High-OCCUPANCY Vehicle Facilities

An Approach to Solving Congestion and Mobility Problems

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MANY VARIED APPROACHES ARE BEING used in metropolitan areas today to respond to the continued increase in traffic congestion, the projected growth in travel demand, declining mobility, air quality and other environmental concerns, and limited financial resources and right-of-way availability. High-occupancy vehicle facilities, which are focused on increasing the person-movement efficiency of a roadway or travel corridor, are one viable technique being considered and implemented in many areas.

Some examples of the person-movement capacity of existing HOV lanes include the single HOV lane on the approach to the Lincoln Tunnel in New York City, which moves more than 35,000 people during peak hours, and the two HOV lanes on I-395 (Henry G. Shirley Memorial Highway) in the Virginia suburbs of Washington, D.C., which carry more than 15,000 people during peak hours.

Since the opening of the I-395 exclusive bus lanes in the Washington, D.C., metropolitan area in the 1970s, numerous areas in North America have developed priority measures for HOVs. A variety of HOV treatments is currently in operation, including busways on separate rights-of-way, HOV lanes on freeways, HOV bypass lanes at freeway ramp meters, arterial street HOV lanes, and transit malls. A total of 40 HOV projects in 20 metropolitan areas are in operation on freeways or separate rights-of-way in North America. These projects currently encompass some 340 miles of HOV lanes, representing a steady growth since 1969 (see Figure 1). Further, additional projects are in the planning, design, and implementation process. If the projects under construction and those programmed for implementation are built, approximately 530 additional miles of HOV lanes will be in operation by the year 2000. This will result in a total of some 880 miles of HOV facilities in operation by the turn of the century.

Purpose and Types of HOV Facilities

Although they differ in design and operation, HOV facilities share a common purpose. HOV lanes are intended to maximize the person-carrying capacity of the roadway or corridor. This is accomplished by altering the design and operation of the facility to provide priority treatments for buses, vanpools, and carpools. The two benefits of travel time savings and more predictable travel times provide incentives for individuals to choose to use HOVs, rather than drive by themselves. This, in turn, can increase the person-movement capacity of the roadway or corridor by carrying more people in fewer vehicles.

In addition to providing a priority HOV lane, most successful HOV projects also involve the provision of supporting services and policies. These include physical improvements, such as park-and-ride lots (see Figure 2), direct access ramps, and HOV bypass ramps at metered freeway entrances. Further, they include the provision of services and supporting policies, such as carpool and vanpool programs, appropriate parking policies, employee transit-pass subsidies, marketing, and public relations programs. Thus most successful projects include a package of appropriate services, facilities, and policies working in concert to encourage greater use of HOVs.

HOV facilities have most commonly been used in roadway corridors that are at or near capacity and where the physical or financial feasibility of expanding the roadway is limited. When properly planned and implemented, HOV facilities can offer a number of advantages. First, although the actual costs will vary depending on the

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type of facility and site, when compared with other fixed-guideway transit alternatives, priority treatments are the least-cost alternative. Implementation times for HOV facilities are often shorter than they are for other transit alternatives and projects can be staged to allow for the opening of individual segments as they are completed. Carpools, vanpools, and buses are able to use most HOV lanes, providing a wider base of support among multiple-user groups. As such, HOV projects are often eligible for multi-agency funding. The multiple-user groups also allow flexibility in operation, including service orientation and hours of operation. Finally, as a result of these factors, HOV facilities often represent lower-risk alternatives.

Even with these advantages, however, HOV facilities may not be suitable for all situations. They represent only one of a number of potential transit and highway improvements that may be appropriate in a given corridor. Further, the implementation of an HOV lane does not necessarily preclude the need to make other improvements or implement additional policies and programs.

HOV Lanes on Freeways and in Separate Rights-of-Way

HOV facilities on freeways or in separate rights-of-way are usually classified into four general categories:

1. Exclusive HOV facilities in separate rights-of-way,
2. Exclusive HOV facilities in freeway rights-of-way,
3. Concurrent flow HOV lanes, and
4. Contraflow HOV lanes.

The definition of each of these facilities and the number of operating projects are summarized in Table 1 and three are illustrated in Figure 3.

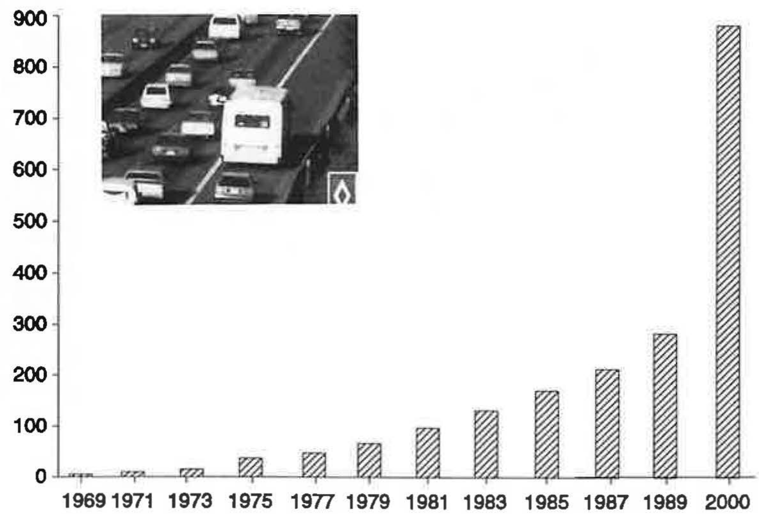
A more detailed summary of the general characteristics associated with the four different types of facilities is provided in Table 2. Three general operating scenarios are used with HOV lanes: (a) 24-hour operation, (b) morning and afternoon-evening operation, and (c) peak-period only operation. No specific operating scenario necessarily corresponds to a certain type of facility. Similarly, the types of vehicles allowed to use the facility and the occupancy requirements vary among projects. Eight projects are for buses only, whereas 21 allow vehicles with 2 or more occupants, and 10 facilities require vehicles with 3 or more occupants. The peak-hour vehicle and passenger volumes associated with the different HOV lanes range from 140 vehicles and 900 passengers to 2,544 vehicles and 11,800 passengers.

Arterial Street HOV Lanes

HOV lanes have been in operation on arterial streets in many areas since the 1960s. These range from short facilities, averaging only a few blocks, to facilities 5 to 10 miles long. Four distinct types of physical designs are commonly found with arterial street HOV lanes. These include concurrent flow lanes, contraflow lanes, median lanes, and bus streets or bus malls. Recently, increased interest has been focused on the potential use of arterial street HOV lanes as both stand-alone projects and connections to existing freeway HOV lanes. A number of metropolitan areas have developed, or are developing, systemwide HOV plans and networks encompassing both freeway and arterial HOV lanes and a wide range of support facilities and services. Thus, many areas are implementing HOV projects in conjunction with a broad range of travel demand management strategies to support and enhance the use of the HOV lane.

Application of IVHS Technology to HOV Facilities

Intelligent vehicle-highway systems (IVHS) represent a continually evolving group of advanced technologies directed at improving the efficiency of the overall transportation system. Combining IVHS technologies with HOV facilities appears to offer numer-



NOTE: Data shown are for continuously operating HOV lanes located either on freeways or in separate rights-of-way. Mileage is not shown for HOV lanes that have been discontinued. Miles for the year 2000 represent projects expected to open by that date. Projects in the planning stage are not included.

FIGURE 1 Miles of operating HOV lanes and projected miles for year 2000.

FIGURE 2 Addicks Park-and-Ride lot: I-10 West (Katy) HOV lane, Houston, Texas.

a

b

c

FIGURE 3 Examples of HOV facilities: (*a*) exclusive HOV facility in freeway right-of-way: I-10 West (Katy) HOV lane, Houston, Texas, (*b*) concurrent flow lane: SR 520 HOV lane, Seattle, Washington, and (*c*) contraflow lane: Gowanus Expressway HOV lane, New York City.

ous benefits including improving the operation of the lane and the overall efficiency of the corridor. A number of projects are currently in operation using IVHS technologies with HOV facilities, and many more are in the planning stage. Many of these projects represent innovative approaches to the creative use of advanced technologies to provide transit with advantages and encourage greater use of high-occupancy modes.

Existing and planned projects fall into four of the five categories used to describe IVHS technologies. A number of HOV lanes in North America are monitored by advanced traffic management systems (ATMS). These systems provide surveillance, monitoring, and control functions for both the freeway main lanes and HOV lanes in Minneapolis, Seattle, and Washington, D.C./Northern Virginia. Future systems are planned for Houston, Orange County, and other metropolitan areas. Upgrading of existing systems is under way in many areas as well.

The application of advanced public transportation systems (APTS) technologies is also found in conjunction with HOV projects. Examples currently in operation include the use of electronic toll collection for buses on the Route 495 HOV lane on the approach to the Lincoln Tunnel in New York City and the use of an automatic vehicle location (AVL) system on the Ottawa transitways. Buses using the Route 495 HOV lane are equipped with automatic vehicle identification (AVI) tags. These electronic tags are read by receivers at the toll plaza, allowing buses to move through the facility without stopping. The toll is automatically subtracted from a prepaid account. The Ottawa AVL system, which uses roof-mounted electronic tags that are read by overhead transmitters, monitors the location of buses, provides real-time schedule information to passengers, and maintains a wealth of other data for management purposes.

The combination of technologies in these two categories and those in the advanced traveler information systems (ATIS) offers a number of opportunities to provide real-time pretrip travel information. One example of this approach is the Houston Smart Commuter IVHS Demonstration Project, which is focused on the potential for gaining more efficient use of major HOV lane travel corridors with greater use of high-occupancy commute modes, shifts in travel routes, and changes in travel time through the provision of real-time traffic and transit information and instant carpool matching services to individuals in their homes and workplaces.

Other IVHS applications are also being examined in conjunction with HOV facilities. The California Department of Transportation has used the I-15 HOV lane in San Diego during off-peak periods to test different advanced vehicle control systems (AVCS). Initial tests of automated vehicle braking systems have been conducted, and further tests are planned. It appears that exclusive barrier-separated HOV lanes, which offer a controlled environment, may be appropriate for the continued testing and initial introduction of AVCS. Other possible applications include the use of AVI tags to help monitor use of the lanes and enforce vehicle occupancy requirements, and fully integrating ATMS, ATIS, and APTS technologies in one corridor.

TABLE 1 DEFINITION AND NUMBER OF HOV PROJECTS IN NORTH AMERICA ON FREEWAYS AND IN SEPARATE RIGHTS-OF-WAY

Type of HOV Facility	Definition	Number of Operating Facilities
Exclusive HOV facility, separate right-of-way	Roadway or lane(s) developed in separate right-of-way and designed for exclusive use by HOVs, usually bus only.	3
Exclusive HOV facility, freeway right-of-way	Lane(s) constructed within freeway right-of-way physically separated from general-purpose freeway lanes and used exclusively by HOV for part or all of day. Concrete barrier is normal form of separation, although some projects use wide (10–15-foot) painted buffer.	11
Concurrent flow HOV lane	Freeway lane in peak direction of travel, not physically separated from general-purpose freeway lanes, designated for exclusive use by HOV for part or all of day. Usually inside lane or shoulder is used, although examples of outside lane or shoulder HOV lanes exist.	33
Contraflow HOV lane	Freeway lane in off-peak direction of travel, commonly the inside lane, designated for exclusive use by HOV traveling in peak direction. Lane is typically separated from off-peak direction general-purpose lanes by some type of changeable treatment such as plastic pylons or posts.	3

International HOV Facilities

HOV lanes and other HOV priority treatments have been widely accepted around the world. Six exclusive HOV projects on separate rights-of-way are currently in operation outside North America. These include guided busway systems in Adelaide, Australia; and Essen, Germany; and busway facilities in Runcorn and Redditch, England; Istanbul, Turkey; and Port of Spain, Trinidad. Ten exclusive HOV lanes are also in operation on freeway and arterial street rights-of-way. Further, nonexclusive HOV facilities, such as downtown bus lanes or other priority features, can be found in more than 100 cities around the world. Additional projects of all types are in the planning, design, and construction stages.

The HOV facilities in operation worldwide were planned and designed to address the same types of concerns and problems as those faced in North America. However, there are differences. Applications of HOV lanes outside North America are more oriented toward bus-only facilities, whereas carpools, vanpools, and buses are allowed to use most North American HOV lanes. Further, projects in other nations are noted for the use of other priority measures, such as signal preemption, better integration of land use and public transportation, and more extensive use of arterial street HOV applications.

Future Directions

Experience to date indicates that HOV lanes are one viable approach to addressing traffic congestion, air quality, and mobility issues in metropolitan areas. When implemented in appropriate corridors and operated properly, HOV facilities are an effective means of moving people instead of vehicles. The travel-time savings and reliability provided by HOV facilities offer incentives that many commuters find attractive enough to convince them to switch from driving alone to carpooling, vanpooling, or taking the bus. However, HOV lanes are not appropriate in all situations, and implementing an HOV lane does not preclude the need for other improvements and supporting policies and programs.

In addition, a better understanding of the issues associated with the use of HOV lanes is needed to ensure that they are operated at their full potential. This includes addressing design, operation, and enforcement concerns to make sure that the integrity of the facilities is maintained by

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TABLE 2 CHARACTERISTICS ASSOCIATED WITH TYPES OF HOV FACILITIES IN NORTH AMERICA

Total Number of Projects	Hours of Operation	Occupancy Requirement	Peak Hour Volume Ranges	
			Vehicles	Passengers
Exclusive HOV facility, separate right-of-way 3	3–24 hours	Bus only	51–180	2,000–11,000
Exclusive HOV facility, freeway right-of-way 11	2–24 hours 5–majority of day 4–peak hours only	6–2 + 5–3 +	140–2,590	900–15,308
Concurrent HOV lane 23	10–24 hours 13–peak hours only	2–bus only 15–2 + 6–3 +	28–2,544	900–11,800
Contraflow lane 3	3–peak only	Bus or bus and vanpool only	375–725	8,250–34,600

TRB's HOV Systems Committee

The Transportation Research Board Committee on High-Occupancy Vehicle Systems has been exceptionally active since it was established in 1988. Formed initially as a task force in 1987, the committee has been involved in a wide variety of projects and has continued to provide a high degree of visibility to HOV projects and supporting programs. As the first TRB committee to develop and adopt a five-year strategic plan, the HOV Systems Committee has also set the standard for other TRB committees to follow.

The strength and major focus of the committee's activities has been national HOV conferences, which have been held annually since 1986, and sessions at the TRB Annual Meeting. The HOV conferences have provided an ongoing forum for the discussion of issues associated with HOV facilities. Conferences held in Houston, Orange County, Minneapolis, Seattle, and Washington, D.C., have been well attended, attracting 200 to 300 participants.

The 1991 conference in Seattle broke previous attendance records, with more than 300 participants. The Seattle Conference also featured two specialty workshops that were focused on travel demand management programs and the planning, design, and operation of HOV facilities. In addition, the committee sponsored the development of six white papers, which were featured in the general sessions and formed the basis for the technical workshops.

A major activity of the committee during the past year has been the development of an HOV video, which provides an overview of HOV facilities in North America and specific case study examples. In addition, since 1989 the committee has published a quarterly newsletter that highlights HOV-related activities and is currently developing a glossary of terms. In 1990 the HOV Systems Committee developed a five-year strategic plan, previously mentioned. This document provides an outline of major objectives the committee wants to accomplish and the projects and programs on which it will focus during the next five years.

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deed, changes can be expected in the structure of the activity system that gives rise to travel, allowing IVHS systems to operate even more effectively (*7*).

This also has enormous implications for land-use and settlement patterns. Controlling congestion means preserving the operational integrity of the publicly financed transportation system in order to preserve our individual private investment in metropolitan and rural lifestyles.

Unanticipated benefits from the new transportation information infrastructure are indeed likely, just as paving roads in the 1920s got us out of the mud and changed the face of prewar America, and just as the limited access highway allowed us to control access onto highway links and not throw away our highway capacity by allowing traffic friction from abutters. Now we anticipate that travelers will control their access onto and within the system so that we do not, for example, replace moving traffic with stopped traffic.

Smart choices made by informed travelers exercising freedom of choice is the goal. The time is right to make smart choices in exercising new technological options to improve the transportation system and the environment.

References

1. E. B. Fisk. U.S. Says Most of Growth in 80's Was in Major Metropolitan Areas. *The New York Times,* Feb. 21, 1991, p. A18.
2. C. Swerdloff. Advanced Logistics in the United States: An Update on Activities. Presented at the International Symposium on Advanced Logistics, Yokohama, Japan, May 28, 1991, p. 2.
3. J. H. Kay. Smart Choices, Not Foolish Cars. *Boston Globe,* Nov. 12, 1991.
4. D. F. Schulz. Keynote Address: Decision Makers Need Help. In *Special Report 231: Transportation, Urban Form, and the Environment,* TRB, National Research Council, Washington, D.C., 1991, p. 12.
5. J. D. Kasarda. Population and Employment Change in the United States: Past, Present and Future. In *Special Report 220: A Look Ahead: Year 2020,* TRB, National Research Council, Washington, D.C., 1988, pp. 83–148.
6. D. Brand. Research Needs for Analyzing the Impacts of Transportation Options on Urban Form and the Environment. In *Special Report 231: Transportation, Urban Form, and the Environment,* TRB, National Research Council, Washington D.C., 1991, p. 107.
7. D. Brand. Observers' Comments. In *Special Report 220: A Look Ahead: Year 2020,* TRB, National Research Council, Washington, D.C., 1988, p. 22.

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allowing only vehicles that meet the occupancy requirements to use the facilities. Further, exploring methods to maximize the use of HOV lanes, through expanded use of supporting facilities, services, and programs, would be beneficial. Use of IVHS and other advanced technologies can assist in these efforts and enhance the operation of all types of HOV facilities. In addition, transportation professionals in all parts of the world would benefit from greater information sharing and the exchange of ideas and experiences with HOV facilities.

Transportation professionals and policy makers face a challenging time in attempting to address traffic congestion, air quality, and mobility issues. Creative and innovative approaches will be needed to meet the increasing demands being placed on the nation's transportation systems. HOV facilities, especially when implemented with supporting facilities, policies, programs, and advanced technologies, offer a promising approach for many areas.

Data for Decisions *continued from page 27*

within DOT, to be headed by a director reporting directly to the secretary and funded from a $90 million authorization over a six-year period. The director of the bureau is charged with the responsibility of "establishing and implementing, in cooperation with the modal administrators, the States, and other Federal officials, a comprehensive, long-term program for the collection and analysis of data relating to the performance of the national transportation system" [Section 6006, 111(c)(2)].

The leadership of DOT has already taken steps to improve its data capabilities through the formation of two data committees to coordinate both the internal and interagency collection of data, preliminary funding of national surveys of passenger and freight movements that have not been conducted in more than a decade, and creation of a new Office of Strategic Planning to help define the long-term strategic issues and policy questions facing the department. DOT has an opportunity to build on these initiatives to create and sustain an institution dedicated to developing the knowledge base to inform policy makers about the strategic choices that will shape the transportation system of the future. The report provides a blueprint for carrying out this objective.

Corrections

In the 71st TRB Annual Meeting Highlights section of *TR News* 159, a participant was inadvertently misidentified in the photograph below. The correct identity of the person pictured is John E. Steward, U.S. Department of Agriculture Forest Service, who made a presentation at the session on Assessing Worldwide Low-Volume Roads: Problems, Needs, and Impacts.

John E. Steward, USDA Forest Service.

In the caption for another photograph in the same article, there was a typographical error in the name of Donn E. Hancher. We apologize for these errors.