pleasure to have the opportunity to show you our bus systems, HOV facilities, and LRT system. We also hope to learn from the experiences with HOV projects throughout the country and world.

The Port Authority of Allegheny County (PAT) is a multimodal transit agency. PAT is the fourteenth largest transit system in the country. We have one of the most comprehensive multimodal systems in the nation. PAT operates approximately 880 buses, an LRT system, and two inclines. The inclines serve not only tourists, but also a large number of commuters. For example, in 1995 almost 1 million riders used the Monongahela Incline. Over half of these passengers were commuters who use the incline on a daily basis.

PAT also operates the ACCESS system, which provides paratransit services to individuals with special needs. ACCESS was started in 1979 and is the largest paratransit system in the country. In 1995, ACCESS provided 2.1 million rides. The success of ACCESS illustrates the importance of listening to your customers, developing a realistic service plan, and building long-term political support.

In the last 20 years we have learned a great deal about how to make arterial street HOV lanes, busways, and freeway HOV facilities work. We have gained valuable experience in planning, designing, operating, and maintaining these facilities. We have also learned the importance of building public and political support for projects.

Even though the Pittsburgh area experienced a 13 percent decline in population between 1980 and 1990, the average commute trip length and vehicle miles of travel increased. As a result, traffic congestion continues to be a problem in the area, especially in corridors restricted by tunnels and bridges. We have used a number of different approaches to address these problems. Many of these techniques build on the area's traditional strengths. For

example, public transit has always been an important part of the transportation system in Pittsburgh and ridership has historically been strong. Currently, almost half of all downtown workers use transit on a daily basis.

In addition to losing population during the 1980s, the economy of the Pittsburgh area also suffered. As a result, maximizing existing resources has been a major focus for PAT and other agencies in the area. Reusing existing railroad rights-of-way for the busways is one example of this approach. The South Busway includes a portion of right-of-way that is shared with the Norfolk and Western Railroad. The Martin Luther King, Jr. East Busway is on part of the right-of-way of the old Pennsylvania Mainline Railroad and shares an active Conrail right-of-way. The new Airport Busway will share a right-of-way that has been abandoned for over 40 years. All of these projects provide good examples of the reuse of existing resources.

Partnering with other agencies represents another key to successful projects in the Pittsburgh area. The Airport Busway provides an excellent case study in multi-agency cooperation. The Airport Busway started out primarily as a PAT project for buses only. PennDOT became interested in the busway as a result of the need to reconstruct the Fort Pitt Bridge. The Airport Busway has evolved and grown into a multi-agency project that includes both HOV and bus-only components. The busway is also being designed so that it can be converted to LRT in the future if needed.

The I-279 HOV facility is another example of multi-agency cooperation. Although I-279 is a PennDOT project, the HOV lane has provided significant benefits to transit. When the HOV lane opened in 1989, buses in the corridor were rerouted to use the facility. Ridership increased significantly as a result of the improved travel time and the travel time reliability offered by the HOV lane. Bus travel times were reduced by about 10 minutes through use of the HOV facility. Ridership increased by almost 50 percent after the lane was opened.

The I-279 facility also points out the need for an ongoing monitoring program to document the results of policy changes and other improvements in a corridor. When the I-279 HOV lane was first opened, there were only two adjacent general-purpose freeway lanes. These lanes experienced significant levels of congestion. A 3+ vehicle-occupancy requirement was in use on the HOV lane initially. Lowering the occupancy requirement from 3+ to 2+, which was a policy decision, resulted in increased carpool volumes. Many of these new carpools were composed of former bus riders, however, resulting in ridership losses on routes in the corridor. A third lane was also added to the freeway during the same period, further reducing incentives to use the bus or carpool.

The impacts of these two changes point out the need to study the implications of policy and operational decisions on the use of HOV facilities. Bus ridership fluctuated in

response to these changes. Passenger volumes are now back to the levels experienced before the vehicle-occupancy requirement was lowered and the third general-purpose lane was added. The I-279 HOV lane has been a success from a transit point of view.

I hope you will have a chance to see the bus, HOV, and LRT facilities in the area. I also hope you enjoy the Conference and your stay in the Pittsburgh area.

General Session — A Look to the Future — Priority Pricing on HOV Lanes

Katherine F. Turnbull, Texas Transportation Institute

91 Express Lanes

Jerry Porter

California Private Transportation Company

Mr. Porter discussed the implementation and operation of the Route 91 Express Lanes in Orange County, California. He summarized the legislation authorizing the toll facility, the financing package, the development and implementation process, and the initial operation of the facility. Mr. Porter covered the following points in his presentation.

- ! The Route 91 Express Lanes were one of four special toll facilities authorized by the California Legislature in 1989. A franchise agreement, creating the California Private Transportation Company, was signed in December of 1990, and construction began in July of 1993. The facility was open to traffic in December of 1995.
- ! The total cost of the project was approximately \$126 million. Financing for the facility came from a number of different sources. These included a consortium of four banks, CIGNA, equity investments by the California Private Transportation Company, and coordinated debt from the Orange County Transportation Authority.
- ! The Route 91 facility includes two lanes in each direction of travel, located in the median of SR 91. The facility is 10 miles in length. The lanes are equipped with a fully automated electronic toll collection system. A congestion pricing or variable pricing strategy is used on the lanes. Currently, tolls vary by time of day based on a published schedule. The lowest toll is \$.25 and the highest is \$2.50 during the morning and afternoon peak-hours. A real-time toll pricing strategy will be implemented in the future, with the fees tied to the level of congestion on the facility. Carpools and vanpools with 3 or more persons can use the facility for free.
- ! All vehicles using the Express Lanes must have a toll tag located on the front windshield. These tags must be purchased in advance. The tags are read each time a vehicle enters the lane, and the toll charge is automatically subtracted from the pre-paid account on the tag. Carpools using the facility must have a toll tag, but they are not charged a fee. Enforcement of the occupancy requirements is done visually as the carpools enter the facility. Enforcement of the toll offense is done electronically. In both cases, tickets are issued by mail. The offense is similar to a parking ticket. The fine is \$100 for the first offense and goes up to \$500 for repeated offenses.
- ! Approximately 60,000 toll tags have been placed since the Express Lanes opened in late 1995. Caltrans has been monitoring traffic volumes, and it appears that SR 91 is operating as well as it has at any point in the past 20 years.
- ! There appear to be a number of reasons for the successful implementation and operation of the Route 91 Express Lanes. First, the environmental approvals were well underway when the project started. Second, there was strong local support for the facility. Third, use of the existing right-of-way in the freeway median simplified the development process. Fourth, the lanes added capacity in the corridor. Fifth, construction of the Express Lanes was relatively easy and no major problems were encountered. Finally, vehicle volumes on the facility have been good from the start.
- ! The Route 91 Express Lanes indicate that commuters will pay for better service. It also appears that 3+ carpools will form to take advantage of the financial incentives. There are issues with this approach, however. The political climate in many areas may not favor toll facilities. There also may be physical constraints in many corridors that limit this approach and the need for intermediate access points in many areas may increase costs. In addition, enforcement is needed, which requires additional personnel and financial resources.
- ! Policy issues that may need to be addressed include social equity concerns and the perception that toll facilities are only for the rich. It also appears that keeping the fee structure simple and easy to understand is important. It is also important to remember that not all projects are the same, and that the revenue expectations may vary significantly between areas.
- ! Key elements to the success of the Route 91 Express Lanes include teamwork, extensive studies, flexibility, good working relationships among all the groups involved, a firm fixed price, and patience. It is important to remember that if this approach was easy, everyone would be doing it.

Katy HOV Lane Priority Pricing Project

Bill Stockton

Texas Transportation Institute

Mr. Stockton discussed the priority pricing project being considered on the I-10 West (Katy) Freeway HOV lane in Houston. He provided an overview of the feasibility study, potential approaches being examined, and the current status of the project. Mr. Stockton covered the following elements in his presentation.

- ! The priority pricing study on the Katy HOV lane is being conducted jointly by the Metropolitan Transit Authority of Harris County (METRO) and the Texas Department of Transportation (TxDOT). The initial feasibility study is funded by METRO and FHWA, and is being conducted by the Texas Transportation Institute (TTI) and LTK Consultants. TxDOT and METRO are responsible for different aspects of the HOV facilities in Houston. TxDOT owns and maintains the HOV lanes, and METRO is responsible for operating the lanes and owns and operates many of the supporting facilities and services.
- ! The study represents one of the priority pricing projects being funded by FHWA as a result of the ISTEA. The purpose of the project is to test the potential to allow carpools with two or more occupants (2+) to use the HOV lane for a fee during the morning and afternoon peak hours when an occupancy requirement of 3 or more persons (3+) is in effect.
- ! The Katy HOV lane is the only HOV facility in the country that utilizes a variable vehicle-occupancy requirement. A 2+ vehicle-occupancy requirement is used during all operating periods except the morning and afternoon peak hours when a 3+ requirement is in effect. These changes were implemented as a result of congestion on the HOV lanes at the 2+ level. In order to maintain the travel time savings and the travel time reliability HOV users had come to expect, the vehicle occupancy requirement was initially raised to 3+ during the morning peak hour, and later during the afternoon peak hour. There is available capacity for additional vehicles at the 3+ level, however.
- ! Priority lane pricing is viewed as one possible approach to managing demand on the Katy HOV lane. Secondary objectives are to increase the overall vehicle occupancy levels in the corridor and to change the perception of some commuters that the HOV lane is underutilized.
- ! A number of key elements are being examined during the feasibility study. These include assessing the available capacity and the potential demand at different pricing levels, legal issues, and public reactions. A variety of potential operating strategies are also being explored, including manual and automated techniques. A major question is how many 2+ carpools will use the facility at different pricing levels. This analysis is critical to ensure that the lane does not become congested again as a result of the demonstration.
- ! The analysis indicates that capacity is available during the morning and afternoon peak hours for additional vehicles. It is anticipated that the 2+ carpools selecting to use the HOV lanes for a fee will be a combination of existing 2+ carpools in the general-purpose lanes and new carpools formed to take advantage of the demonstration. It would not be beneficial if 3+ carpools break down into 2+ carpools, however.
- ! Both manual and automatic operating scenarios are being considered. One issue is how to spread the use of the HOV lane by 2+ carpools over the peak hour. Significant congestion could occur if all the new 2+ carpools try to enter the lane at approximately the same time. The automated approach would use the same toll tags and technology currently in use on the Harris County Toll Roads in the Houston area.
- ! A number of legal and institutional issues were examined in the assessment. These included the ability to charge for use of the HOV lane, the ability to enforce fines and penalties associated with not paying the toll, and other policy changes needed to implement a demonstration. The other analysis indicated that METRO has the authority to charge for use of the lanes under specific conditions, that the fines are enforceable with minor modifications to local ordinances, and that there are no critical policies prohibiting a demonstration.
- ! Like other priority congestion pricing projects, the most critical issue is public acceptance or public tolerance. A review of the national literature indicates that the key issues appear to be social equity, double taxation, and how the revenue is used. Two focus groups were conducted in Houston as part of the feasibility study. One focus group was comprised of commuters who use the Katy Freeway and the other composed of residents throughout Houston. The preliminary results indicated that both focus groups were somewhat skeptical about the concept. Both groups were also interested in how the revenue from the demonstration would be spent. The participants also indicated they would use a

priority pricing project occasionally. This information was of help in assessing various pricing strategies.

- ! The focus group results also indicate the need for a strong public information and marketing program as part of the demonstration. A key element of this program should focus on explaining how the project revenues will be used. Providing feedback to commuters during the project was also identified as important by the focus group participants, as was providing visible benefits from the test.
- ! It is anticipated that METRO and TxDOT will make a decision on whether to implement the demonstration by the end of the year. If a decision is made to move ahead with a test, the first phase manual demonstration could be in operation by the middle of 1997.

I-15 Freeway HOV Lanes Congestion Pricing Project

Mario Oropeza

San Diego Association of Governments

Mr. Oropeza discussed the congestion pricing project on the I-15 Freeway HOV lanes in San Diego. He summarized the background of the study and the current status of the project. Mr. Oropeza covered the following elements in his presentation.

- ! The I-15 HOV lanes are located approximately 10 miles north of downtown San Diego. The I-15 Freeway HOV Lane Congestion Pricing project is an HOV buy-in demonstration. The project is one of the federally funded congestion pricing demonstration grants authorized in the ISTEA.
- ! The San Diego Council of Governments (SANDAG) is the lead agency on the project in cooperation with Caltrans, which owns and operates the I-15 HOV and freeway facilities. The other major participants are the Metropolitan Transit Development Board (MTDB), which is responsible for developing a transit operating plan to use the project revenues, and the California Highway Patrol (CHP), which is responsible for enforcement.
- ! The I-15 HOV lanes are approximately 8 miles in length. The lanes are located in the median of the freeway and are separated from the general-purpose lanes by concrete barriers. The lanes are reversible, operating inbound in the morning peak-period and outbound in the afternoon peak-period.
- ! The HOV lanes operate at a level-of-service F. The initial analysis indicated that 4,000 to 5,000 vehicles could be added to the HOV lanes during the peak-period, and almost 1,000 vehicles could be added during the peak hour.
- ! The idea for the demonstration originated as part of the examination of potential transportation control measures in the regional air quality plan. The I-15 Corridor Committee identified three major problems in the corridor. These included traffic congestion in the general-purpose lanes, available capacity in the HOV lanes, and the need for expanded transit services.
- ! Thus, the impetus for the project came from the local level. The concept was also supported by the mayor of a suburban community in the corridor. This individual was elected to the State Assembly and sponsored the enabling legislation needed for the demonstration project.
- ! The proposal for the demonstration project is to allow single-occupant vehicles to use the facility for a fee. Initially, a monthly charge will be assessed, but it is anticipated that a variable fee scale based on the level of congestion in the general-purpose lanes and the travel time savings provided by the HOV lanes will ultimately be used. Carpoolers will continue to use the facility for free. The enabling legislation for the project requires that a level-of-service B or Caltrans HOV lane standard be maintained on the HOV lanes.
- ! The objectives of the demonstration project are to test congestion pricing as method of managing congestion on the freeway lanes, managing demand on the HOV lanes, expanding transit and rideshare services in the corridor, and enhancing air quality in the region. Three major benefits are expected to be realized from the test. These include improving travel times for single-occupant vehicles paying to use the HOV lanes, improving traffic flow in the freeway general-purpose lanes, and expanding transit and carpool services.
- ! Four major groups will be affected by the project. The first group is single-occupant drivers who select to use the HOV lanes for a fee. These individuals should experience a faster commute, with travel time savings of six to nine minutes in the peak-periods. The second group is commuters using the mixed flow traffic lanes. Traffic flow should be better for these individuals as a result of other commuters diverting to the HOV lanes. The third group is carpoolers, vanpoolers, and bus riders. These individuals will still realize the travel time savings and the travel time reliability offered by

the HOV lanes. Additional services, such as new park-and-ride facilities, new transit routes and increased bus frequencies, and cash incentives for carpoolers and vanpoolers, are anticipated to be offered. Bus riders represent the final group. As noted, these commuters will still receive travel time savings and travel time reliability, as well as improved bus services.

- ! It is anticipated that the project will be implemented in two phases. The first phase is implementation planning. The major activities during this phase include refining the scope, schedule, and budget for the demonstration and developing operating plans for the interim test and final project. The interim operations will be implemented and bid documents will be prepared for the fully automated project phase. Single-occupant vehicles will be allowed to use the HOV lanes during the interim operations for a monthly fee. Two payments options are currently being explored. These are a monthly decal and an automatic vehicle identification (AVI) tag. A fixed fee, which has not yet been set, will be used during the initial operating period. It is anticipated that the monthly fee will be similar to the cost of a monthly bus pass.
- ! The second phase of the project represents full implementation of the demonstration. During this phase the AVI toll collection and enforcement system will be installed and operated. At this point it is anticipated that a variable fee structure will be implemented for single-occupant vehicle use of the HOV lanes. The exact charge will depend on the time of day, traffic congestion levels, and estimated travel time savings. The additional transit and ridesharing services will also be implemented during this phase.
- ! The implementation planning phase is currently underway. This phase is scheduled to be completed by the fall of 1997, with the interim operations initiated in November of 1997. The second phase will begin as soon as the design documents are completed.
- ! The public involvement components of the project include a Community Advisory Committee, news releases, periodic publications, and presentations. Additional strategies are being used to communicate with other groups that may not be reached by the more traditional approaches.

General Session — A Look to the Future — ITS and HOV Facilities

Katherine F. Turnbull, Texas Transportation Institute

Booz Allen

Mr. Subramaniam provided an overview of the transportation system used during the Olympics in Atlanta. He discussed the agencies involved in coordinating the transportation system, the various components and approaches used to manage the transportation system during the Olympics, and the experience with different techniques. Mr. Subramaniam covered the following points in his presentation.

- ! There were a number of agencies and groups involved in planning and implementing the transportation network used during the Olympics. These included the Atlanta Olympic Committee, the Atlanta Regional Commission (ARC), the Georgia Department of Transportation (GDOT), the Metropolitan Atlanta Rapid Transit Authority (MARTA), the City of Atlanta, the counties, FHWA, FTA, the Federal Railroad Administration (FRA), and law enforcement agencies. These groups worked cooperatively to develop, fund, implement, and operate the various components of the transportation system.
- ! A model, called the Olympic Transportation Information System, was used to estimate the demand for travel during the Olympics. The model used the event schedule, anticipated ticket sales, average vehicle occupancy, and mode choice factors as inputs to develop demand estimations for travel during the Olympics. The demand projections were then constrained by the available capacity on the road network and the transit system. An Olympic Transportation Management Plan (TMP) was developed based on these forecasts, as well as other factors. The TMP contained transportation plans and transportation networks for over 50 Olympic venues. Each venue transportation plan had a project manager. Most of the events were held within a three mile circle of the central part of Atlanta. Travel demand into and out of this area was very high.
- ! The effectiveness of the different elements of the Olympic transportation system are currently being evaluated. This assessment covers the ITS components, TDM strategies, HOV facilities, transit services, and other elements. The assessment includes both quantitative and qualitative measures.
- ! The Olympic TDM program had two major elements. These were a commuter options program and a freight management plan. The commuter options program focused on promoting TDM strategies with businesses and public agencies in the area. Commuters seemed to

respond to this effort as travel during the peak-period was about 15 percent below normal.

- ! There were two elements to the freight management plan. One element focused on goods movement within the 3-mile Olympic circle, while the other addressed long distance freight shipments. Delivery vehicles within the Olympic circle were restricted to midnight to 6:00 a.m., and no trucks were allowed on the I-75 and I-85 connector. These two elements seemed to work well, and no major problems were reported by trucking firms.
- ! The Advanced Traffic Management System (ATMS) played an important role during the Olympics. The ATMS, which covers most of the I-75 and I-85 freeways, includes closed circuit television cameras, aerial surveillance, changeable message signs, highway advisory radio, and other elements. The Traffic Management Center operated 24-hours a day during the Olympics.
- ! A variety of priority treatments were provided for buses and other HOVs. These include the HOV lanes on I-85 and I-75. In addition, approximately 1,000 buses were added for the Olympic spectator services. Most of the major park-and-ride lots were filled during the games. MARTA played a major role in transporting visitors and commuters. MARTA provided 24-hour operations during the Olympics.
- ! The Advanced Traveler Information System (ATIS) included approximately 130 kiosks located throughout the metropolitan area. The kiosks provided information on Olympic events, transit routes and schedules, traffic conditions, and weather. A cable television station was also dedicated to ATIS. The Atlanta Showcase, funded by FHWA, highlighted many of the ATIS projects.

Automated Vehicle Research at Carnegie Mellon University

Dean Pomerleau

Carnegie Mellon University

Dr. Pomerleau discussed the automated highway system (AHS) research underway at Carnegie Mellon University. He provided an overview of the AHS and showed a video highlighting the development and testing of an automated vehicle at Carnegie Mellon University. Dr. Pomerleau covered the following topics in his presentation.

- ! The development of the AHS has been motivated in part by the ISTEA. A portion of the Act included a requirement for the development of a fully automated highway system test facility by 1997. The AHS focuses on a futuristic vision of “hands off - feet off” computer aided driving. Such a system could provide enhanced safety, vehicle throughput, and efficiency. For example, approximately 95 percent of all traffic accidents are caused by human error.
- ! A consortium was selected through a competitive procurement process to assist with the development of the AHS. The team includes a mix of public agencies, universities, and private sector firms. A number of activities and projects are being conducted over a two year period.
- ! The development of a smart car at Carnegie Mellon University has focused on a two pronged approach. One component includes elements that warn a driver of inappropriate behavior. The development of a more futuristic fully automated vehicle and transportation system is being undertaken in the second component.
- ! Recent research activities have focused on the problems associated with lateral control of a vehicle. Mistakes in lateral control, or steering, by drivers are significant contributing factors to accidents, accounting for some 15,000 fatalities a year. These types of accidents typically involve a driver falling asleep or not paying attention. Carnegie Mellon University is examining ways to address these issues through automating specific features in an automobile.
- ! One of the big questions with the development of the AHS is whether the intelligence should be put into the vehicle or into the roadway. Both alternatives are being investigated by the Consortium. The work at Carnegie Mellon University has been on intelligent vehicle applications. Research is underway focusing on short-term benefits related to collision warning systems. Longer term projects are exploring actual control of various driving functions.
- ! A Pontiac Mini-Van has been developed as a test bed vehicle. The van is equipped with a number of different computers, cameras, and sensors. The two primary sensors are a video camera pointed out the front windshield and a radar located on the roof. The camera is used to help sense the location of the roadway.
- ! A number of tests, accounting for some 20,000 miles of autonomous travel have been conducted. One of the tests, called *No Hands Across America*, involved driving the test vehicle from Washington, D.C. to San Diego. The results from this test were very encouraging. Approximately 98.2 percent of the trip was made with the vehicle steering itself; without the driver having to intervene. The longest uninterrupted segment was in Kansas, when the operator did not have to actually touch the steering wheel for slightly over an hour or almost 70 miles.
- ! Other tests being conducted include automatic lane changing, detecting obstacles, tracking vehicles, and exiting a freeway. A number of simulation experiments are also being conducted to test multiple vehicle scenarios, such as reducing the headways between automated vehicles. A variety of other tests are underway on different elements of the AHS. These include not only the technical aspects of automated vehicles and roadways, but also social, institutional, legal, human factors, environmental, social equity, and privacy

Innovative Marketing and Public Information Programs

John Billheimer, SYSTAN, Inc. — Presiding

Effective HOV Marketing and Public Communication

Luisa Paiewonsky

Massachusetts Highway Department

Luisa Paiewonsky discussed the marketing and public information program used with the Southeast Expressway HOV lane in Boston, which was opened in November 1995. The six-mile contraflow lane uses the movable barrier technology. The facility is open to buses, vanpools, and carpools with three or more occupants. Luisa described the marketing program used to introduce the lane to the public and to encourage carpooling, vanpooling, and use of public transit. The following points were highlighted during the presentation.

- ! With funding from FHWA, the Massachusetts Highway Department (MassHighway) developed a \$558,000 marketing program for the new HOV facility. Although MassHighway does not typically employ marketing strategies, it was felt that a marketing program was needed for the Southeast Expressway project due to previous experiences with HOV lanes in the corridor. These included a contraflow HOV lane in 1971 and an HOV lane created by converting a general purpose lane in 1977. Although the contraflow lane had public support, the project was discontinued due to significant operational problems with setting up and taking down the pylons. The take-a-lane project suffered from lack of public support and was also discontinued.
- ! Developing the current HOV lane on the Southeast Expressway represented a challenge for a number of reasons. First, the Southeast Expressway is the second most heavily traveled freeway in New England. Second, the Expressway is in a densely developed corridor, with railroad tracks and established neighborhoods immediately next to the freeway in many stretches. As a result, the project presented design and operational challenges, as well as marketing challenges.
- ! A feasibility study was conducted to examine potential HOV facilities in the corridor. MassHighway involved other agencies, enforcement personnel, local communities, and neighborhood groups in the planning process for the HOV facility. This effort represented the start of the marketing and public information program on the project. A key element of this process was that the Department listened to other agencies, groups, and the public.
- ! The contraflow lane concept, which had public support in 1971, emerged as the favored approach. A public information effort was used to explain the use of the movable barrier system and the contraflow lane project to local residents, neighborhood groups, and policy makers. The public response focused on the truck used to move the barrier to create the lane. The zipper truck, which was the name that caught the attention of the public, became a major focus for the marketing campaign.
- ! The Department used the *HOV Marketing Manual* prepared for FHWA to help guide the development and implementation of the public information program. The comments and questions from the local groups were also used to help develop the marketing plan. Listening to the concerns and issues voiced at the local level was a critical element in the project.
- ! One month before the lane was opened, the zipper truck was introduced to the public. The truck was tested on the Southeast Expressway to ensure that it functioned properly and to acquaint motorists in the corridor with the operation of the facility.
- ! Approximately twenty percent of the marketing budget was used to fund a public relations program. A public relations agency and two advertising firms were hired to assist with this portion of the program. Activities conducted during this phase included media tours of the lane, the truck, and the operations center. A time trial between a vehicle in the HOV lane and a vehicle in the general purpose lane was staged to promote the travel time savings offered to users of the HOV facility. The zipper truck continued to be a focal point for much of the marketing effort.
- ! Advertising comprised approximately seventy percent of the marketing budget. Advertising allowed the Department to directly control the message, which does not always happen with public relations. Techniques used with the Southeast Expressway HOV lane included newspaper advertising, radio spots, an illustrated bus, and other media. Advertising is expensive and care should be taken in developing the best media mix.

- ! A light tone was taken with many of the advertisements. For example, one of the themes used was “its your choice.” This approach stressed the advantages of the HOV lane without criticizing driving alone.

The Vancouver Experience

Heidi Stamm

Pacific Rim Resources

Heidi Stamm presented the marketing plan developed and implemented on the Hastings Street HOV project in Vancouver, British Columbia. She provided an overview of the project, the development of the marketing plan, and the unique elements of the program. The following points were highlighted during the presentation.

- ! The project included both a freeway HOV lane and an arterial street HOV lane in the Hasting Street corridor. In addition, the project also involved other improvements along Hastings Street. New street lights, sidewalks, trees, benches, curbs and gutters, five new signalized intersections, and bicycle facilities were included in the project. The new traffic signals provided safety improvements and benefits to traffic in the general purpose lanes and the HOV lane. These elements were all used in the marketing effort.
- ! The estimated travel time savings for HOVs using the facility is 15 minutes. Most of the travel time savings are realized in the freeway section of the project.
- ! The loss of on-street parking was an issue in the development of the arterial street portion of the project. Approximately 130 on-street parking spaces were removed to create the HOV lane. Business owners along the roadway were very concerned about this change. Another issue arose over the operating hours. Concerns were voiced by school administrators and parents who did not want the lane open when children were trying to cross the street to go to school. The operating period of 6:00 a.m. to 8:30 a.m. represents a compromise to accommodate both the schools and commuters in the corridor.
- ! The vehicle-occupancy requirement was also an issue on the project. The policies of the regional planning agency support a 3+ vehicle-occupancy requirement for HOV facilities. Although approximately 40 buses an hour currently operate on the arterial section of the project, only 6 buses an hour use the freeway portion. Concerns were raised that a 3+ vehicle-occupancy requirement would result in too few users and the empty lane syndrome. As a result, a 2+ vehicle-occupancy level was used. This decision was not made until one month before the project was open, which made developing the marketing plan more difficult.
- ! There were also a number of marketing challenges on the project. The first of these related to developing and carrying out a marketing program with a limited budget of \$130,000 Canadian. Second, marketing was a new activity for staff at the Ministry of Transportation and Highways. Third, the Ministry had an existing ridematching service, which was provided by a private operator. The service was uneven, and consideration was being given to discontinuing the system. Finally, the HOV facility was being implemented during an election period.
- ! Although there is an existing bus-only lane in Vancouver, the project represented the first HOV lane in British Columbia. As a result, there were no policies to govern many aspects related to planning, designing, and operating the facility. The fact that the project encompassed both freeway and arterial street components further complicated deployment.
- ! All of these issues had to be addressed in the marketing plan. A public involvement process was initiated early in the project to address neighborhood and business concerns. One of the keys to the success of the project was the involvement of “Go Green”, which is a consortium of public agencies in the Vancouver area committed to encouraging environmentally friendly behaviors and activities. This group supported the project and helped with the marketing and public information elements.
- ! “Be a Roads Scholar” was one of the slogans used with the marketing program. Brochures were distributed to businesses in the corridor and mailed directly to households in the area. Bus signs were also used, promoting the slogans “Time Travel Begins this September” and “Group Savings Plan Starts this September.” Most of the promotional materials focused on the time and cost savings provided to HOVs through use of the facility.
- ! The market research conducted at the start of the project helped identify the potential user groups and the messages that appealed to them. This information was used to target the advertising in suburban newspapers, direct marketing, and other activities. Given the modest budget, emphasis was placed on lower cost approaches, working through employers and the “Go

Green” group, and coordinating the merchants in the corridor.

- ! A number of elements contributed to the difficulties and opportunities associated with the project. First, the project would have benefitted from regional policies related to vehicle-occupancy requirements and other HOV lane objectives. Developing a separate marketing effort focusing on the needs of the retail merchants located along Hastings street was well received. Presenting a realistic picture to the key constituents on the design and operation of the facility was important. Involving all the appropriate agencies early in the planning process was critical to developing the successful multi-agency approach. Sharing the written marketing plan with all groups proved to be very beneficial in that everyone was aware of what was going to be done and why. It also helped to have the overall project manager actively involved in all aspects of the marketing program.

Targeting Marketing of Transit and HOV Facilities in Pittsburgh

Scott Meyers

Port Authority of Allegheny County

Scott Meyers discussed a relatively simple and low cost marketing program used by the Port Authority of Allegheny County (PAT) to promote bus ridership, including routes operating on the HOV facilities in the area. The program, called *Route Specific Marketing*, was initiated in June of 1995. The program was successful in attracting new riders to bus service using the I-279 HOV lanes. Mr. Meyers highlighted the following points about the marketing program in his presentation.

- ! The project represents the joint efforts of PAT and the Pennsylvania Department of Transportation (PennDOT). Local governments in the corridor were also actively involved in the marketing program.
- ! In June of 1995, PennDOT initiated work to widen the Suffolk Street Bridge, which is the second most heavily traveled bridge in the Pittsburgh area. Approximately 90,000 vehicles a day use the facility. During the construction, the bridge was reduced to two lanes of travel during the peak-period and occasionally to one lane during off-peak periods. The lane closures caused traffic congestion well in advance of the bridge. The HOV lanes were not affected, however, providing added incentives for bus riders and carpoolers.

- ! The program represented the combined efforts and resources of PennDOT and PAT. PennDOT was very interested in marketing the bus services available on the I-279 HOV lanes. Encouraging carpooling was also a part of the promotional activities. The PAT budget for direct advertising was very small, so a major focus of the program was on obtaining free or low cost media coverage.

- ! Within PAT, both the Media Relations and the Marketing Departments were actively involved in the program. The Media Relations Department was successful in getting the radio and television traffic reporters to highlight bus, rideshare, and park-and-ride services in the corridor. The *North Hills News Record*, the local newspaper in the North Hill area, ran a weekly column on the status of construction activities and available transit services.

- ! The Marketing plan was a very low cost effort over about a two week period. A budget of approximately \$2,000 to \$3,000 was used for a direct mail campaign covering some 2,700 homes in the North Hills area. The mailing included a letter discussing the construction schedule, available bus services, and the location of park-and-ride lots. The mailing also contained coupons for discounts on a variety of items. These were provided by the *North Hills News Record*.

- ! PAT also participated in the North Hills Community Days as another method of disseminating information on the project. The PAT mascot, Coal Cat, spent the day handing out bus schedules and other items.

- ! This project provides an example of what can be done over a very short time period — two weeks in this case — to market a very specific construction problem. Since the program was so short, follow-up market research on the impact of the effort was not done. From bus driver observations and other feedback, however, it appears that the marketing program was successful at attracting new riders.

- ! This case study provides a good example of a low cost marketing approach involving the coordinated efforts of PAT, PennDOT, the local media, and the local communities. PAT plans to use this model with other construction projects, including the Fort Pitt Tunnel reconstruction.

Marketing the Atlanta HOV Lanes

John Martin

Siddall Matus & Coughter, Inc.

Mr. Martin discussed the marketing program used with HOV facilities in Atlanta. He provided an overview of the marketing elements and different phases of the promotional activities. Mr. Martin highlighted the following points in his presentation.

- ! A major focus of the program was helping the Georgia Department of Transportation (GDOT) build a ridesharing market. Identifying the factors for success is critical with any marketing program. The factors for success with an HOV facility include not only the HOV lanes, but also managing the construction process and ensuring that the supporting facilities and services are available. The support and involvement of major employers is also a critical component of many programs. In addition, commuter and political understanding and support are important.
- ! Marketing of an HOV facility should focus on the benefits to users. A market plan can be developed around these benefits. It is important to remember that it takes time to change behavior, especially those related to driving alone.
- ! The integrated marketing program used to promote the HOV facilities in Atlanta contained a number of components. These included an infrastructure support program, a construction communication program, an employer outreach program, a political relations program, and a longer-term promotional effort.
- ! The infrastructure support program focused on ensuring that adequate rideshare facilities and services existed. An inventory of existing park-and-ride lots, ridematching and transit services, and other supporting activities was completed. This study identified that while there are a number of park-and-ride lots in Atlanta, many are not oriented toward the HOV lanes.
- ! Corridor specific marketing plans should also be used to help link commuters to available services. Individual identities can be established for the marketing and promotional efforts in different corridors.
- ! Internal employee relations within GDOT represented another important focus of the marketing program. The Department has over 10,000 employees, and it was important that appropriate staff members had a good understanding of the project. The employees also represent an untapped sales force on projects. Internal newsletters, brochures, and electronic mail were all used to keep employees informed on the status of activities.
- ! Political relations programs represented a major part of the overall marketing program. It is hard to gauge the effectiveness of political relation efforts because if you are effective nothing happens. One-on-one meetings, letters, newsletters, and brochures can all be used to communicate with policy makers.
- ! The communications effort on the Express Lane construction activities and schedule was one of the more ambitious parts of the marketing program. A five phased marketing program was developed and implemented to present the construction impacts in a more positive light. The first effort helped explain the HOV and TDM concepts and why these approaches were needed in Atlanta. The second phase was the system-wide construction announcements. This phase explained the impacts of construction activities on commuters, along with information on alternative routes, transit services, and ridesharing.
- ! The construction ground breaking was the third phase. This phase began to communicate more information on the Express Lanes, as well as highlight the start of the construction process.
- ! The fourth phase was an ongoing solutions update program. This effort provided updated information on construction activities and schedules. A telephone hot line was used to respond to specific problems and questions. Information was also provided through metro traffic reports and news releases.
- ! An evaluation of the market program indicated a 92 percent awareness of the Express Lane construction, a 50 percent recollection of the advertising campaign, and 77 percent support for construction of the lanes.
- ! The Olympics provided an opportunity to further promote the HOV lanes and TDM strategies. A program called the Commute Connections Network was developed and implemented to help with travel during the Olympics. Working with the Atlanta Olympic Committee, the Commute Connections Network became the official TDM program for the Olympics. All of the organizations and agencies cooperated on different marketing materials, advertisements, and public information.
- ! Now that the Olympics are over, the real work begins. Efforts are now focusing on selling the success of TDM. A marketing effort currently underway using the

theme, *It Was Only A Test*, indicates that programs implemented during the Olympics need to be continued and expanded. With projected increases in traffic, TDM strategies will continue to be needed in the future.

- ! Marketing HOV facilities and TDM programs is a challenge. Rather than marketing concrete, you are promoting a change in behavior. As a result, it is important to continually reinforce the message on the benefits of ridesharing and using transit.

Innovative Transit Services

Allen Biehler, Port Authority of Allegheny County — Presiding

Allegheny County's Paratransit Brokerage System

Evin Rozner

ACCESS Transportation Systems, Inc.

Mr. Rozner discussed ACCESS Transportation Systems, Inc., which is the paratransit system in Allegheny County. He provided an overview of the system's operating characteristics, ridership levels, funding sources, and the requirements of the Americans with Disabilities Act. Mr. Rozner covered the following points in his presentation.

- ! ACCESS provides door-to-door, advanced reservation paratransit services in the Pittsburgh area. ACCESS has been in operation since 1979. ACCESS is managed by a private company, which serves as a broker, under the sponsorship of the Port Authority of Allegheny County (PAT). Service is provided by both for-profit and non-profit groups.
- ! ACCESS service is provided in a 730 square mile area. Approximately 1.3 million people live in the area. The service is available to the general public, but it is also the ADA mandated complimentary paratransit service. Further, ACCESS provides service to the elderly, which is funded through the state lottery, and serves clients of 100 human service agencies.
- ! The annual operating budget for ACCESS is approximately \$23.9 million. The system carries about 185,000 trips a month, of which 45,000 are for ADA clients. The service network includes nine carriers in 12 locations and 480 vehicles. Funding for ACCESS comes from the State lottery proceeds, PAT, participating agencies, and riders.
- ! As a service broker, ACCESS performs a number of functions. These include customer service, eligibility determination, service coordination, service monitoring, technical assistance, training, and public involvement.
- ! The service providers perform a number of functions. These include taking reservations, scheduling and dispatching trips, procuring and maintaining vehicles, training drivers, and trip-by-trip eligibility screening.
- ! Like other paratransit services, ACCESS faces numerous challenges in providing cost-effective and efficient service. Funding, streamlining the eligibility and screening process, and coordinating with fixed-

route services represent just a few of the challenges in the Pittsburgh area.

Innovative Services in Houston

Jeff Arndt

Metropolitan Transit Authority of Harris County

Jeff Arndt described the transit operating strategies that have evolved with the development of the HOV lane system in Houston. Bus routes and services have been expanded as the HOV lane system has grown from the initial 10 mile contraflow lane on the I-45 North Freeway to the current 65 miles of operating HOV lanes on 5 freeways. Mr. Arndt highlighted the following elements during his presentation.

- ! The bus service provided on the initial contraflow lane on the I-45 North Freeway focused on express service from suburban park-and-ride lots to downtown Houston. Commuter service to the downtown area continued to be the major transit service introduced as additional HOV lanes were opened on other freeways. The HOV facilities provided travel time savings and improved travel time reliability to commuters, and ridership on the new bus routes increased significantly. An extensive system of park-and-ride lots were developed along the HOV lanes.
- ! The expansion of the HOV lane system provided opportunities to serve non-downtown destinations from the major park-and-ride lots. Express services to the Texas Medical Center, Greenway Plaza, and the Post Oak/Galleria area have been implemented from some park-and-ride lots.
- ! As the HOV lane system expanded, the Metropolitan Transit Authority of Harris County (METRO) began the development of regional transit centers. Most of these centers were located at strategic points to allow quick access to and from the HOV lanes. The centers have become the focal point for connections between express and local services, allowing passengers to easily transfer among different routes. The evolving system provides riders with the opportunity to reach more destinations with just one transfer.
- ! A more recent development has been the introduction of suburban circulation services and reverse commute opportunities. Although the Houston facilities are reversible HOV lanes, a high level of commuter service is provided in the outbound or non-peak direction of

travel using the general-purpose lanes. Buses traveling outbound to the park-and-ride lots provided the opportunity for reverse-commute services linking inner city neighborhoods with suburban employment and activity centers. Since most of the METRO park-and-ride facilities are not located at major activity centers, a series of circular routes are being developed to provide connections between major park-and-ride lots and suburban employment and activity centers. The initial response to these services has been good.

- ! METRO has recently initiated another program to encourage greater use of the HOV lanes by vanpools. During the energy crisis of the early 1980's, many large employers in the Houston area sponsored vanpool programs. The passing of the energy crisis coupled with the downturn in the Texas economy resulted in the elimination of these programs by most businesses. The METROVan program is an attempt to renew interest in vanpools. METROVan is a subsidized third-party vanpool program designed to reach new markets that may be too small to serve with fixed-route transit service. METRO provides three different approaches to subsidizing the service. These include matching monthly employer funding for a vanpool up to \$35 per month for the first four months of operation, matching monthly employer vanpools subsidies up to \$35 per ride, and subsidizing \$10 a ride for the guaranteed ride home program. The METROVan program has been well received and there are currently 35 vans in operation.
- ! The bus system associated with the HOV lanes in Houston provides a good example of how transit routes and services can be expanded over time to encompass multiple markets, service strategies, and approaches. All of these elements were not planned at the beginning of the HOV lane development, but rather have evolved over time.

Hot Topics with HOV Facilities

Russell Henk, Texas Transportation Institute— Presiding

The Question of Rail vs. HOV/Bus in the San Diego I-15 Corridor

David Schumacher

Metropolitan Transit Development Board

Mr. David Schumacher described the Major Investment Study (MIS) currently being conducted on the I-15 Freeway corridor in San Diego. Rail and a high speed bus system using an HOV facility represent two of the alternatives

being examined in the MIS. Mr. Schumacher highlighted the following points in his presentation.

- ! The San Diego area has a significant LRT system. LRT lines provide service to the Mexican border to the south, to the eastern part of the city, and to Old Town San Diego. An additional line to Mission Valley will open next year. When this segment opens, the LRT system will include almost 50 miles. The I-15 corridor represents a missing link in this system.

- ! The I-15 corridor is approximately 35 miles in length, stretching from downtown San Diego to the suburban community of Escondido. Close to the downtown area, the corridor encompasses both I-15 and SR 163. The I-15 Freeway has the highest vehicle volume of any facility in San Diego, and is one of the busiest in the state. Traffic levels are projected to continue to increase in the future.
- ! An eight mile HOV facility is currently in operation on I-15. It is a two lane, reversible barrier separate facility. The lanes were designed to allow for conversion to rail in the future if demand warranted.
- ! Alternatives being examined in the MIS include adding general-purpose lanes, conventional rail, high performance rail, and high speed bus/HOV lanes. The high speed bus/HOV alternative is being considered for the first time in the San Diego area. This alternative is designed to be the equivalent of the LRT option. It has the same characteristics as the LRT option, including a dedicated right-of-way, a limited number of stops, and a high frequency of service.
- ! Five different evaluation criteria were used in the phase one analysis of the MIS. These criteria focused on transit and land use, transit ridership and travel time, engineering, capital and operating costs, and financing. The transit and land use impact appears to be the one key criteria for comparing the two alternatives. Three elements were examined in the transit and land use assessment. These were variations in development patterns, street designs, and dispersed employment patterns.
- ! The transit ridership and travel time criteria showed variations in different parts of the corridor. The boarding per mile forecasts in northern parts of the corridor were lower than any of the existing or planned LRT corridors. On the other hand, the ridership forecast in the southern end were high.
- ! There are existing express buses in the corridor that make the trip from Escondido to downtown San Diego in about 40 to 50 minutes. This same trip by conventional rail or LRT would take well over an hour. It is almost more difficult to serve suburban areas with the rail alternative, as a transfer from feeder bus to rail would be required.
- ! Engineering was the third criteria examined. Due to the hilly topography in the corridor, the rail alternative would require a number of aerial structures. There is

also constricted right-of-way in most of the corridor, which poses problems for the bus/HOV alternative.

- ! The capital costs estimates for the rail alternative is in the range of \$900 million to \$1.2 billion. The capital costs for the HOV alternative is less, although the direct access ramps drive the costs up. In terms of operating costs, the high-speed bus alternative is just slightly higher than the rail alternative.
- ! Financing is a problem for both alternatives. Funding for any improvement in the corridor is limited. There is also a need for short term improvements in the corridor. A congestion pricing project is currently being considered for the I-15 HOV lane. The demonstration would allow single-occupancy vehicles to use the HOV lane for a fee. The revenues generated from the project would be used to fund expanded transit services in the corridor.
- ! Although a final decision has not been made, it does not appear that rail is a feasible alternative for the full corridor. The second phase of the MIS will examine additional hybrid bus and rail alternatives, lower cost HOV access options, and specific bottleneck solutions. Phasing of HOV alternatives, converting a general-purpose lane to an HOV lane in combination with congestion pricing, and different high speed feeder bus options are also being explored.

HOV Facilities and the Environment

Peter Sucher
HNTB, Inc.

Peter Sucher described some of the concerns raised by environmental groups on the proposed Cross Westchester Expressway (CWE) or I-287 HOV project in the New York area. The positions of the groups opposed to the HOV facility, as well as those of the New York State Department of Transportation (NYSDOT), were discussed. Mr. Sucher highlighted the following elements during his presentation.

- ! I-287 is a major commercial and commuter corridor in lower Westchester County, a suburb of New York City. The CWE links many of the municipalities in Westchester County with the regional transportation network. It also provides the only bridge across the Hudson River in a 16-mile radius.
- ! I-287 experiences serious levels of traffic congestion in both the morning and afternoon peak-periods. After extensive studies, the NYSDOT proposed a reversible, barrier separated HOV facility on the I-287 and the

concurrent flow HOV lanes on the New York State Thruway. Public hearings on the I-287 project were conducted in late 1995. Although the HOV concept was initially supported by environmental groups, a vocal faction, called the Tri-State Coalition, began to question the environmental benefits of the project.

- ! The CWE was constructed as a six-lane expressway in the 1950s. It was later designated a part of the Interstate System, even though it is not built to Interstate standards. Interchanges are closely spaced and there are no service or frontage roads. There are a number of office parks and corporate headquarters located in the corridor. The CWE carries approximately 100,000 to 110,000 vehicle a day. Driving alone is the predominate commute mode, although there is a fair number of two person carpools. Transit service is very limited in the corridor.
- ! Demand forecast projects upwards of 140,000 vehicles a day and a level-of-service F for the peak-periods. Three alternatives were considered in the Environmental Impact Statement (EIS), which was initiated in 1989. These were a six-mile rehabilitated facility, widening the facility to eight-lanes, and adding a reversible HOV lane. These three alternatives were carried through the EIS. Although there has been no record of decision, the HOV options is the preferred alternative by the NYSDOT.
- ! The NYSDOT realized that the HOV lane alone would not be enough to influence commuters to change from driving alone to carpooling or taking the bus. As a result, the Department began to make other improvements in the corridor to increase the chance of success for the HOV alternative. Several park-and-ride lots have been constructed and new express bus routes have been initiated. Working with the Thoroughway Authority, the Department implemented a moveable barrier that allows the Thoroughway to operate four lanes in the peak-direction of travel during the peak-periods. The Thoroughway also implemented special toll lanes to give HOVs priority at the toll plazas. A transportation management association was formed to help promote ridesharing and other TDM strategies. A highway helper program has also been implemented to assist with incident management.
- ! The Tri-State Coalition began raising environmental concerns about the HOV alternatives almost three years ago. The group has used the local media, a newsletter, and other approaches to spread their message. The group has suggested that HOV lanes are nothing more than roadway projects and that HOV lanes do not help

relieve traffic congestion. They also stress that HOV lanes serve radial trips and are not effective in serving suburban trips. The group further suggest that HOV facilities are not transit alternatives and argue against 2+ carpools. Even though there are many examples to prove that this information is not always correct, there has not been a concerted effort to counteract these statements. Other comments from the group focus on a few unsuccessful HOV projects, rather than the many successful projects. Representatives from the Coalition claim that HOV lanes are regularly converted into general use lanes, increase air pollution, and encourage residential sprawl. They do support converting general-purpose lanes to HOV lanes, however.

- ! Transportation professionals need to do a better job of presenting a realistic picture of the benefits and the limitations of HOV facilities. Planners and engineers should be prepared to respond to misinformation, such as many of the comments made by the Coalition.

Arterial Street HOV Lanes: Unique Issues and Unique Solutions in Toronto

Tyrone Gan

iTRANS

Stephen Schijins

McCormick Rankin

Mr. Gan and Mr. Schijins discussed arterial street HOV facilities in the Toronto area. They summarized many of the challenges involved in planning, designing, developing, and operating arterial street HOV lanes. Mr. Gan and Mr. Schijins covered the following points in their presentation.

- ! There are a number of challenges with arterial street HOV facilities. In general, there is less experience with these types of HOV lanes than with freeway facilities, and less research has been conducted on arterial street projects. Issues like access controls, on-street parking, turning vehicles, pedestrians, bicyclists, and other elements all need to be considered with arterial street HOV lanes.
- ! Public transit services play a very important role with arterial street HOV lanes, and many projects are oriented specifically toward buses. In many cases, the transit agency is the lead group in the development, implementation, and operation of arterial street HOV lanes. In addition, arterial facilities may be part of a larger HOV network, requiring consideration of connectivity to other system elements.

- ! Estimating the demand for an arterial street HOV facility is a critical step in the planning process. Forecasting arterial street HOV demand can be more difficult than estimating the use of a freeway facility. Three elements have been used to address this problem in the Toronto area. These are identifying the outputs that are required for the decision making process, using a variety of customized demand estimation tools, and developing a range of travel demand forecasts.
- ! The elements needed in the decision making process include the estimated demand for buses, vanpools, and carpools, as well as the general traffic projections. These forecasts can be developed at the link, mid-block, and intersection level. Two different general forecasting approaches are used in the Toronto area. The first is a bottom-up process, which uses existing traffic data as the base and a modified pivot-point analysis. This technique produces a range of estimated demand for a facility. An alternative approach, which focuses more at a macro or strategic level, uses regional transportation planning models. These models start with the entire transportation network and then window down to the arterial street system.
- ! Decision makers also want information on the estimated benefits from an arterial HOV facilities. A first step in assessing the potential benefits is to clearly identify the objectives of a project. The possible benefits, which may include travel time savings and improved travel time reliability for buses and carpools, can then be estimated. Other benefits may be increased carrying capacity of the roadway and higher transit usage. A range of customized tools have been developed to help estimate these and other potential benefits. Recognizing the uncertainty with forecasting techniques, these approaches provide a range of estimated benefits.
- ! A number of operational issues should be examined during the planning process. These included safety concerns, the level-of-service in the HOV lane and the regular-traffic lanes, signal progression, possible signal priority for transit vehicles, driveway access, turning restrictions for non-HOVs, and enforcement.
- ! The *Fatal Flaw* analysis technique used to evaluate freeway HOV projects in Toronto has been modified for use with arterial street applications. Similar factors have been applied to arterial street HOV facilities, although the actual performance measures are different.
- ! A number of creative approaches can be used with arterial street HOV lanes. The Don Mills Road HOV facility in Toronto uses the curb lane during the peak-period for buses and 3+ carpools. During the off-peak period the lane is open to all traffic. The Edmond Avenue HOV lane represents a multi-use approach. In this case, the curb lane is open to buses and taxis during the peak-period. During off-peak periods the curb lane is used for parking and goods delivery.
- ! In downtown Ottawa, the second lane on Albert Street is reserved for buses and the curb lane is available for short-term parking and delivery vehicles. The bus lane was first implemented using the curb lane. So many conflicts emerged with other users, however, that the bus-only facility was moved to the second lane.
- ! Providing bus bays at transit stops is important if the HOV lane is being used by carpools and vanpools. Special consideration should be given in locating bus bays. One alternative is to move the bus bay back a little from the intersection. This approach can benefit bus operations, general traffic flow, and pedestrian access.
- ! Providing adequate information signs is also important on arterial street HOV lanes, especially with part-time facilities. Signs can be used to both educate commuters and to help enforce the lane. Ultimately, HOV regulations should be added to the driver training manuals.
- ! Enforcement can be an issue with arterial street HOV facilities. Posting the fines for violating the use regulations, as is done with many freeway HOV lanes, is one approach that can be used with arterial street facilities. Another technique is to use a self-enforcement program, like the HERO program in Seattle.
- ! Accommodating right turn movements for general traffic is a common operational issue with curb lane HOV facilities. The current regulations in Toronto is that vehicles making right turns can only use the HOV lane within 45 meters of an intersection. This rule is not being enforced, however, and surveys of existing HOV lanes indicate that most vehicles enter the HOV lane well in advance of the intersection.
- ! A focus group conducted with bus drivers who regularly use the arterial street HOV lanes helped identify a number of operating issues. First, the drivers all supported the HOV lanes and felt they provided significant benefits to transit. Second, they noted that right turning vehicles were a problem. Third, they suggested that the HOV lanes should be operated on

weekends when shopping and recreational travel was heavy.

Puget Sound Lane Conversion Study

Don Samdahl

BRW, Inc.

Don Samdahl presented a recent study conducted for the Washington State Department of Transportation (WSDOT) that examined converting general purpose lanes to HOV lanes. The objective of the study, which included both technical and policy assessments, was to establish guidelines for the consideration of lane conversion projects. Mr. Samdahl discussed the following elements concerning the study.

- ! A Steering Committee, comprised of representatives from agencies and groups in the Seattle area, was formed to help guide the study and to serve as a forum for the discussion of the issues and opportunities associated with lane conversion projects. Interviews were conducted with key stakeholders in the region to obtain their views on converting general-purpose lanes to HOV lanes. A limited sample telephone survey was used to gather similar input from commuters and travelers in the area. The results of the interviews and telephone surveys indicated a polarization of opinions, with sizable minorities strongly favoring the approach and disagreeing with the concept.
- ! The technical portion of the study focused on the development of a screening tool to help estimate the impacts on traffic flow in the HOV lane and the general-purpose lanes that would occur with a lane conversion project. The screening methodology was then applied on freeways throughout the region. Approximately 40 freeway segments were examined in the analysis. The results identified a narrow window of opportunity for considering converting general-purpose lanes to HOV lanes on a few freeway segments.
- ! A number of potential issues with HOV lane conversion projects were identified early in the study. These included the HOV demand needed to justify lane conversion, the impacts on general-purpose traffic, and possible diversion to parallel streets, and the minimum number of travel lanes needed to consider converting a lane. Other issues considered in the analysis were using lane conversion projects to complete missing links in the HOV network, allowing trucks to use HOV facilities, peak-period only HOV operation, and priority pricing alternatives. Implementation issues related to costs, development time, and environmental concerns were also examined.
- ! Most respondents to the telephone survey favored adding an HOV lane rather than converting an existing lane. Approximately one-fourth of the respondents favored converting an existing lane, while a little over one-fourth strongly disagreed with this approach. Thus, it appears that there is a good deal of polarization on the lane conversion issue. More respondents favored lane conversion if it provided a needed missing link in the HOV network. Lane conversion was also noted as having more positive environmental impacts.
- ! A number of points were identified from the surveys and focus groups on how lane conversion projects could be made positive for all groups. These included not adversely affecting the remaining general-purpose lanes, converting a lane for only peak-hour use, providing missing links in the HOV network, and improving air quality in the area. A number of possible policy objectives were developed to help guide decisions on lane conversion projects.

Planning Regional HOV Systems

Barbara Fischer, New Jersey Department of Transportation — Presiding

The Puget Sound HOV Pre-Design Studies

Chris Wellander

Parsons Brinckerhoff

Chris Wellander discussed the Puget Sound HOV Pre-Design Studies (PSHOV) conducted for the Washington State Department of Transportation (WSDOT). The goal of the project was to develop a series of conceptual designs and recommended priority treatments to improve the access, operation, performance, safety, and reliability of the HOV system in the Puget Sound region. Mr. Wellander covered the following major points in his presentation.

- ! The PSHOV was a comprehensive assessment of ways to tie together and enhance the HOV system in the Puget Sound region. Seattle has a long history of using HOV facilities to help address travel demand and congestion issues. The core freeway program includes the development of 276 lane miles of HOV facilities by 2015. Currently there are approximately 140 lane miles of HOV facilities in operation.
- ! In 1994, the Washington State Department of Transportation (WSDOT) initiated the PSHOV to look at ways to improve the continuity of the HOV system, to identify additional support facilities and services, and to explore methods to enhance the safety and enforcement of existing lanes. The study result would be used to develop a long-range HOV system plan, which would tie into the MPOs regional plan and WSDOT's state highway system plan.
- ! The PSHOV included 13 elements or sub-studies. There were region-wide system studies and subarea corridor studies. Topics examined on a region-wide basis included travel forecasting, estimating future congestion points, assessing transit and ridesharing markets, examining the potential for freeway-to-freeway HOV connections, lane conversion, safety, and enforcement. More detailed assessments were conducted in six corridors.
- ! The PSHOV was a two year effort. Over 100 representatives from various agencies and groups participated on 10 advisory committees overseeing the various study elements. There were also 12 consulting firms involved in conducting the different tasks.
- ! Most of the HOV facilities in the Puget Sound region are concurrent flow lanes located on the inside of the freeway. One potential issue with this type of facility is ingress and egress. As a result, one of the sub-studies examined the use of direct access connections. A variety of direct access designs were considered, including drop ramps, flyover ramps, on-line transit stops, T ramps, Y ramps, and other treatments.
- ! Freeway-to-Freeway HOV connections were also explored. Although this approach provides significant benefits to HOVs, it is also expensive. Direct HOV connections for a four quadrant interchange would cost approximately \$200 million.
- ! Similar approaches and techniques were used with all the subarea studies. All feasible alternatives were identified first, followed by a fatal flaw analysis and a second tier assessment. A more detailed examination was conducted to identify a preferred set of options. The results from all the subarea studies were compiled and a priority listing of projects was developed.
- ! Several measures of effectiveness were used in the analysis. The estimated travel time savings and costs emerged as the two most important measures during evaluation. Travel time savings were examined for both transit and ridesharing based on different types of access and different access locations. Other measures of effectiveness focused on safety, enforcement, land use, and environmental issues.
- ! The existing core regional HOV lane network was also reevaluated. Adjustments to the core systems were recommended based on this analysis. Five new segments were identified for addition to the system and three segments were recommended for deletion. Other key recommendations included the addition of 25 direct access ramps, 12 quadrants for freeway-to-freeway connections, and 48 new lane miles of HOV facilities. The cost for all of these new elements was estimated at approximately \$1.5 billion.

An HOV Strategy for the Greater Toronto Area

Brian Ogden

Ontario Ministry of Transportation

Rod McDougall

IBI Group

Mr. Ogden and Mr. McDougall discussed the process used to develop a freeway and arterial HOV strategy in the Greater Toronto Area. The recently completed study was

conducted to help identify key elements of a future HOV network and to coordinate the activities of the different municipalities in the area. Mr. Ogden and Mr. McDougall covered the following topics in their presentations.

- ! The Greater Toronto Area includes six Regional Municipalities. Currently, approximately 4.7 million people reside in the Greater Toronto region, which is the largest urban area in Canada. Almost half of the population of Ontario lives in the area. Further, Toronto accounts for some 25 to 30 percent of all economic activity for Canada.
- ! There is a two tier municipal governmental structure in the area. There are six Regional Municipalities and 36 Area Municipalities. Both population and employment are forecast to continue growing. Most of this growth is occurring in the suburban areas. Travel patterns are also changing to reflect this growth. Travel demand is changing from a more traditional radial orientation focusing on downtown Toronto to a decentralized pattern focusing on suburban areas.
- ! Traffic congestion is a significant problem on freeways in the area. Highway 401 is a major east-west, 12 lane freeway that is one of the busiest freeways in North America with over 400,000 vehicles a day. Highway 407, which is currently under construction, will be the first toll facility in the area. Transit, including commuter rail, subways, and buses, plays a key role in serving many parts of the region.
- ! Major investments have been made in all parts of the transportation system. It will not be possible to meet the anticipated future needs, however. As a result, more emphasis is being placed on managing the existing system and making selected improvements.
- ! The objective of the Greater Toronto Area strategy was to define a network of freeway and arterial HOV facilities to provide a continuous system of HOV lanes across regional boundaries. All of the six Regional Municipalities had at least started examining HOV facilities within their boundaries, and many had extensive studies. A wide-range of potential HOV facilities had been identified through these efforts. In many cases, projects being examined in one municipality did not match with those under consideration in another municipality.
- ! Representatives from each of the six Regional Municipalities, the Ministry of Transportation, and a few of the larger Area Municipalities participated throughout the study. The first step in the study was to

take a fresh look at existing projects and forecasted travel patterns. A set of regionally significant goals and policies was also developed.

- ! Six area HOV network strategies were developed to help identify key projects. These strategies reflected the regional goals and policies. Common elements among the six strategies were identified to help target the most important facilities. The recommended HOV network emerged from this process.
- ! Major goals of the study focused on increasing the efficiency of the planned road network, while maintaining safety, supporting transit in the Greater Toronto Area, and supporting environmental sustainability. The generic network strategies focused on supporting the Greater Toronto Area urban structure and providing transit priority on arterial roads, connections with the existing rapid transit system, links between the municipalities, and queue jump lanes for HOVs at strategic locations.
- ! Each of the six generic strategies were defined in more detail. Elements common to most of the strategies were identified to help establish the major priorities. These elements were then evaluated based on a set of key defining factors. This last screen resulted in a recommended system of arterial and freeway HOV networks. The networks connect with the existing rapid transit and HOV system, support the urban development pattern in the Greater Toronto Area, and link municipalities.

- ! The recommendations also address the other supporting infrastructure needs and programs. These include marketing and public information, TDM programs, enforcement, and transit services. The study also recommended that an ongoing advisory group comprised of representatives from the municipalities and the Ministry be charged with coordinating the implementation of the plan.

Regional Planning in Nashville

Larry Ridlen

Greshman Smith & Partners

Mr. Ridlen discussed a recent regional HOV study conducted in the Nashville area. He provided an overview of the transportation system in the area, recent development trends, forecasted growth, and the major elements of the study. Mr. Ridlen covered the following points in his presentation.

- ! A four mile concurrent flow HOV lane has been in operation on I-65 since 1993. This facility was implemented as part of a widening project on I-65. After the HOV lane was opened, the Tennessee Department of Transportation (TDOT) sponsored a study to look at future needs for HOV facilities in the region.
- ! The metropolitan area includes five counties, with Nashville and Davidson County located in the center of the region. Nashville is the capital of Tennessee. The capital and state office buildings are located downtown. In the last 10 to 15 years, several automobile manufacturing facilities have located in suburban areas. These manufacturing plants and other suburban developments have influenced travel patterns in the area. More trips are now focused on suburb to suburb commutes rather than suburb to downtown trips.
- ! The purpose of the study was to examine a regional HOV system. TDOT sponsored the study, but the MPO was really the driving force behind the project. FHWA, the local transit agency, and other groups were also involved. Two advisory committees were formed to help oversee the study. The first was a project steering committee. This committee, which was comprised of policy makers from the participating agencies and other groups, helped guide the study. The second was a technical advisory committee. This committee was comprised of technical staff members from the various agencies. The technical advisory committee assisted with specific elements of the study.
- ! The goals and objectives of the study focused on increasing the person carrying capacity of the regional transportation system, reducing vehicle delay, reducing vehicle miles of travel, reducing the need to add additional general purpose freeway lanes, enhancing transit operations, and providing information to the public on HOV facilities. Five major tasks were completed during the study. These included collecting data, analyzing traffic volumes, assessing travel time and vehicle occupancy levels, identifying an appropriated HOV system for the region, developing a uniform HOV lane design treatment, and selecting the appropriate routes or networks.
- ! A matrix with eight measures was used in the evaluation of alternative networks. The eight measures were weighted based on criteria established by the Advisory Committee. Five of the nine corridors evaluated ranked high on the eight measures. A sixth corridor, which included the existing HOV lanes on I-64, was added to ensure system continuity.
- ! These six alternatives were then examined in more detail. This analysis looked at potential design constraints, right-of-way limitations, preliminary designs, and cost estimates. The air quality impacts of the alternatives were also examined. The environmental assessment was important, as Nashville is an air quality non-attainment area.
- ! The recommendations from the study identified a number of corridors where HOV demand in the year 2016 would be between 800 and 1,200 vehicles in the peak hour. These included most of the radial corridors serving the downtown area. Concurrent flow HOV lanes operating during the peak hours were selected as the most appropriate design treatment for these corridors. Supporting TDM and transit strategies were also identified.

ITS and HOV Facilities

Carlos Lopez, Texas Department of Transportation— Presiding

The Houston Experience

Mike Raney

Metropolitan Transit Authority of Harris County

Mr. Raney discussed ITS projects and activities in the Houston area. He provided an overview of the Greater Houston Transportation and Emergency Management Center, called TranStar, the application of ITS with the Houston HOV lane systems, and other related projects. Mr. Raney covered the following topics in his presentation.

- ! The development and deployment of the HOV lanes and ITS in Houston has occurred through the coordinated efforts of the Metropolitan Transit Authority of Harris County (METRO) and the Texas Department of Transportation (TxDOT). The HOV lanes have evolved over the last 20 years. Currently, some 64 miles of a planned 110 mile system are in operation.
- ! The success of the 9 mile contraflow HOV lane on the I-45 North Freeway resulted in the development of a more extensive HOV system. The Houston HOV lanes are barrier separated reversible facilities located in the center median of five radial freeways. Approximately 80,000 passenger trips are carried on the lanes each weekday in buses, carpools, and vanpools. There are 23 park-and-ride lots serving the HOV lanes. A number of these are major facilities, with spaces for over 1,000 vehicles and direct access ramps to the HOV lanes. A number of access design treatments are used including slip ramps, T and double T ramps, and wishbone ramps.
- ! TranStar is the Greater Houston Transportation and Emergency Management Center. The development and operation of TranStar represents the coordinated efforts of METRO, TxDOT, the City of Houston, and Harris County. Personnel from all agencies are located in the Center, which is managed through a cooperative agreement.
- ! Most of the HOV lanes are currently monitored by closed-circuit television cameras. The network of cameras is being expanded, and all of the HOV lanes will soon be under the surveillance system.
- ! METRO is responsible for enforcement of the vehicle-occupancy requirements, hours of operation, and other HOV lane regulations. The METRO police force

includes approximately 180 officers. About 50 officers are assigned to the HOV lanes on a daily basis. In most cases, two officers are assigned to each HOV lane. Although the surveillance system helps with the enforcement program, it is still important to have officers on the lanes during all operating hours.

- ! These officers can also help prevent wrong-way movements on the facilities. Approximately 200 feet of space is provided in the enforcement areas, which are usually located at key access points, to allow enough room for officers to pull vehicles over.
- ! The violation rate for the vehicle-occupancy requirement on the HOV lanes is less than 5 percent. Police personnel in marked city, county, or other jurisdictional vehicles are allowed to use the HOV lanes with only the driver.

Beaver County's Mobility Manager System

Bruce Ahern

Beaver County Transit Authority

Mr. Ahern discussed the application of ITS with public transit services. He described the Mobility Manager pilot project, which is being implemented at the Beaver County Transit Authority. The following topics were addressed in Mr. Ahern's presentation.

- ! The Mobility Manager demonstration is one of four pilot projects being sponsored by FTA. Funding for the first two phases is approximately \$300,000. The program will incorporate ITS and innovative service strategies to better meet diverse travel needs in Beaver County in the Pittsburgh Metropolitan area. Ultimately, the concept will incorporate regular route bus services, paratransit services, rideshare services, coordinated human services programs, airport shuttles, and taxicabs. Deployment of the Mobility Management Pilot Program will start in 1997.
- ! The Beaver County Transit Authority (BCTA) is a small system that provides suburban, rural, and intercity service in an area surrounding the Pittsburgh International Airport. BCTA has a fleet of 40 vehicles, and provides regular route and paratransit services. One of the unique features of Beaver County is that there is not a traditional downtown in the area. The largest community in the County has a population of

approximately 20,000. As a result, the market served by BCTA is different from those served by many transit agencies.

- ! BCTA contracts for all services, but owns the vehicles and capital facilities. Since 1990, BCTA has completed a \$7 million modernization program. In the next two years a \$10 to \$12 million facility modernization program will be completed.
- ! The Mobility Manager represents a new model for transit services. This concept is intended to help meet the demands of the changing travel markets for transit. Suburb-to-suburb commuting is now the predominant travel market in many areas. New service orientation and a quality product will be needed to meet the demands of this travel market.
- ! Planning for the Mobility Manager pilot program began at BCTA in 1992, with the development of a mission statement for the agency. The role of BCTA is to manage and coordinate the local and regional mobility needs with a high quality, innovative, and technologically advanced transportation network. ITS is a cornerstone that can help reengineer travel to better serve existing and future customers. ITS will allow BCTA to operate as a travel agency and service coordinator, rather than as a traditional transit agency. ITS will allow BCTA to provide accurate real-time information on all modes.
- ! The first two phases of the project included an evaluation of technologies that would add value and increase the service choices for the target market groups. Performance specifications were developed for each of the system components, along with an integration plan. Cellular Digit Packet Data (CDPD) represents the backbone of the communications system being used to transmit real-time data over a wireless network. A computer aided scheduling package that is integrated with a global positioning system (GPS) and an automatic vehicle location (AVL) system will also be implemented. Finally, the transit operations center will be upgraded and a comprehensive traveler information system will be deployed. The anticipated budget for the full project is approximately \$2.5 million.

Quantifying the Benefits of HOV Facilities Using Automatic Vehicle Identification Technology

Shawn Turner

Texas Transportation Institute

Mr. Turner presented the results of a study that examined the application of automatic vehicle identification (AVI) technology to monitor speeds, travel time savings, and travel time reliability on HOV lanes in Houston. The research project was funded through the Southwest Region University Transportation Center (SWUTC). Mr. Turner highlighted the following points in his presentation.

- ! The AVI traffic monitoring system was developed in the Houston area by the Texas Department of Transportation (TxDOT) and the Texas Transportation Institute (TTI). A series of AVI readers are being located along selected freeways and HOV lanes. The readers are spaced approximately every one to two miles on freeway segments close to the city and one to five miles further out. The system was developed to provide real-time information on traffic speeds and conditions on the freeways and HOV lanes. A real-time traffic map, showing speeds in different colors, can be accessed through the Internet.
- ! The objective of the study was to use the extensive data available from the AVI real-time traffic system to quantify the potential benefits of the Houston HOV lanes. Specifically, the study focused on assessing the travel time savings and travel time reliability provided by the HOV lanes. The study used 1994 data from the AVI system.
- ! The average monthly speeds for both the general-purpose freeway lanes and the HOV lanes were examined for three corridors. The results show a greater variation in speeds for the general-purpose lanes than for the HOV lanes. Examining daily AVI data show an even greater variation in speeds on the freeways. On the other hand, speeds on the HOV lanes tended to be consistently in the range of 55 to 60 miles per hour (mph).
- ! The study results indicate that the AVI real-time traffic system can be used to monitor the travel time savings and travel time reliability for the Houston HOV lanes. This approach appears to be much more cost-effective and efficient than traditional monitoring methods, such as the floating car technique.
- ! The data can be further analyzed to develop a travel time savings and travel time reliability index. For example, the monthly standard deviation can be calculated to develop a confidence interval on the travel time reliability for the HOV and the general-purpose lanes. As could be anticipated, the travel time savings and the travel time reliability intervals for the HOV

lanes are much better than those for general-purpose lanes.

- ! The study provides just one example of how the wealth of data generated from ITS can be used in planning and evaluating HOV facilities. There are many other potential applications, including model calibration, travel flow studies, and even origin-destination studies.

A Software Decision Support Tool to Analyze the Use of ITS Technologies and HOV Facilities

Bill Yurcik

University of Pittsburgh

Mr. Yurcik discussed a class project conducted at the University of Pittsburgh. The project developed a general decision support tool for use in examining investments in HOV facilities based on net present value (NPV) analysis. Mr. Yurcik covered the following points about the development and use of the decision support tool in his presentation.

- ! The decision support tool provides a framework to assist with the analysis of alternative HOV scenarios. A number of input values are needed. The input values are not just point estimations, but can be any common mathematical distribution. This approach increases the statistical confidence of the output.
- ! The software provides a graphical influence diagram, which outlines the costs and benefits of various alternatives. The software can be modified to incorporate new approaches and situations, such as the addition of ITS technologies with an HOV facility. The tool also automatically identifies the sensitivity of the various input values.
- ! The decision support tool requires about 25 different input values to calculate the NPV for a given HOV alternative. A number of different scenarios were run as part of the class project, indicating possible uses for the decision support tool.
- ! The use of this and other techniques may help enhance the analysis process involving HOV facilities, ITS technologies, and other transportation improvements. The tool provides one example of how NPV analysis can be applied in the transportation field.

Recent HOV Project Experience

Tim Lomax, Texas Transportation Institute— Presiding

Harbor Freeway Transitway in Los Angeles

Ron Klusza, Retired

California Department of Transportation

Mr. Klusza discussed the new Harbor Freeway (I-110) Transitway in the Los Angeles area. He provided an overview of the various elements associated with the project and the current status of the project. Mr. Klusza covered the following points in his presentation.

- ! The I-110 Harbor Freeway is a north/south facility linking the San Pedro Harbor to downtown Los Angeles. It was constructed as an eight-lane freeway in the 1950s and has operated at level-of-service F during the peak-periods for the last 20 years. The average daily traffic is 236,000 vehicles.
- ! The Harbor Freeway Transitway study began in 1979. Construction of the Transitway was initiated in 1989, and the facility was open to traffic in June of 1996. The freeway corridor is almost 20 miles in length, but the HOV facility is only 10 miles. The Transitway is located between the Artisa (I-91) Freeway and the Santa Monica (I-10) Freeway. Almost three miles of the facility is elevated. The Transitway includes six transit stations. Five of these stations have one or more park-and-ride lots.
- ! When the Transitway was opened in June, only one station was operational. The remaining five stations will be completed and will be in operation by the Summer of 1997. The northern terminus of the Transitway is also still under construction and will be open in the Spring of 1997. The interim terminus provides direct access ramps at 39th Street. These ramps provide HOVs with access to the Los Angeles Coliseum, the Sports Arena, Exposition Park, the Shrine Auditorium, the University of Southern California, and the surface streets in downtown Los Angeles. A slip ramp to the Harbor Freeway general-purpose lanes is also provided.
- ! The south end of the Transitway will terminate at the Artesia Station, which is still under construction. The transit station and the park-and-ride lot will have direct access to the Transitway by an elevated ramp. The ramp crosses the Artesia Freeway on a right hand curve and drops into the median of the Harbor Freeway on a left hand curve. The elevated section is 67 feet wide and has two lanes and a shoulder in each direction of travel. The ramp traffic merges into one lane northbound and a short distance later a slip ramp is provided for freeway HOVs to enter the northbound Transitway.

- ! The Harbor Freeway Transitway also has a connection with the Century Freeway Transitway. The Century Freeway, which was oped in 1993, includes a LRT line in the median, HOV lanes in each direction adjacent to the LRT line, and three or more general-purpose lanes in each direction. HOV access to the Harbor Freeway is provided by direct connection ramps from the Century Freeway. Two lanes in each direction of travel are provided on the Transitway in this section. Transit stations north of the Century Freeway, which are still under construction, will have a third lane in each direction for decelerating, stopping, and starting vehicles.
- ! North of the Century Freeway the Transitway transitions from an at-grade section to an elevated T section. The Transitway in this elevated section is 67 feet wide, with two lanes and a shoulder in each direction of travel.
- ! A multimodal, multilevel station complex has been constructed at the interchange of the Harbor Freeway Transitway and the Century Freeway Transitway. This facility is now open. The upper level station is for access to the LRT line on the Century Freeway. At ground level is a park-and-ride lot, bus bays, and access to the local streets. Due to right-of-way restrictions, only one bus platform could be provided at the ground level station. The layout requires buses to criss-cross at the center platform. Between these two stations is the Harbor Freeway Transitway station.
- ! The station south of the Artesia Freeway will be located adjacent to the Harbor Freeway. The four remaining stations north of the Artisa Freeway are located in the median of the Transitway. These stations have split platforms with single bus lanes.
- ! The design geometrics of the Harbor Transitway stations are not being recommended as design standards for future facilities. Future standards should eliminate criss-crossing buses, and single lane stations. The cost of the Harbor Transitway was slightly under \$500 million. Federal funding covered 90 percent of the cost.

I-270 and I-310 in Maryland

Heidi Van Luvan

Maryland State Highway Administration

Heidi Van Luvan discussed the development of HOV facilities in the Baltimore area and in the Maryland suburb of Washington, D.C. She summarized the planning studies

and the HOV projects currently underway. Ms. Van Luven covered the following topics in her presentation.

- ! A proactive HOV strategy has been taken in Maryland. A long-range system plan was adopted to guide the development of future HOV facilities. Short-term actions have also been taken to preserve right-of-way for future projects. The long-range HOV system plan includes HOV facilities on the beltways around Baltimore and Washington, D.C., as well as the grid system between the two metropolitan areas. A number of radial routes are also included in the plan.
- ! Concurrent flow HOV lanes are being planned on a 32 mile section of the Baltimore Beltway. Some parts of the facility are in the design stage, while others are in the planning phase. A few sections are under construction. The HOV lanes in these sections will be striped as wide shoulders initially. The intent is that once HOV volumes increase, it will be opened as an HOV lane.
- ! A similar approach has been taken on I-95. Overhead signs indicate that the shoulders are future HOV lanes. These lanes will be open to HOV traffic when the HOV lanes on the Baltimore Beltway are completed.
- ! A number of projects should be implemented on U.S. 50 by the Year 2000. Wide shoulders have already been constructed on U.S. 50, and are signed as future HOV lanes. It is anticipated that they will be opened to HOV traffic in a few years.
- ! A planning study is underway on U.S. 301. The Major Investment Study (MIS) is examining alternatives in the 50 mile corridor. The three year study includes a 75 member citizen task force to help provide local input. The task force is examining the transportation alternatives and land use issues in the corridor. The task force recently recommended HOV lanes on Maryland 5 and on a connecting bypass. The land use portion of the study recommended focusing future growth around the transportation facilities, providing park-and-ride lots at strategic locations, and preserving right-of-way for a future LRT line.
- ! Another major study is focusing on the Capital Beltway in the Washington, D.C. area. The Capital Beltway in Maryland is 42 miles long. Major growth is occurring in the beltway corridor and traffic congestion is a significant problem. The right-of-way in the corridor is very limited. A number of HOV alternatives are being examined in the study. These include concurrent

flow lanes, a busway, and barrier separated lanes. The study will be completed in the Fall of 1998.

- ! HOV alternatives are being considered on the Woodrow Wilson Bridge, which is a draw bridge on I-95. The bridge is currently operating at almost twice it's design capacity. Further, when the draw bridge opens traffic delays can be significant. A number of proposals are being examined, including eight-general purpose lanes and two HOV lanes. The preferred alternative should be selected in early 1997.
- ! A shoulder bus lane is currently in operation on U.S. 29 and a study is underway examining the potential of a median busway. Planning for the lanes started in 1991, when almost ten miles of I-270 were widened to eight lanes and four continuous collector-distributor lanes. Signs were placed over the new median lane that read "Future HOV Lane." These lanes should be open to HOVs later this year. A short three-mile section was recently opened on the eastern connector. It will connect to the mainline HOV lane in the future. The lane operates in the peak-period, peak-direction with a 2+ vehicle occupancy requirement. Currently, approximately 500 vehicles are using the lane in the peak-hour. Future connections to the Capital Beltway are also being explored.

Dallas Interim HOV Lanes

Doug Skowronek

Texas Transportation Institute

Mr. Skowronek discussed the HOV planning activities in the Dallas area. He summarized the status of the East R. L. Thornton HOV lane and the facilities under construction on the Stemmons Freeway. Mr. Skowronek covered the following points in his presentation.

- ! The HOV facilities in the Dallas area represent the coordinated efforts of Dallas Area Rapid Transit (DART) and the Texas Department of Transportation (TxDOT). The East R. L. Thornton Freeway (I-30) contraflow lane was the first freeway HOV lane in North Texas. It uses the moveable barrier technology to create the HOV lane. I-30 is an eight-lane radial freeway located on the east side of the Dallas. The facility experiences a high directional split in the peak-periods. The HOV lane operates in the morning and afternoon peak-periods with a 2+ vehicle-occupancy requirement.
 - ! The barrier transfer vehicle operates at about four miles per hour. In the morning it takes approximately 90 minutes to set up the lane. The vehicle starts at 4:00 a.m. and the lane is open to traffic at 6:00 a.m. In the afternoon, the set-up starts at 2:30 p.m. and the lane opens at 4:00 p.m. To date, the barrier transfer machine has worked well and only a few problems have been encountered.
 - ! Vehicles access the lane from a short concurrent flow HOV lane and a crossover. Currently, the morning peak hour vehicle volumes in the HOV lane are averaging approximately 55 buses and 1,300 carpools. The 55 buses are moving some 1,500 passengers and the carpools carry an additional 2,800 passengers. Bus ridership increased by approximately eight percent when the lane first opened. The violation rate has been about one percent. DART is responsible for enforcement.
 - ! Concurrent flow HOV lanes will be opening later this year on the Stemmons (I-35E) Freeway. The Stemmons Freeway is a six lane radial facility with an average daily traffic of 150,000 vehicles. Limited access concurrent flow HOV lanes on the inside shoulders are currently under construction. At 2+ vehicle-occupancy requirement will be used, and the lane will operate on a 24-hour basis. The HOV lane is approximately seven miles in length in the south bound direction and five miles in the north bound direction.
- There are two intermediate access points and two enforcement areas.
- ! The freeway lanes have been narrowed from 12 feet to 11 feet to allow for an 11.5 foot HOV lane, a 2.5 foot buffer, and a 2 foot off-set between the HOV lane and the center median. At the south end of the facility, a one-lane reversible ramp has been constructed to provide better access for HOVs continuing south on I-35E.
 - ! Demand projections forecast that 1,200 vehicles, carrying 3,500 people will use the lanes during the peak hours. Travel time savings for HOVs are estimated at nine minutes during the morning peak hour and five minutes in the afternoon. The facility is scheduled to open in the middle of September.
 - ! I-635 is an eight lane circumferential freeway, with average daily traffic volumes of 240,000 vehicles. It has an almost equal directional split. Concurrent HOV lanes on the inside shoulder are under construction on a 6.5 mile section. Limited access will be provided to the lanes, and a 2+ vehicle-occupancy requirement will be used. The lanes will operate on a 24-hour basis.
 - ! The cross section for the I-635 facility includes an 11 foot HOV lane, a 3 foot off-set, and a 2.5 foot buffer. Three enforcement areas are also being provided. Travel time savings for HOVs is estimated at 13 minutes in the peak hours.
 - ! A number of marketing and public information activities are being conducted with the opening of the Stemmons HOV lanes. DART sponsored a one-day seminar on the operation and enforcement of the lanes for local elected officials, enforcement personnel, and other groups. A video and slide presentation is also being used to inform commuters, neighborhood groups, businesses, and other groups. A HERO program, like the one in Seattle, is also being considered to assist with enforcement.

I-66 In Northern Virginia

Paul Prideax

Virginia Department of Transportation

Mr. Prideax discussed the HOV facilities in the Northern Virginia/Washington, D.C. Metropolitan area. He described a one-year demonstration project lowering the vehicle-occupancy requirement on the I-66 HOV facility from 3+ to 2+. Mr. Prideax covered the following points in his presentation.

- ! The Northern Virginia/Washington, D.C. area has a wide spectrum of transportation alternatives for commuters. These include freeways, HOV facilities, commuter rail, Metro rail, commuter buses, vanpools, carpools, and a bicycle and pedestrian network. Freeways in the area include I-95, I-66, I-395, and I-495. HOV lanes are in operation on I-95, I-395, and I-66.
- ! Two lane, barrier separated HOV facilities are located in the median of I-95 and I-395 (Shirley Highway). The lanes are reversible, operating in the inbound direction in the morning and in the outbound direction in the afternoon. I-66 outside of the Beltway includes concurrent flow HOV lanes. The lanes are restricted to HOVs only during the peak hours in the peak-direction of travel.
- ! I-66 inside the Beltway is restricted to HOVs during peak-periods in the peak-direction of travel. Thus, in the morning the two freeway lanes in the inbound direction are restricted to HOVs. This operation is the result of a decision from the U. S. Secretary of Transportation in the 1970s. This requirement, which is known as the Coleman Decision after the Secretary at the time, places additional restrictions on the State of Virginia. For example, it requires that any changes or modifications to the HOV requirements be approved by the Metropolitan Washington Council of Governments, the Washington Metropolitan Area Transit Authority, the Governor of Virginia, and the U. S. Secretary of Transportation.
- ! When the I-66 facility first opened, a 4+ vehicle-occupancy requirement was used. This requirement was lowered to 3+ in response to concerns that the facility was underutilized. Although vehicle volumes increased, there was still criticism that the lanes were not adequately used. As a result, the Virginia Department of Transportation (VDOT) initiated a one-year demonstration lowering the vehicle-occupancy requirement to 2+.
- ! A before-and-after evaluation was conducted on the demonstration. Vehicle-occupancy and vehicle classification counts, and vehicle travel time runs were taken before the demonstration was initiated and at points during the test. In addition, ridership levels on commuter rail, METRO, and buses were also monitored, along with HOV violation rates, accident statistics, and air quality impacts. This information was collected for I-66 and for parallel roadway and transit facilities.
- ! The results of the evaluation have been documented in a report by VDOT. Both positive and negative impacts were noted during the demonstration. During the 2+ demonstration, 50 percent more people were moved in 62 percent more vehicles, while still operating at or above the speed limit. Carpools did divert from congested parallel roadways to I-66 with the lower occupancy requirement. There was also a reduction in the violation rates and a reduction in the accident rates during the demonstration.
- ! The change in the vehicle-occupancy requirement appeared to have a slight negative impact on transit services in the corridor. Slightly under a three percent decline was documented on combined transit services in the corridor. Based on analysis using the regional air quality model, emissions increased during the demonstration. I-66 was operating just under capacity during the demonstration, which could be a problem for future growth.
- ! The Department recommended continuing the 2+ vehicle-occupancy level after the demonstration was completed and a formal request was made to all four agencies. This recommendation was approved with certain conditions. First, a transit feeder bus fare “buy down” strategy was implemented to offset ridership loss. Second, a volume threshold was established to identify the need to reevaluate the policy and to consider raising the vehicle-occupancy level back to 3+. The level is 1,950 vehicles per hour per lane in the peak direction on a recurring basis. Quarterly data collection is being conducted to monitor conditions on the facility. In April of 1996, all four groups approved the continuation of the 2+ vehicle-occupancy requirement.

International HOV Experience

Chuck Fuhs, Parsons Brinckerhoff — Presiding

HOV Facilities in Madrid, Spain

Julio Pozueta

Departamento de Urbanistics

Angel Aparicio

Ministry of Transport

Mr. Pozueta and Mr. Aparicio discussed the HOV lanes on National Highway 6 in Madrid. They also showed a video on the operations of the facility. Mr. Pozueta and Mr. Aparicio covered the following points in their presentations.

- ! The population of the Madrid metropolitan area is approximately 4.5 million people. The transportation system serving the area is very complex. It includes an extensive roadway and freeway system, a subway, suburban rail service, and buses. Bus-only lanes are in operation on a number of arterial streets. The bus-only lanes were first implemented in the 1970s to provide buses with faster operating speeds in congested corridors. Contraflow, barrier-separated, and concurrent flow lanes have all been used. The experience with these facilities has been very positive, but enforcement has been a problem in some areas.
- ! The Federal Ministry and the Regional Department of Transportation recently presented a new freeway plan for the Madrid metropolitan area. It includes the construction of several new HOV lanes to help reduce congestion in many corridors. The plan will be implemented through the development of detailed plans for each corridor. These plans will examine the most appropriate type of HOV facility for the specific corridor.
- ! Planning and design activities have been initiated in the National Highway 6 corridor. A 16-kilometer, two-lane, barrier-separated, reversible HOV facility is being considered in this corridor. The lanes would be located in the median of the freeway, which is being widened to eight lanes. The corridor, which is located on the northwestern side of the city, includes rapidly growing suburban residential areas. Residents of the area tend to have high incomes and most drive alone to work in Madrid. Congestion is a problem in the corridor.
- ! It is anticipated that the HOV lanes will be open to buses and 3+ carpools. The lanes will also be connected to the radial street bus-only lanes in the downtown area and the downtown bus station. A travel

time savings of 20 minutes is being projected for individuals using the facility in the year 2000.

HOV Facilities in Capetown, South Africa

Hein Stander

BKS, Inc.

Mr. Stander discussed a new HOV facility in Capetown, South Africa. He provided an overview of the transportation system in Capetown and the development of the HOV lanes. Mr. Stander covered the following topics in his presentation.

- ! The population of the Capetown metropolitan area is about 2.5 million people. Two major freeways, N-1 and N-2 link the suburbs to the downtown area. Commuter rail lines also serve these corridors.
- ! The HOV project was first considered when the need arose to repave the four lane N-2 Freeway. A third lane in each direction was added in some areas, and a feasibility study recommended reserving the lanes for public transport. Construction of the lanes, which are approximately four miles in length, started in 1993, and the facility opened in December of 1995. The lanes are open to buses and minibuses/taxis, which accommodate between 10 and 16 passengers. The lanes are reserved for buses and minibuses/taxis during the peak-period in the peak-direction of travel.
- ! The N-2 Freeway is a congested facility. Initial use of the HOV lanes has been good. Some 40 buses and 350 minibuses/taxis use the lane during the morning peak-hour, carrying approximately 7,000 passengers. During the peak hour, the lanes carry more people than the adjacent freeway lanes. The average vehicle-occupancy levels in the general-purpose lanes are slightly over two people per vehicle due to the still relatively low vehicle ownership rates in the city. Since the lanes are only four miles long, however, there is still significant traffic congestion in the corridor.
- ! Travel time savings, traffic volumes, accidents, violation rates, and public responses are all being monitored as part of an evaluation study. The initial results indicate an increase in vehicle volumes in both the general-purpose lanes and the HOV lanes. The number of buses increased from 40 to 50, and the number of minibuses/taxis increased from 350 to 415. Travel time savings of at least eight minutes were

realized by buses using the lane. A few accidents were recorded, but these did not appear to be out of the ordinary. There is some concern about the speed differences between the lane and the general purpose lanes, however. Enforcement has also been a bit of a problem. Public response has been generally good, although there were a few negative comments initially.

HOV Facilities in Zurich, Switzerland

Christian Thomas

Zurich Transport Ministry

Mr. Thomas provided an overview of the transportation system in Zurich. He discussed the roadway, tram, and bus systems in the city and highlighted some of the issues and opportunities in the area. Mr. Thomas covered the following points in this presentation.

- ! Zurich is surrounded by mountains, hills, rivers, and a lake. These all limit the expansion of the city, including the transportation system. The roadway system has not changed significantly in the last 20 years because of these limitations.
- ! Zurich has an extensive street car or tram system. There are 11 lines serving all parts of the city. The older parts of the center city are very densely developed. Buses are not allowed in this area because of the narrow streets. Trams are allowed in the center city due to their carrying capacity and ability to maneuver in the narrow street system.
- ! A number of priority treatments are used to provide buses and trams with travel time savings and enhanced travel time reliability on the arterial street network. Measures include traffic signal priority and pre-emption treatments, queue jumps around congested areas, and other transportation system management (TSM) techniques. The use of these strategies provide “virtual” HOV lanes in many areas.
- ! The transportation system in Zurich provides an excellent example of a multimodal approach. All of the various modes work together to enhance the mobility of area residents and to maintain a high quality of life.

HOV Facilities in Taipei, Taiwan

Jason Chang

National Taiwan University

Chen-Tan Ho

Taipei Department of Transportation

Dr. Chang and Mr. Ho discussed the downtown bus lanes in Taipei. They provided an overview of the development and the current operation of the contraflow bus lanes. The following points were covered in their presentation.

- ! Traffic congestion is a problem in Taipei, especially in the downtown area. A number of approaches are being taken to address this problem. A rapid rail system is being developed and a series of downtown bus lanes are being implemented. Buses represent the backbone of the transit system in the area.
- ! A variety of approaches and designs being used to develop the bus lanes. For example, one contraflow bus lane was implemented by changing a two-way street to a one-way arterial and a bus lane. In other cases, the bus lane is located in the center median of the roadway.
- ! Two of the older bus lanes are located on Xin-Yin Road and Zen-Eye Road. These parallel streets connect the older downtown area with a rapidly developing residential and commercial area to the east. Approximately 80 to 100 buses use each lane during the morning and afternoon peak hours.
- ! In most cases, bus stops are located before an intersection to help speed the flow of buses. A variety of signs and pavement markings are used to delineate the bus lanes. Diamond markings are used on the pavement to help identify the lanes, along with overhead signs.
- ! The lanes have improved bus travel speeds in the downtown area, especially during the morning peak-period. Ridership increases have also been recorded on some routes using the lanes. The reaction from bus passengers has been positive, and for the most part motorists and taxi drivers have been supportive of the lanes.
- ! Additional bus lanes are being considered in the downtown area and in other parts of the city. In addition, HOV facilities are being examined on some freeways in the region.

Arterial Street HOV Applications

Bill Finger, City of Charlotte Department of Transportation— Presiding

Bus Stop Treatments with Arterial Street HOV Facilities

Kevin Hall

Texas Transportation Institute

Kevin Hall summarized the results of a Transit Cooperative Research Program (TCRP) study examining bus stop locations and bus stop design treatments on arterial streets. The objectives of the study were to assess current practices with bus stop designs and to develop guidelines for use by practitioners interested in locating and designing bus stops to maximize transit operations and to enhance passenger convenience. The following elements were highlighted by Mr. Hall in his presentation.

- ! The study included a mail-out survey of transit systems throughout the country and on-site visits to cities in Arizona, Michigan, and California. The on-site visits involved interviews with representatives from local transit agencies and visual observations of some 270 bus stops. More detailed field studies were conducted at 14 bus stops, and pedestrian flow assessments were carried out at 10 locations.
- ! One of the most popular treatments for bus stops on arterial streets is the bus bay. The primary reason for using a bus bay is to allow the transit vehicle to stop to drop off and pick up passengers outside the main traffic lane. One option to this approach is the open bus bay, which allows buses to pull into a bus bay at a far side stop.
- ! The queue jumper bus bay is sometimes found with arterial street HOV facilities. This treatment allows buses to use the right turn lane at an intersection to bypass traffic waiting at the signal.
- ! One of the field studies examined the operations of a queue jumper bus-lane and bus bay in Arizona. This facility allows buses to bypass general-purpose traffic at a congested intersection. Buses are allowed to use the right-turn lane for through movement, pulling directly into a far-side open bay bus stop. The right-turn lane is signed “Right Turn Only - Buses Exempted.” This approach might be appropriate for consideration at intersections with heavy volumes of buses.
- ! Pedestrian treatments and amenities can also be used to enhance arterial street HOV lanes. Sidewalks, landscaping, shelters, and other amenities can improve access to bus stops located along arterial streets and can enhance passenger comfort. Providing pedestrians with easy and safe access to bus stops is important to encourage ridership. Many transit agencies are working with developers and local businesses to better incorporate bus stops into adjacent land uses.
- ! Bus stops must also meet the requirements of the Americans with Disabilities Act (ADA). A number of elements will need to be examined to ensure that bus stops are accessible to individuals with special needs.
- ! Coordinating bus stop enhancements with arterial street improvements is one approach being used in some areas. For example, in Phoenix, bus stops and pedestrian enhancements are being coordinated with, and incorporated into, the local street improvement program.
- ! Available right-of-way, land use compatibility, driveway access, and other issues need to be considered in the development and placement of bus bays and bus stops. Signing is also critical for all types of arterial street HOV and bus stop treatments.

Arterial Street HOV Lanes - Can They Be a Reality: Policy Experience from Metropolitan Toronto

Tom Mulligan

Municipality of Metropolitan Toronto

Tom Mulligan discussed the policies supporting arterial street HOV applications in the Toronto area and the experience to date with arterial street HOV lanes. The HOV policies are part of the overall land use and transportation plan, which includes an orientation towards higher land use densities, use of public transit, and less reliance on single-occupant vehicle travel. Mr. Mulligan highlighted the following elements in his presentation.

- ! Metropolitan Toronto is a regional municipality with a population of approximately 2.2 million people. Metropolitan Toronto, which is comprised of six local municipalities, is responsible for the major regional services including police, welfare, transit, water and sewer, and the regional road system. The local municipalities are responsible for land use planning, garbage collection, and the local road system. Metropolitan Toronto is part of the Greater Toronto

Area (GTA), which includes five regional municipalities and has a population of over 4 million people. Metropolitan Toronto is located in the center of the GTA.

- ! The GTA has experienced significant population and employment growth over the last 20 years, and this growth is projected to continue. Some 2 million more people will live in the area by the year 2011. The majority of recent residential development has been low density suburban housing. As a result, the GTA has experienced significant increases in traffic. If the current trends continue, the existing transportation system will not be able to accommodate future traffic volumes.
- ! Much of the transportation system in the areas is at or near capacity. As a result, demand management techniques are being considered to help address future needs. Long-range land use and transportation plans focus on reducing the dependence on single-occupant vehicles. Strategies include HOV facilities, transit services, higher density developments, walking, and bicycling.
- ! Arterial street HOV lanes are an important part of the short and long range transportation strategies. Arterial HOV facilities can improve transit operations and increase ridesharing, as well as enhancing the overall environment. An arterial street HOV network plan was developed in 1991, and it will be implemented over a 20 year period. The network plan focuses on suburban areas, linking major residential and employment modes. Connections to downtown are limited as these trips are well served by existing rapid transit and commuter rail.
- ! In 1991, however, the HOV network did not include any freeway HOV facilities. In Toronto, the freeway system is under the jurisdiction of the Ministry of Transportation of Ontario. The Ministry did not have an HOV plan at that time. Since 1991, however, the Ministry, working with the Regional Municipalities, has developed a comprehensive GTA-wide freeway HOV plan.
- ! Implementation of the arterial street HOV network began in 1992. Currently, approximately 40 lane miles are in operation. The curbside lane is used for the HOV facility. Buses, taxis, vanpools, carpools with three or more people (3+), and bicycles are allowed to use the lanes. The normal hours of operation are weekdays from 7:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m. Recently, a number of factors including

reduced funding, utilization levels, and public reaction, have lead to a reexamination of the HOV facilities.

- ! Research and information on arterial HOV facilities is extremely limited. In addition, the arterial street environment is much different than the freeway environment. These two elements make assessing the existing arterial street HOV lanes in Toronto difficult. Arterial street HOV lanes look different, operate differently, and should be evaluated differently than freeway facilities.
- ! Bus travel times have improved with the arterial HOV lanes in Toronto. On average, buses save at least four to five minutes by using the lanes. Carpool and vanpool travel times are about the same as vehicles in the general purpose lanes, primarily due to buses stopping in the lanes. The number of carpools has not increased significantly since the lanes were open. The HOV lanes usually carry as many or more people than the general-purpose lanes. However, violation rates are high in many areas.
- ! Overall, the arterial street HOV plan appears appropriate, but the implementation process may be slowed down to devote more attention to the operation of existing facilities. A major issue has been the role of the arterial street HOV lanes, including bus-only use. Some transit advocates and environmental groups have promoted bus-only facilities. Toronto has had bus-only lanes since the early 1970s.
- ! Another issue is whether to convert existing general-purpose lanes to HOV lanes or to widen the roadway to add new HOV lanes. Most of the planned HOV lanes are in suburban areas. Roads in these areas have two lanes in each direction. Most corridors have available right-of-way to widen to six lanes, and plans call for these new lanes to be HOV lanes. There is opposition in some areas to the widening projects, however. In some older neighborhoods, where right-of-way is not available, curb lanes have been converted for HOV use. There has also been opposition in these areas to curb lane use.
- ! Enforcement continues to be a challenge with the arterial street HOV lanes in Toronto. It is difficult for police to enforce arterial HOV applications. Different measures of effectiveness may need to be applied with arterial projects, and violation rates of 10 to 20 percent may be acceptable if the basic function of the facility is not jeopardized. New enforcement techniques continue to be explored in Toronto.

- ! The experience in Toronto indicates that arterial street HOV lanes offer both unique opportunities and unique challenges. The arterial HOV facilities do function well and do provide benefits to HOVs. It is important to remember that arterial HOV projects are much different than freeway facilities. Keys to success include political and public support, cooperation from the local transit agency, coordinating with the local police, and public information and marketing programs.

Issues with Arterial Street HOV Studies

Susan Serres

Parsons Brinckerhoff

Susan Serres discussed some of the unique aspects associated with evaluating HOV treatments on arterial streets. Since the arterial street environment is much different than the freeway environment, different issues and factors need to be considered in assessing the potential for arterial street HOV facilities. Ms. Serres highlighted following points in her presentation.

- ! Arterial street HOV facilities offer a number of potential benefits. These include increasing transit travel speeds and improving travel reliability, linking park-and-ride lots and freeway HOV lanes, and providing priority at signalized intersections. The arterial environment is different than the freeway environment, however. As a result, issues such as on-street parking, driveway access to developments, and turning vehicles at intersections may influence arterial HOV treatments.
- ! Continuous right side HOV lanes are one of the most frequent type of arterial street applications. A solid line or skip-striping may be used between the HOV lane and the mixed-traffic lane. General-purpose traffic may be allowed to use the lane at intersections for right turns, or a separate right turn lane may be provided.
- ! Adequate signing is needed to communicate to both HOV lane users and general-purpose traffic. Clear and sample messages are important. Frequent signs should be provided.
- ! Arterial street HOV lanes may be implemented by converting a curb lane, a shoulder, or a general-purpose lane, as well as by widening a roadway and by adding a new lane. All of these approaches have advantages and disadvantages.
- ! A left-side HOV lane may be considered in unique situations. Providing for left turns and providing transit access may both be issues with left-side treatments. A center HOV lane represents another approach that may be appropriate in some instances. Contraflow lanes, like the examples in Pittsburgh, are still another technique used in a number of areas. Finally, bus-only streets and transit malls are in operation in a few areas.
- ! A number of treatments can be used at signalized intersections to give priority to HOVs. These include improved signal timing, signal priority, and queue jump lanes. These treatments tend to be used with buses, rather than with vanpools and carpools.
- ! Spot treatments focus on a specific area. Examples of HOV spot treatments include turning restrictions for general-purpose traffic, allowing HOVs to make turns at certain areas, and other specific elements.
- ! Representatives from businesses and other land uses in the corridor should be involved early in the planning process for arterial street HOV facilities. Issues relating to on-street parking, delivery vehicles, and driveway access may need to be addressed with these treatments. Multi-agency teams represent a good approach for planning, designing, implementing, and operating arterial street HOV lanes.
- ! The planning process used in the Seattle area includes a number of steps. First, candidate corridors for arterial street HOV projects are identified. Assessing both existing and design year conditions is an important part of this process. Intersection operations, transit activities, and HOV demand represent a few of the factors that should be evaluated. Potential HOV strategies are then identified and evaluated.
- ! A fatal flaw screening may be used as a first level of evaluation. The viable alternatives can then be applied to the corridor or roadway, and a more rigorous evaluation can be completed. This evaluation may include quantitative measures of effectiveness such as cost, travel time savings, cost effectiveness, and person throughput. Qualitative measures may include community support, safety, enforcement, and travel time reliability.
- ! Arterial street HOV projects represent viable alternatives in many urban areas. More research is needed on the best treatments for different situations. More information on best practice case studies would also be of help.

Hot Topics with HOV Facilities II

Kevin Haboian, Parsons Brinckerhoff — Presiding

Market Strategies and Potential Utilization of the Atlanta Express Lanes

Gary Erenrich

COMSIS Corporation

Mr. Erenrich provided an overview of the methods and procedures used to identify and prioritize potential HOV markets and projects in Atlanta. A strategic modeling process and an infrastructure readiness review were used to identify park-and-ride lots, ridesharing programs, agency coordination, and employer programs to support the implementation of approximately 30 miles of HOV lanes in the Atlanta area. Mr. Erenrich covered the following points in his presentation.

- ! The TDM estimation model developed by COMSIS in the early 1990s was used in this study to help identify the market potential for area-wide and employer-based strategies. The study examined three potential markets — existing vanpools, carpools, and buses; commuters who change from driving alone to using an HOV; and commuters who shift to complementary TDM strategies offered by employers. The potential for each of these markets to increase the use of the HOV lanes was assessed.
- ! Prior to the opening of the HOV lanes, approximately 80 percent of the commuters in the Atlanta metropolitan area drove alone. Carpoolers account for some 12 percent of all commuters, while transit has even a lower share. One reason for the low transit use is that only three of 13 counties in the region have transit services. The Metropolitan Atlanta Rapid Transit Agency (MARTA) serves two counties and one other county has its own system. In addition, suburb-to-suburb commute trips have increased significantly in the last few years. These trips are not served by public transit.
- ! The study identified seven major activity centers in the area. Commuters could use the HOV lanes on I-20, I-85, and I-75 to reach four of these activity centers. The location of park-and-ride lots and other supporting facilities were also identified.
- ! The first step in the assessment examined the potential of the three markets noted previously. The 1996 network trip table was used to estimate the anticipated travel time savings from using the HOV lanes and to identify high, medium, and low markets. The high

potential market was comprised of commuters who could utilize the HOV lanes for a majority of their trip. The medium market had less direct service using the HOV lanes, while the low market had trip origins and destinations that did not match the HOV lanes at all. The analysis indicated that approximately 25 percent, or 465,000 of the home-based work trips to the seven major activity centers could use some portion of the HOV lanes. Some 29,000 of these trips were estimated to be in the high potential category.

- ! A similar analysis was conducted focusing on the home end of the trip. The origin and destination information was further analyzed by corridor to identify trips that would likely use different HOV lanes.
- ! The TDM model, which used a pivot point analysis, was used to analyze the impact of various TDM and employer-based programs. The outputs of the model include modal split, average vehicle occupancy, person trips, vehicle trip reductions, and vehicle miles of travel reduction. Surveys of employers, employees, and residents were also conducted as part of the study.
- ! The results of both efforts were used to identify the strategies that provided the largest impact for travel to each of the major activity centers. The results indicate that travel time savings provide the most incentive for HOV lane users. For example, travel time savings were rated above cost savings. Employer-based programs also offer the potential to support HOV lane use, along with regional carpool, vanpool, and transit services. The need to extend the HOV lanes was also noted.

HOV — A Component of the Central Florida Transportation Solution

Jack Freeman

HNTB Corporation

Mr. Freeman discussed HOV related activities in the Orlando area. He provided an overview of the planning activities underway in the I-4 corridor, including the Multimodal Master Plan. Mr. Freeman addressed the following elements in his presentation.

- ! The I-4 Freeway was constructed in the 1950s and 1960s. In the mid-1980s, a study examined future freeway expansion needs. One of the recommendations

from this study was that 16 lanes were needed on I-4 in the downtown Orlando area. This recommendation generated a great deal of negative response from neighborhood, environmental, and other groups. Partly as a result of this study, the Florida Department of Transportation (FDOT) developed an Interstate Highway Policy in 1991. The policy directs that multimodal considerations should be significant elements of any upgrading of the Interstate system. The policy also placed a cap on the number of lanes on the Interstate system in the state. The policy states that Interstate freeways should include no more than six general-purpose lanes and four special use or HOV lanes, for a maximum of 10 lanes.

- ! The Department, working with the MPO and other agencies, recently completed the I-4 Multimodal Master Plan and a Major Investment Study (MIS) for the I-4 Freeway in the Orlando area. The development of these plans was guided by the Interstate Highway Policy. The I-4 corridor included in the study is 75 miles in length and covers four counties. I-4 is currently six lanes in the metropolitan Orlando area and four lanes in other parts of the corridor. I-4 serves the major tourist attractions in the area and experiences severe levels of congestion.
- ! The I-4 Multimodal Master Plan includes HOV, transit, and highway improvements. The planning process examined the best investment strategy to enhance mobility in the corridor. Alternatives examined included adding general-purpose lanes and special use or HOV lanes. Various HOV options were considered, including concurrent flow lanes and exclusive barrier separated lanes.
- ! A number of transit alternatives were also examined in the development of the Master Plan. These included express buses in the HOV lanes, LRT, and high speed rail. Nine different options, called Conceptual Mobility Enhancement Alternatives, were developed and evaluated. These options included different combinations of freeway, HOV, and transit elements. These alternatives were evaluated against a series of measures of effectiveness, as well as different financing strategies.
- ! The adopted alternative in the I-4 Multimodal Master Plan includes six general purpose lanes, two HOV lanes, and LRT. The plan also included a financing and implementation strategy. The anticipated construction cost for all of the improvements is approximately \$2.7 billion. It is estimated that the implementation of the plan will take until at least 2020. Staging of the

improvements will be linked to available financing. Interim HOV lanes may be used during construction to help manage traffic and to start encouraging transit ridership, vanpooling, and carpooling.

- ! Concurrent HOV lanes were included in the recommended plan with some sections of barrier separation. Although additional analysis is underway, a 3+ vehicle-occupancy requirement was recommended. Other major factors examined as part of the HOV analysis were enforcement techniques, access points, transit services, and other supporting elements.
- ! An interim HOV lane is being considered to help address congestion issues while the full facility is being constructed. The interim facility would be a single reversible HOV lane located in the freeway median.

Canada's First Interprovincial HOV Facility

Ottavio Galella

TRAFIX Consultants

Salah Barj, STO

Mr. Galella discussed a new HOV project in Ontario and Quebec. The facility is on the Portage Bridge, which connects Ottawa, Ontario and Hull, Quebec. Mr. Galella covered the following points in his presentation.

- ! The project required a great deal of coordination among agencies in the two Provinces. The project has two objectives. The first was to improve travel time and travel time reliability for HOVs. The second was to connect the existing Transitway in Ottawa with arterial street HOV lanes in Quebec.
- ! The Portage Bridge has three traffic lanes in each direction of travel and a narrow center median. Average daily traffic on the bridge is approximately 52,000. The directional split is about 60/40 on the facility. Average delay time to cross the bridge during the peak hour ranges from 5 to 20 minutes.
- ! The feasibility study completed on the HOV or reserved lane indicated that some 75 buses, 52 taxis, and numerous 3+ carpools use the bridge during the peak hour. The person throughput of the HOV lanes was estimated at about 2,000 people per hour.
- ! The existing HOV facility is a curb lane on the right side of the street. Buses must merge across the general traffic lanes on the bridge to make a left-hand turn. A number of alternatives were examined to provide

priority to HOV in the area. The implemented alternative includes a leftside HOV lane on the bridge and signal priority at the intersection.

- ! The transit authority has realized significant benefits since the facility was implemented. Buses crossing the bridge save between 5 and 20 minutes depending on the time of day. The authority has also realized operating savings by eliminating two buses due to these time savings. The facility provides a good example of a relatively low cost approach to providing buses, taxis, and 3+ carpools priority across a congested bridge.

NCHRP HOV Systems Manual

*Katherine F. Turnbull, Texas Transportation Institute and Donald G. Capelle,
Parsons Brinckerhoff — Presiding*

Dr. Turnbull and Dr. Capelle provided an overview of the HOV Systems Manual being developed under the sponsorship of the National Cooperative Highway Research Program (NCHRP), by the Texas Transportation Institute (TTI) and Parsons Brinckerhoff. The manual will provide a comprehensive approach to developing policies, planning, designing, implementing, marketing, operating, enforcing, and evaluating HOV facilities. The steps in developing the Manual were reviewed. These included a state-of-the-art literature review and a survey of representatives from state departments of transportation, transit agencies, MPOs, cities, and other groups.

The outline for the HOV Systems Manual was reviewed and the major topics to be addressed in each section were discussed. The following chapters will be included in the Manual.

Chapter 1 — How to Use This Manual

Chapter 2 — Introduction to HOV Facilities

Chapter 3 — Policy Considerations with HOV Facilities

Chapter 4 — Planning HOV Facilities

Chapter 5 — Operating and Enforcing HOV Facilities on Freeways and in Separate Rights-of-Way

Chapter 6 — Design of HOV Facilities on Freeways and in Separate Rights-of-Way.

Chapter 7 — Operating and Enforcing of Arterial Street HOV Facilities

Chapter 8 — Design of Arterial Street HOV Facilities

Chapter 9 — Transit and Supporting Programs and Policies

Chapter 10 — Supporting Programs and Policies

Chapter 11 — Implementation Considerations with HOV Facilities

Chapter 12 — Marketing HOV Facilities

Chapter 13 — Monitoring and Evaluating HOV Facilities

Chapter 14 — Additional Research Needs

The elements to be included in the various chapters were discussed, and participants identified issues and other items to be included. These comments will be used in developing the final manual, which will be available in 1997.

FHWA HOV Demand Estimation Project

Richard Dowling, Dowling and Associates — Presiding

Mr. Dowling provided an overview of the recently completed HOV Demand Estimation project, which was sponsored by FHWA. The research project was a two-year effort examining current HOV demand estimation techniques and developing a methodology and a computer software program. The research was completed by Cambridge Systematics, Inc., in association with Dowling and Associates, SYSTAN, Inc., and Dr. Adolph May.

Mr. Dowling reviewed the steps in the research project. These included an assessment of current HOV demand models, a survey of practitioners, the development of the new HOV demand estimation procedures, and the development of the computer software program.

A demonstration was provided on the use of the software package. The various features of the model were highlighted through example applications. The use of the model in different planning scenarios was also described.

The HOV Demand Estimation model can be obtained through FHWA. The software is also being distributed through McTrans.

List of Participants

**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV FACILITIES
AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
<u>Busway</u>					
Ottawa, Ontario, Canada					
Southeast Transitway	1 each direction	5.1 (3.0)	24 hours	Buses only	No
West Transitway	1 each direction	11.0 (6.5)	24 hours	Buses only	No
Southwest Transitway	1 each direction	4.2 (2.5)	24 hours	Buses only	No
Pittsburgh, PA					
East Patway	1 each direction	9.9 (6.2)	24 hours	Buses only	No
West Patway	1 each direction	6.6 (4.1)	24 hours	Buses only	No
Minneapolis, MN					
U of M Intercampus Busway	1 each direction	1.8 (1.1)	24 hours	Buses only	No
Dallas, TX					
Southwest Texas Medical Center busway	1 each direction	1 (0.6)	24 hours	Buses only	No
<u>Barrier-Separated: Two-Way</u>					
Los Angeles, CA					
I-10 (El Monte) San Bernardino Fwy.	1 each direction	6.4 (4)	24 hours	3+ HOVs	Changed from buses only in 1978
I-105/I-110 fwy/fwy connectors	1 each direction	1.6 (1)	24 hours	2+ HOVs	No
Denver, CO					
I-25 opposing flow not separated	1 each direction	12 (7.5)	6 am to 10 pm	Buses only	No
Orange County, CA					
I-5	1-2 each direction	7.2 (4.5)	24 hours	2+ HOVs	No
Houston, TX					
I-610/US 290 elevated, opposing flow not separated	1 each direction	2.4 (1.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
Seattle, WA					
I-90	1 each direction	2.4 (1.5)	24 hours	2+ HOVs	No
<u>Barrier-Separated: Reversible-Flow</u>					
Northern Virginia					
I-395 (Shirley Hwy.)	2 reversible	24 (15)	24 hours	2+ HOVs	No
Houston, TX					
I-10 (Katy Freeway)	1 reversible	21 (13)	5 am-12 noon, 2-9 pm, 5 am-5 pm WB Sat., 5 am-9 pm Sun.	3+ peak hours, 2+ other times	Opened for authorized buses and vanpools, lowered and raised since
I-45 (Gulf Freeway)	1 reversible	19.4 (12.1)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
US 290 (Northwest Freeway)	1 reversible	21.6 (13.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	No

(Continued)

**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV FACILITIES
AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
I-45 (North Freeway)	1 reversible	21.6 (13.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	Started with buses and vanpools only, changed operation periods
US 59 (Southwest Freeway)	1 reversible	18.4 (11.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
San Diego, CA I-15	2 reversible	12.8 (8)	6-9 am, 3-6:30 pm	2+ HOVs	No
Minneapolis, MN I-394	2 reversible	8 (5)	6-10 am, 2-7 pm	2+ HOVs	No
Pittsburgh, PA I-279/579	1-2 reversible	6.6 (4.1)	5-9 am, noon-8 pm	2+ HOVs, all traffic NB after 8 pm during sports games	Changed from 3+ and operating periods, all traffic allowed to use lanes during sports games downtown
Norfolk, VA I-64	2 reversible	12.8 (8)	5-8:30 am WB, 3-6 pm EB, mixed flow other times	2+ HOVs	No
Seattle, WA I-5 North (Express Lanes)	2-3 reversible	SB 4.2 (2.6) NB 2.6 (1.6)	5-8:30 am SB, 12 noon-4 am NB	2+ HOVs	Changed from 3+ NB
I-90	2 reversible	9.9 (6.2)	24 hours	2+ HOVs	No
<u>Concurrent-flow: Buffer-Separated/Non-Separated</u>					
Phoenix, AZ					
I-10	1 each direction	33.6 (21)	24 hours	2+ HOVs	Changed from 3+
SR 202	1 each direction	12.8 (8)	24 hours	2+ HOVs	No
I-17	1 each direction	9.6 (6)	24 hours	2+ HOVs	No
Vancouver, BC, Canada					
H-99	1 each direction	SB 6.4 (4) NB 1.6 (1)	24 hours	3+ HOVs	Changed from buses only
Los Angeles County, CA					
I-10 (El Monte) San Bernardino Fwy.-(wide buffer separation)	1 each direction	12.8 (8)	24 hours	3+ HOVs	Changed from buses only in 1978

(Continued)
**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV
 FACILITIES
 AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
I-105	1 each direction	25.6 (16)	24 hours	2+ HOVs	No
I-110	2 each direction	24.3 (15.2)	24 hours	2+ HOVs	No
I-210	1 each direction	29.6 (18.5)	24 hours	2+ HOVs	No
I-405	1 each direction	31 (19.4)	24 hours	2+ HOVs	No
I-605	1 each direction	11.2 (7)	24 hours	2+ HOVs	No
SR 91	1 each direction	22.9 (14.3)	24 hours	2+ HOVs	Changed from peak periods only
SR 118	1 each direction	18.2 (11.4)	24 hours	2+ HOVs	No
SR 134	1 each direction	21.3 (13.3)	24 hours	2+ HOVs	No
SR 170	1 each direction	9.8 (6.1)	24 hours	2+ HOVs	No
Orange County, CA					
I-5	1-2 each direction	54.4 (34)	24 hours	2+ HOVs	No
SR 55	1 each direction	19.7 (12.3)	24 hours	2+ HOVs	No
I-405	1 each direction	38.4 (24)	24 hours	2+ HOVs	No
SR 57	1 each direction	19.2 (12)	24 hours	2+ HOVs	No
SR 91	1 each direction	4.2 (2.6)	24 hours	2+ HOVs	No
SR 91 toll/HOV lanes ²	2 each direction	16.2 (10.1)	24 hours	3+ HOVs free	No
Riverside County, CA SR 91					
	1 each direction	27.2 (17)	24 hours	2+ HOVs	No
San Bernardino County, CA					
SR 60	1 each direction	16 (10)	24 hours	2+ HOVs	No
SR 71	1 each direction	3.7 (2.3)	24 hours	2+ HOVs	No
Santa Clara/San Mateo Counties, CA					
US 101	1 each direction	40 (25)	5-9 am, 3-7 pm	2+ HOVs	No
SR 237	1 each direction	9.6 (6)	5-9 am, 3-7 pm	2+ HOVs	No
SR 85	1 each direction	35.2 (22)	5-9 am, 3-7 pm	2+ HOVs	No
I-280	1 each direction	17.6 (11)	5-9 am, 3-7 pm	2+ HOVs	No
San Tomas Expy.(shoulders)	1 each direction	12.8 (8)	6-9 am, 3-7 pm	2+ HOVs	No

(Continued)

**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV FACILITIES
AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
Montague Expy. (shoulders)	1 each direction	9.6 (6)	5-9 am, 3-7 pm	2+ HOVs	No
Alameda County, CA					
I-80	1 each direction	3.8 (2.4)	5-9 am, 3-7 pm	2+ HOVs	No
I-880	1 each direction	8 (5)	5-9 am, 3-7 pm	2+ HOVs	No
Contra Costa County, CA					
I-80	1 each direction	21.9 (13.7)	5-9 am, 3-7 pm	2+ HOVs	No
I-680	1 each direction	23 (14.4)	5-9 am, 3-7 pm	2+ HOVs	No
I-580	1 each direction	9.8 (6.1)	7-8 am, 5-6 pm	2+ HOVs	No
Marin County, CA US 101 (2 projects)	1 each direction	21 (13)	6:30-8:30 am, 4:30-7 pm	2+ HOVs	Changed from 3+
Sacramento, CA SR 99	1 each direction	6.2 (3.9)	24 hours	2+ HOVs	No
Denver, CO, US 36 Boulder Turnpike	1 EB only	6.6 (4.1)	6-9 am	Buses only	No
Hartford, CT					
I-84 (wide buffer separation)	1 each direction	16 (10)	24 hours	2+ HOVs	Changed from 3+
I-91 (wide buffer separation)	1 each direction	14.4 (9)	24 hours	2+ HOVs	No
Ft. Lauderdale, FL I-95	1 each direction	43.2 (27)	7-9 am, 4-6 pm	2+ HOVs	No
Miami, FL I-95	1 each direction	19.2 (12)	7-9 am SB, 4-6 pm NB	2+ HOVs	No
Orlando, FL I-4	1 each direction	48 (30)	7-9 am SB, 4-6 pm NB	2+ HOVs	No
Atlanta, GA					
I-20	1 each direction	15 (9.4)	6:30-9:30 am WB, 4:30-7 pm EB	2+ HOVs	No
I-75	1 each direction	64 (40)	24 hours	2+ HOVs	No
I-85	1 each direction	32 (20)	24 hours	2+ HOVs	No
Honolulu, HI					
Moanaloa Fwy.	1 each direction	3.8 (2.4)	6-8 am, 3:30-6 pm	2+ HOVs	No
Kalaniana'ole Hwy. H-1	1 (WB only)	3.2 (2.0)	5-8:30 am	2+ HOVs	No
H-1	1 each direction	12.8 (8)	6-8 am, 3:30-6 pm	2+ HOVs	No
H-2	1 each direction	13.1 (8.2)	6-8 am, 3:30-6 pm	2+ HOVs	No

(Continued)
**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV
 FACILITIES
 AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
Montgomery County, MD US 29 (shoulders)	1 each direction	4.8 (3)	Peak periods only	Buses only	No
I-270 (eastern connection)	1 each direction	4 (2.5)	Peak periods only	2+ HOVs	No
Boston, MA I-93 North	1 (SB only)	1.8 (1.1)	6:30-9:30 am	2+ HOVs	Changed from 3+
Minneapolis, MN I-35W	1 each direction	8 (5)	6-9 am NB, 4-7 pm SB	2+ HOVs	No
I-394	1 each direction	11.2 (7)	6-9 am EB, 4-7 pm WB	2+ HOVs	No
Morris County, NJ I-80	1 each direction	17.6 (11)	Peak periods only	2+ HOVs	No
I-287	1 each direction	XXXX	Peak periods only	2+ HOVs	No
Suffolk County, NY I-495	1 each direction	19.2 (12)	6 am-8 pm	2+ HOVs	No
Ottawa, Ontario, Canada Hwy. 17 (shoulder)	1 (WB only)	4.8 (3)	7-9 am	Buses only	No
Nashville, TN I-65	1 each direction	11.5 (7.2)	7-9 am NB, 4-6 pm SB	2+ HOVs	No
Northern Virginia I-66 (outside Capital Beltway)	1 each direction	11.2 (7)	6-9 am, 3:30-6 pm	2+ HOVs	No
I-66 (inside Capital Beltway)	2-3 each direction	15.4 (9.6)	6:30-9 am EB, 4-6:30 WB	2+ HOVs	Changed operating periods and from 3+
Norfolk/Virginia Beach, VA SR 44 (shoulder)	1 each direction	6.4 (4)	5-8:30 am WB, 3-6 pm EB	2+ HOVs	No
I-64	1 each direction	8 (5)	Peak periods only	2+ HOVs	No
I-564	1 EB only	3.2 (2)	3:30-6 EB	2+ HOVs	No
Seattle, WA I-5 North	1 each direction	SB 22 (13.6), NB 18 (11.3)	24 hours	2+ HOVs	Changed from 3+
I-5 South	1 each direction	SB 13.4 (8.4), NB 26 (16.1)	24 hours	2+ HOVs	No
I-90	1 each direction	11.7 (7.3)	24 hours	2+ HOVs	General purpose lane conversion

(Continued)

**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV FACILITIES
AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
I-405 (median and shoulders)	1 each direction	SB 36 (22.5), NB 35 (21.7)	24 hours	2+ HOVs	No
SR 167	1 each direction	6.7 (4.2)	24 hours	2+ HOVs	No
SR 520 (shoulder)	1 WB only	3.7 (2.3)	24 hours	3+ HOVs	Changed from bus only in AM peak period
<u>Contraflow</u>					
Honolulu, HI					
Kalaniana'ole Hwy.	1	WB 7 (4.4) EB 1.6 (1)	5-8:30 am, 4-6:30 pm	2+ HOVs	Changed from 3+
Kahekili Hwy.	1	1.8 (1.1)	5:30-8:30 am, 3:30-7 pm	2+ HOVs	No
New Jersey, Rte. 495 (to Lincoln Tunnel)	1 EB only	4 (2.5)	6-10 am	Buses only	No
New York City, NY I-495 Long Island Expy.	1	6.4 (4)	7-10 am	Buses, vanpools, taxis	No
Dallas, TX I-30 East	1 each peak direction	WB 8.3 (5.2), EB 5.3 (3.3)	6-9 am, 4-7 pm	2+ HOVs	No
Boston, MA I-93 Southeast Expy.	1 each peak direction	9.6 (6)	6-10 am, 3-7 pm	3+ HOVs	Additional hour added in AM period
Montreal, Quebec, Canada Rte. 10/15/20 Champlain Bridge	1	6.9 (4.3)	6:30-9:30 am NB, 3:30-7 pm SB	Buses only	Speed limit reduced
<u>Queue Bypasses</u>					
Bay Area, CA					
S.F./Oakland Bay Bridge toll plaza, I-80	3	1.4 (0.9)	6-9 am, 3-6 pm	3+ HOVs	Number and location of lanes reoriented
Dumbarton Bridge toll plaza, SR 84	1	3.2 (2)	Peak periods	2+ HOVs	Changed from 3+
San Mateo Bridge toll plaza, SR 92	1	1.6 (1)	Peak periods	3+ HOVs	No
SR 4	1	0.8 (0.5)	Peak periods	3+ HOVs	No
Various freeway entrance ramps	1	0.2 (0.1)	When demand warrants	2+ HOVs	No
Los Angeles and Orange Counties, CA					

(Continued)
**OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV
 FACILITIES
 AS OF JANUARY 1997**

HOV Facility	Number of Lanes	Project Length km (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules since Opening
Over 250 entrance ramps	1	0.2 (0.1)	When demand warrants	2+ HOVs	No
San Diego, CA					
Various entrance ramps			When demand warrants	2+ HOVs	No
Coronado Bridge toll plaza	1 (WB only)	0.2 (.1)	24 hours	2+ HOVs	No
A Street entrance ramp to I-5 freeway	1	0.6 (0.4)	24 hours	Buses only	No
I-5/Mexico port of entry	4 gates	0.2 (0.1)	24 hours M-F	4+ HOVs	No
Honolulu, HI, H-2	1 (SB only)	1.3 (0.8)	6-8 am, 3:30-6 pm	2+ HOVs	No
Illinois, Chicago, I-90 toll plaza	1 (EB only)	0.8 (0.5)	Peak periods	Buses only	No
Minneapolis, MN, Various entrance ramps	1	0.6 (0.2)	Peak periods	2+ HOVs	No
New Jersey					
Ft. Lee, I-95 (to George Washington Br.)	1 (EB only)	1.6 (1)	7-9 am	3+ HOVs	No
Union, Rte. 495 (Lincoln Tunnel toll plaza)	1 (WB only)	0.5 (0.3)	6-10 am	Buses only	No
Seattle, WA					
SR 509 shoulder	1 (NB only)	1.3 (0.8)	24 hours	2+ HOVs	Changed from 3+
SR 526	1	0.8 (0.5)	24 hours	Buses only	No
Freeway entrance ramps (69) ³	1	0.2 (0.1)	24 hours	2+ HOVs	No
Ferry terminal dock, downtown	1-2	0.2 (0.1)	24 hours	Registered carpools/ vanpools only	No

Footnotes

¹ 7-day week; all others are 5-day week.

² This project is a privatized toll road with congestion pricing. Registered 3+ HOVs can travel free.

³ Included are 39 metered ramps and 30 non-metered ramps.

6/95 corrections and insertions to both tables included from Boston, Seattle, California (1995 update), Phoenix, Florida and New Hampshire

**LISTING OF PROPOSED MAJOR FREEWAY/EXPRESSWAY HOV FACILITIES
AS OF JANUARY 1997 (Listed by State/Province)**

Project	Project Length		Status or Anticipated Opening
	Route- kilometers (miles)	Lane- kilometers (miles)	
<u>Arizona, Phoenix</u>			
Route Loop 202 (East Papago Freeway) I-10 to SR 101 concurrent-flow lanes	1.6 (1)	3.2 (2)	1997
I-10 (91st to Chandler Rd.) concurrent- flow lanes	8 (5)	16 (10)	1997
I-17(SunCap/University-Berkeley) concurrent-flow lanes	1.6 (1)	1.6 (1)	1997
<u>British Columbia, Vancouver, Canada</u>			
H-7 Barnet Hastings Highway, concurrent-flow lanes	9.6 (6)	19 (12)	1996
Trans Canada Highway, concurrent flow- lanes	12.8 (8)	25 (16)	Late 1990s
<u>California, Bay Area</u>			
I-580 concurrent-flow lanes	(NA)	(NA)	Late 1990s
I-80 (Contra Costa County) concurrent- flow lanes	56 (35.2)	112 (70)	Staged through 1998
US 101 (Marin County) concurrent-flow lanes	4.8 (3)	9.6 (6)	Late 1990s
I-80/580/880 (Alameda County) concurrent-flow lanes	27 (17)	52 (32.3)	Staged through late 1990s
I-680 (Contra Costa County) concurrent- flow lanes	9.6 (6)	18 (11.2)	Staged through 1999
I-880 (Santa Clara County) concurrent- flow lanes	9.6 (6)	17 (10.8)	Late 1990s
SR 237 (Santa Clara County) concurrent- flow lanes	24 (15)	48 (30)	Late 1990s
SR 85 (Santa Clara County) concurrent- flow lanes	3.2 (2)	6.4 (4)	1999
SR 101 (Marin County) concurrent-flow lanes	8 (5)	14.4 (9)	Late 1990s
SR 101 (Santa Rosa) concurrent-flow lanes	8 (5)	16.6 (10.4)	Late 1990s
<u>California, Los Angeles County¹</u>			
I-10- (San Bernardino Fwy.) concurrent- flow lanes	33 (20.3)	66 (41)	2001-2003
I-10 (Santa Monica Fwy.) concurrent- flow lanes	15 (9.3)	30 (18.6)	2020
I-110 (Harbor Fwy.) transitway extension and ramps	3.2 (2)	12.8 (8)	1998, 2011
I-405 concurrent-flow lanes	64 (40)	128 (80)	1996-2002
I-605 concurrent-flow lanes	17 (12)	38 (24)	Late 1990s
I-710, concurrent-flow lanes	13 (8)	26 (16)	Beyond 2015
I-5 concurrent-flow lanes	58 (36)	115 (72)	2000-2013
SR 14 concurrent-flow lanes	58 (36)	115 (72)	1997-2020
SR 30 concurrent-flow lanes	13 (8.3)	27 (16.6)	1997-99
SR 57 concurrent-flow lanes	7.2 (4.5)	14 (9)	1997

(Continued)

LISTING OF PROPOSED MAJOR FREEWAY/EXPRESSWAY HOV FACILITIES**AS OF JANUARY 1997 (Listed by State/Province)**

Project	Project Length		Status or Anticipated Opening
	Route-kilometers (miles)	Lane-kilometers (miles)	
SR 60 concurrent-flow lanes	30 (19)	61 (38)	1997-2002
SR 71 concurrent-flow lanes	6.4 (4)	12.5 (7.8)	2006
<u>California, Ventura County</u>			
SR 118 concurrent-flow lanes	24 (15)	48 (30.2)	Beyond 2000
<u>California, Orange County</u>			
I-5 concurrent-flow lanes	19 (12)	38 (24)	2002-2004
SR 91, concurrent-flow lanes	14 (9)	30 (18.8)	Funding study pending
SR 55/405, 57/91 interchanges, HOV ramps	9.6 (6)	21 (13)	2000-2005
SR 73 concurrent-flow lanes	4.8 (3)	7 (4.4)	Planning studies pending
I-605 concurrent-flow lanes	4.8 (3)	9.6 (6)	Planning studies
SR 22 concurrent-flow lanes	19 (12)	38 (24)	Planning studies pending
<u>California, San Bernardino County</u>			
I-10 concurrent-flow lanes	16 (10)	32 (20)	1999
SR 60, concurrent-flow lanes	19 (12)	38 (23.6)	Beyond 2000
SR 30 concurrent-flow lanes	32 (20)	64 (40)	Beyond 2000
SR 71, concurrent-flow lanes	5 (3.1)	10 (6.2)	Late 1990s
I-215, concurrent-flow lanes	8 (5)	16 (10)	1999
<u>California, Riverside County</u>			
SR 60, concurrent-flow lanes	32 (20)	62 (39)	1996-99
SR 71, concurrent-flow lanes	9.6 (6)	19 (12)	Planning studies
I-215, concurrent-flow lanes	11.2 (7)	22 (14)	Planning studies
<u>California, Sacramento</u>			
I-5, concurrent-flow lanes	27 (17)	52 (32.4)	Late 1990s
SR 99, concurrent-flow lanes	9.6 (6)	18 (11.4)	Late 1990s
<u>California, San Diego County</u>			
I-5, concurrent-flow lanes	37 (23)	73 (45.6)	Staged through 2010
I-15, concurrent-flow lanes or transitway	14 (9)	27 (16.8)	Beyond 2000
I-15, congestion pricing demonstration on reversible lanes	12.8 (8)	26 (16)	1996
<u>Colorado, Denver</u>			
I-25, barrier-separated reversible lanes ramps	6.4 (4)	12.8 (8)	Late 1990s
<u>Connecticut, Hartford</u>			
I-84 WB concurrent-flow lane	2.4 (1.5)	2.4 (1.5)	1996-98
<u>Florida, Orlando-Tampa</u>			

(Continued)

LISTING OF PROPOSED MAJOR FREEWAY/EXPRESSWAY HOV FACILITIES**AS OF JANUARY 1997 (Listed by State/Province)**

Project	Project Length		Status or Anticipated Opening
	Route-kilometers (miles)	Lane-kilometers (miles)	
I-4 concurrent-flow lanes	64 (40)	141 (88)	Beyond 2000
I-4 interim reversible lane (Orlando)	9.6 (6)	9.6 (6)	Late 1990s
<u>Florida, Ft. Lauderdale</u>			
I-95 concurrent-flow lanes	46 (29)	93 (58)	Beyond 2000
<u>Maryland</u>			
I-270 concurrent-flow lanes	19 (12)	33 (24)	1996-98
SR 141 concurrent-flow lanes	(NA)	(NA)	Late 1990s
I-95/495 Capital Beltway concept to be determined	(NA)	(NA)	Planning studies
<u>Massachusetts, Boston</u>			
I-93, north contraflow lanes	12.8 (8)	26 (16)	2004
SR 3 south concurrent-flow lanes	18 (11)	36 (22)	Planning studies
I-93 Southeast Expy. reversible flow lane	12.8 (8)	12.8 (8)	2004
I-93 Central Artery concurrent-flow lanes	6.4 (4)	12.8 (8)	2004
Route 128 (I-95) concurrent-flow lanes	22 (13.7)	44 (27.4)	2004
Route 3 North (concept to be determined)	35 (22)	70 (44)	Late 1990s
I-90 Massachusetts Turnpike queue bypasses	1.6 (1)	1.6 (1)	Late 1990s
<u>Minnesota, Minneapolis</u>			
I-35W, concurrent flow lanes	19 (12)	38 (25)	1996
I-94, concurrent-flow lanes	56 (35)	116 (70)	Late 1990s
<u>New Hampshire</u>			
I-93 concurrent-flow lanes	32 (20)	64 (40)	Planning studies
<u>New Jersey, Morris and Somerset Counties</u>			
I-287 concurrent-flow lanes	12.8 (8)	26 (16)	Late 1990s
I-95 New Jersey Turnpike concurrent-flow lanes	16 (10)	32 (20)	1996
<u>New York, New York</u>			
I-495 Long Island Expy. concurrent-flow lanes	48 (30)	96 (60)	Staged through 2010
I-287 Cross Westchester Expy. (concept to be determined)	8 (5)	16 (10)	Late 1990s
Gowanus Expy., concurrent-flow lanes	8 (5)	16 (10)	Late 1990s
<u>North Carolina, Charlotte</u>			
US 74, reversible lane and ramps	6.9 (4.3)	6.9 (4.3)	1997-2001
<u>Ontario, Toronto area, Canada</u>			
H-403 (Hwy. 407 and 401) concurrent-flow lanes	8 (5)	16 (10)	Late 1990s

(Continued)

LISTING OF PROPOSED MAJOR FREEWAY/EXPRESSWAY HOV FACILITIES**AS OF JANUARY 1997 (Listed by State/Province)**

Project	Project Length		Status or Anticipated Opening
	Route-kilometers (miles)	Lane-kilometers (miles)	
H-404 (Hwy. 401 to Maj. Mackenzie Drive) concurrent-flow lanes	(NA)	(NA)	Beyond 2000
H-427 (Hwy. 401 to 7) concurrent-flow lanes	(NA)	(NA)	Planning studies
H-400 (Hwy. 401 to 407) concurrent-flow lanes	(NA)	(NA)	Planning studies
<u>Ontario, Ottawa, Canada</u>			
Extensions to busway system	8 (5)	16 (10)	Staged through 2000
Concurrent-flow freeway bus lanes	(NA)	(NA)	Late 1990s
<u>Pennsylvania, Pittsburgh</u>			
Airport Busway	8 (5)	16 (10)	Late 1990s
Wabash Tunnel reversible HOV lane	1.6 (1)	1.6 (1)	Late 1990s
East Busway extension	(NA)	(NA)	Beyond 2000
<u>Texas, Dallas</u>			
I-635 LBJ Fwy. interim concurrent-flow lanes	11.7 (7.3)	21 (13)	1997
I-35 East Stemmons Fwy. concurrent-flow lanes	12.5 (7.8)	24 (15)	Late 1990s
I-35 East/US 67 R.L.Thornton concurrent-flow lanes	12.8 (8)	19 (12)	Late 1990s
I-30 concurrent-flow lanes	4.8 (3)	9.6 (6)	Late 1990s
US 75 (Plano) reversible lane	8 (5)	8 (5)	NA
<u>Texas, Houston</u>			
US 59 (Southwest Fwy.) reversible-flow lane extension	1.6 (1)	1.6 (1)	1997
US 59 (Eastex Fwy.) reversible-flow lane	32 (20)	32 (20)	1998-2000
I-45 (North Fwy.) reversible-flow lane extension	10 (6.2)	10 (6.2)	Late 1990s
I-45 (Gulf Fwy.) reversible-flow lane extension	6.4 (4)	6.4 (4)	Late 1990s
I-10 (Katy Fwy.) reversible-flow downtown extension	4.8 (3)	4.8 (3)	1998
I-10 (Katy Fwy.) long range plan concept to be determined	NA	NA	Planning studies
I-610 (North and West Loop) concept to be determined	NA	NA	Planning studies
<u>Texas, San Antonio</u>			
I-35 North Pan Am Fwy. concept to be determined	NA	NA	Planning studies
I-410 North Loop concept to be determined	NA	NA	Planning studies
<u>Utah, Salt Lake City</u>			
I-15 concurrent-flow lanes	32 (10)	64 (20)	2000-2005

Virginia, Norfolk/Virginia Beach

I-264, concurrent-flow lanes	6.4 (4)	12.8 (8)	1996
Route 44, concurrent-flow lanes	32 (10)	64 (20)	Late 1990s

Virginia, Washington D.C. Area

I-66, concurrent-flow lanes	12 (7.5)	24 (15)	Mid-late 1990s
I-95/495 Capital Beltway concept to be determined	32 (20)	64 (40)	To be determined

Washington, Seattle/Tacoma/Everett

I-405 extensions to concurrent-flow lanes (median)	12.8 (8)	26 (16)	Staged through 2000
I-5 South, extensions to concurrent-flow lanes	35 (22)	64 (40)	Staged through 2000
I-5 North, extensions to concurrent-flow lanes	8 (5)	16 (10)	Staged through 2000
SR 520 concurrent-flow lanes	6.4 (4)	12.8 (8)	Staged through 2000
SR 525 concurrent-flow lanes	4.8 (3)	9.6 (6)	Staged through 2000
SR 167 extensions to concurrent-flow lanes	9.6 (6)	19 (12)	Staged through 2000
SR 16 concurrent-flow lanes	9.6 (6)	16 (10)	Staged through 2000
SR 526 queue bypass	1.6 (1)	1.6 (1)	NA

NA Not available

¹ Programmed list of future Los Angeles County projects is currently being reassessed as part of a long range plan update.