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Regional Public Transportation Organizations

DIANNE S. SCHWAGER, DANIEL LYSY, AND ELLEN KRETT

Over the past two decades, regional public transportation organizations have been created throughout the United States to coordinate and improve transportation services. Many of these organizations have done much to improve declining transit service quality, modernize capital plants, expand local and regional fixed route transit services, and introduce specialized services for commuters and the transportation disadvantaged. Our research indicates that there are essentially two types of regional public transportation organizations: those that operate public transportation services and those that do not. The former were generally established in the 1970s during a period of consolidation and expansion of public transportation funding and service. In many areas fixed rail services were being initiated or expanded, fixed route bus services were being extended in particular to suburban communities, and paratransit services were being introduced to serve the specialized travel needs of mobility-restricted persons. Regional public transportation organizations that do not operate transit services are, by and large, more likely to have been established in the 1980s. Such organizations administer, guide, fund, and oversee diverse transportation services operated by other public or private organizations. They were formed to serve the following purposes: tailor services to jurisdictional needs and priorities; increase authority and decisionmaking by suburban communities; increase competition through contracting for services; reduce operating costs for transit by providing different levels of services in different areas; and redistribute public support for public transportation within regions. Our research does not suggest that any particular type of organization performs better or worse than another. Factors other than organizational structure (such as management ability, organizational stability, community [public and private] support, and solvency) are more likely to determine the effectiveness of a regional public transportation organization.

Over the past two decades, regional public transportation organizations have been created throughout the United States to coordinate and improve transportation services. Many of these organizations have done much to improve declining transit service quality, modernize capital plants, expand local and regional fixed route transit services, and introduce specialized services for commuters and the transportation disadvantaged.

OVERVIEW OF ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES

The character of U.S. regional public transportation organizations varies. They serve all or part of one or more counties. Their Boards are elected or appointed; board members are full- or part-time, paid or unpaid. Their responsibilities may include, in whole or in part, planning, managing, policy setting, financing, coordinating, and operating the following public transportation services:

- Fixed route and schedule transit services, including rapid rail, commuter rail, light rail, and motor bus modes;
- Paratransit services for travelers with specialized mobility needs, for travelers located in specific areas (e.g., lower density communities), or for other specific user groups or trip types; and
- Regionwide commuter services, including buspool, vanpool, and carpool programs.

Regional public transportation organizations may contract for some services (for example, commuter or handicapped programs, and local community bus service) or for all or part of some functions (for example, major overhaul maintenance, legal, and management services). Regional agencies rarely provide limousine or taxi services—private providers typically operate these services.

Regional public transportation organizations are generally financed through passenger fares, through federal and state capital and operating assistance, and often, although not always, through a dedicated local funding mechanism such as a sales tax. Dedicated taxes may be piggybacked on an existing county or state tax or may be levied through a transportation authority. Dedicated funding provides greater certainty in transit planning and operation from year to year, partly by allowing some independence from the local budgetary cycles.

EMERGING TRENDS: FACTORS AFFECTING PUBLIC TRANSPORTATION SERVICES AND REGIONAL ORGANIZATIONS

Most regional public transportation organizations established by the end of the 1970s were formed to operate regionwide fixed route and schedule transit services. In some cases, these organizations were formed to plan, construct, and operate new rail systems, which were often financed by local dedicated revenues. In other cases, the mission of these new organizations was to extend an existing fixed route bus or rail system to suburban areas or introduce specialized paratransit services to communities throughout a metropolitan area.

The 1980s have brought new concerns, including increasing financial constraints. At a 1982 conference on the future directions of urban transportation, sponsored by the Transportation Research Board and the U.S. Department of Transpor-

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tation, the following influences on U.S. public transportation were cited:

- *Continued suburbanization of residential population and development of new employment centers.* Regional travel patterns continue to be more dispersed as residential and employment growth occurs outside the central business district of urbanized areas. Suburban areas that once had little employment now show concentrations of business and other activity. The new travel patterns are not conducive to fixed route transit, which generally requires radial trips.
- *Dominance of the automobile.* Americans generally prefer to travel by automobile, seeking the freedom, flexibility, and convenience offered by this transportation mode. Federal and state subsidies to highway systems and the current low price of gasoline reduce out-of-pocket and perceived costs of automobiles, fostering their use. Unconstrained land development policies in many areas also make automobile travel necessary for many.
- *Lack of secure and predictable funding.* Due to the decline in federal assistance, urban transit systems must seek added support from state and local revenues and increase fares. These efforts to supplement federal assistance have often been successful, but continued availability of public assistance and the impacts of higher fares on ridership are uncertain, making planning difficult for many communities.
- *Increased costs of public transportation.* The costs of providing public transit services have exceeded the inflation rate. Many attribute the rise to organized labor and its effectiveness in negotiating wage rates, benefits, and job security guarantees. Furthermore, some regard federal protection of certain employees (through Section 13 [c], for example) as a barrier to reducing transit costs or introducing innovations in services.
- *Increased scope of public transportation.* Public transportation services need not be defined as a particular mode (i.e., fixed route and schedule bus or rail service) or be exclusively publicly owned. Many communities are reassessing the traditional definition and including in public transportation services all modes (whether publicly or privately owned or operated), including services largely supported by passenger fares and ridesharing services, where costs are shared but no fare is paid.
- *Increased private sector involvement.* The private sector is playing an increased role in the operation and financing of public transportation services and facilities. Innovative approaches to financing projects (particularly joint development of rights-of-way and stations) are one example. Others are employer-supported ridesharing and commuter buses, private local bus and paratransit services supported by contracts with communities or transit agencies, and Transportation Management Organizations (TMOs), which include private business representatives seeking to resolve local transportation problems. The current administration generally advocates greater private sector participation and more competition among public transportation providers as means to reduce operating costs and create service alternatives.
- *Changing concepts of the nature of policymaking bodies that address regional public transportation needs and priorities.* A number of areas throughout the United States have concluded that regional public transportation should be administered by organizations that do not directly operate transit services. Such organizations could
  - –Preclude the involvement of their members (often elected or appointed officials) in day-to-day operations, thus reducing political decisionmaking in these matters;
  - –Work with local officials on matters that affect transit such as taxes, parking regulation, highway development, and land use; and
  - –Serve as a regional transportation broker, funding and contracting with public and private providers of transportation services.

Another benefit of having such organizations, proponents suggest, is that it provides a specific response to the transportation needs of particular localities and market segments—because a single-service provider is not required to serve all trips or all areas of the region. Such organizational activities may also lower transit costs by contracting with private operators to meet certain needs.

REVIEW OF SELECTED REGIONAL PUBLIC TRANSPORTATION ORGANIZATIONS

As part of a recent research project, regional public transportation organizations in thirteen U.S. metropolitan areas were reviewed. The structure and responsibilities of regional organizations nationwide were thus examined for their usefulness to policy makers. The following areas were reviewed:

- Atlanta, Georgia;
- Chicago, Illinois;
- Dallas, Texas;
- Hampton/Newport News, Virginia (Peninsula);
- Los Angeles, California;
- Minneapolis/St. Paul, Minnesota;
- Phoenix, Arizona;
- Portland, Oregon;
- San Diego, California;
- San Francisco, California;
- Seattle, Washington;
- Tidewater Virginia; and
- Washington, D.C.

The research considered the demography of each region; the policy responsibilities of each organization and the composition of its board; the types of public transportation services available and the organizations that provide these services; the types of funding for public transportation; and other characteristics, some unique to the region in question. Key findings of the review are summarized below.

Board Membership and Policy Responsibilities

The boards of regional transportation organizations are composed of either elected officials or appointed representatives. None of the boards has members directly elected to the board. Board membership is allotted among jurisdictions either proportionate to population, as in Dallas and Chicago, or equally, as in Washington, D.C. In some instances, some or all of the board members are appointed by the governor. This is the

case in Minneapolis and San Diego where the chairpersons are gubernatorial appointees and in Portland where all seven board members are appointed by the governor and approved by the state senate.

All regional transportation organizations that directly provide transit services are responsible for establishing service routes, schedules, and fares and negotiating labor agreements. Organizations that do not directly provide transit services are not generally responsible for these matters. In particular, no organization negotiates with organized labor. However, an organization may provide oversight through budget review and influence decision making through the allocation of public support.

In Chicago, Los Angeles, Minneapolis, San Diego, and San Francisco, the regional public transportation organization is empowered to set or enforce fare box ratio requirements, assist in coordinating local transit fares, and evaluate fare policies. In Minneapolis/St. Paul, one of the newer regional transportation organizations has broad policy making duties, including examining transit service needs, facilitating the establishment of new and alternative transit services, and contracting with public or private operators for all new routes and services.

Planning Responsibilities

In some areas, such as Atlanta, Chicago, and Washington, D.C., the regional Metropolitan Planning Organization (MPO) or Council of Governments (COG) has primary responsibility for long- and/or short-range transportation planning. In other areas, such as Dallas, Minneapolis, Phoenix, Portland, San Diego, and San Francisco, the regional transportation organization is responsible for planning, but coordinates with other organizations, in particular with transit service providers or regional planning organization(s).

Financial Responsibilities

Some regional transportation organizations (Peninsula, Portland, San Francisco, Seattle, and Tidewater) receive UMTA Section 9 and often state funds. In some cases these funds are received by another organization in the region and later passed through or allocated to the regional transportation organization. This is the case, for example, for Section 9 funds in Atlanta, Chicago, Minneapolis, and Washington, D.C.

At least five of the organizations were formed or reorganized to allocate public funding to service providers (Chicago, Los Angeles, Minneapolis, San Diego, and San Francisco). Public funding may include federal, state, and/or local dedicated revenues. Eleven of the organizations have a dedicated source of local revenues. In at least one case, these funds are passed through from another regional organization. These organizations also have bonding authority.

Modes Available in the Region

Regional fixed-route motor bus service and specialized paratransit services are available in all thirteen regions; ten have or are planning or constructing light or heavy rail services; two have commuter rail service; and several sponsor or support ridesharing programs. Six of the organizations were formed or their powers were extended after a local referendum authorized a dedicated tax to plan, construct, and operate (or contract) rail transit services.

Contracting for Services

Contracting for specialized services has long been a practice of many regional public transportation organizations. Contracting for other services, in particular with private operators, has recently increased. The organizations in Atlanta, Los Angeles, Phoenix, San Francisco, Seattle, and Washington, D.C., currently do not contract for public transportation services. Other organizations, such as those in Chicago, Dallas, Minneapolis, San Diego, and Tidewater Virginia, contract with numerous service providers for local and express fixed-route bus services, paratransit, and commuter services.

Involvement with Other Regional Organizations

Most of the organizations responsible for regional public transportation are accountable to or at least coordinate with other regional organizations. For example,

- Atlanta—Metropolitan Atlanta Rapid Transit Authority (MARTA) is the regional public transportation agency. However, the Atlanta Regional Commission (ARC) is responsible for transportation planning; coordinates transportation, land use, and environmental and human services planning; receives UMTA Section 9 funds; and monitors the effects of rail construction. The Metropolitan Atlanta Rapid Transit Oversight Committee (MARTOC) is the link between MARTA and the state legislature.
- Chicago—The Regional Transit Authority (RTA) is largely responsible for regional public transportation; however, the Chicago Area Transit Study (CATS) develops and adopts the TIP with the RTA; receives UMTA Section 9 funds; has authority over the capital program; and can override RTA decisions.
- Portland—The Tri-County Metropolitan Transportation District of Oregon (Tri-Met) is largely responsible for regional public transportation. However, the Portland Metropolitan Services District (Metro) is responsible for issues with regional significance, including transportation oversight and planning and land use planning. Metro has legal authority to operate transit services in Portland but does not have taxing authority.
- Minneapolis—The Regional Transit Board (RTB) is largely responsible for public transportation in the region. However, the Metropolitan (Metro) Council addresses matters legislatively determined to be regional, has budget and planning control over regional service agencies, and maintains the land use plan. Metro Council approves RTB's capital and transit implementation plans and appoints RTB's board members, except for the chairperson, who is appointed by the governor.
- Washington, D.C.—The Washington Metropolitan Area Transit Authority (WMATA) is largely responsible for regional public transportation. However, the Washington Metropolitan Council of Governments (WMCOG) is responsible for long-term transportation planning. The Northern Virginia

Transportation Commission (NVTC) is a policy forum that coordinates mass transit; reviews requests for funds; and allocates local, state, and federal funds to transit services in its jurisdiction, which includes WMATA and the cities and counties in Northern Virginia that operate, contract for, or otherwise subsidize fixed-route express and local bus services and specialized paratransit services. The Washington Suburban Transit Commission is a regional organization in Maryland that coordinates transit services and oversees cost allocation and funding for WMATA services.

Clearly, the specific responsibilities and general characteristics of the regional public transportation organizations differ significantly. These differences affect the structures of institutional relationships in their regions, which are discussed and compared below.

ALTERNATIVE REGIONAL PUBLIC TRANSPORTATION ORGANIZATIONS

Based on our evaluation of the thirteen regional public transportation organizations, we distinguished two types of organizations: those that directly operate regional public transportation services and those that do not directly operate regional transportation services. There are various arrangements in this latter group. The regional or local service providers may be wholly owned subsidiaries of the regional organization responsible for public transportation. The regional organization may have the authority to operate services but not be presently exercising this authority. Transportation services may be contracted and administered but not operated by the regional organization.

Regional Organizations That Directly Operate Public Transportation Services

Table 1 identifies the seven regional public transportation organizations reviewed that directly operate public transportation services. Each of the regional organizations that directly operates public transportation services is responsible for regional transit services and policy, including decisions on service routes and schedules, fares, and labor negotiations. Some other roles that these organizations play in public transit in their communities are described below.

Organizations Associated with Rail System Development

MARTA and WMATA, the oldest of these organizations, were established largely to finance, operate, and construct regional transit. Both are completing heavy rail systems. Dallas Area Rapid Transit (DART), one of the newest of these organizations, was formed to develop a multimodal public transportation system for the Dallas region, including bus and rail transit, carpooling, vanpooling, and specialized services. DART began by contracting for most services, including local and express bus services and specialized paratransit; but now it is in the process of acquiring the Dallas Transit System (DTS) and planning for the construction of a 93-mile light rail system, which it will probably operate.

Sole Providers of Regional Services

With the exception of WMATA, the regional organizations included in Table 1 are the only significant transit service providers in their region. (Although two suburban counties represented on MARTA's board in the Atlanta region do not receive transit services and are considering separate bus or park and ride services.) Montgomery County, Maryland, initiated RIDE-ON ten years ago to feed WMATA's rail service; RIDE-ON is now a 350-bus operation providing local and feeder services. Similarly, local and feeder services are being operated in Northern Virginia, including DASH in Alexandria, CUE in Fairfax City, and the Fairfax Connector in Fairfax County. Specialized, independent services such as Washington Elderly and Handicapped Transportation System (WEHTS) in Washington, D.C., TRIPS in Northern Virginia, and subsidized taxis in Arlington and Alexandria provide door-to-door services to the elderly and handicapped residents in these areas.

These suburban services have been introduced to replace as well as to supplement WMATA suburban bus routes. They have lower operating costs than WMATA, particularly for labor. RIDE-ON is operated by county employees; several of the Virginia systems are contracted out.

WMATA has not resisted this shift. The different funds and priorities of the jurisdictions create a difficult management environment for a regional transit provider and some suburban services have proven expensive and difficult for WMATA to operate. Local control of suburban bus service is enabling WMATA to concentrate on rail and regional bus service and is resulting in lower cost services in suburban jurisdictions.

A Regional Service Broker

Tidewater Transportation District Commission (TTDC) is one of the most innovative public transportation organizations in the United States. In addition to directly operating transit services, TTDC serves as a regional coordinator and broker of transit services, monitoring and evaluating public transportation needs and the services that fulfill them, including services that are competitively bid and contracted. It has encouraged private participation for many years and is considered a model organization.

Some demographic characteristics of the Tidewater metropolitan area led TTDC to develop innovative transit arrangements. The area has a low-density population and the employment characteristics of many mid-size communities. Traditional transit is not appropriate for most of the region's transit needs and is too expensive for the community. Consequently, TTDC seeks to provide less costly, more useful services, bypassing traditional concentrations on bus or rail and offering a wide range of public transportation services.

TTDC directly operates fixed-route bus and minibus service on 40 routes; during the summer it provides trolley service for tourists in resort communities; in 1983 it initiated an experimental ferry service which still continues, with ridership highest in the summer. In addition to these fixed-route services, TTDC operates, contracts for, or coordinates the following specialized services:

TABLE 1 REGIONAL ORGANIZATIONS THAT DIRECTLY OPERATE PUBLIC TRANSPORTATION SERVICES

Regional Public Transportation Organizations	Major Planning Responsibilities	Financial Responsibilities				Responsible for Transit Services and Policies				Involvement with Other Regional Organizations
		Section 9 Recipient	Allocate Revenues	Dedicated Local Funds	Bonding Authority	Routes	Fares	Labor Agree-ment	Contract for Services	
Atlanta, Georgia Metropolitan Atlanta Rapid Transit Authority (MARTA)	No	No	N/A[a]	Yes	Yes	Yes	Yes	Yes	Yes	ARC plans and receives Section 9 funds. MARTOC is link to legislature.
Dallas, Texas Dallas Area Rapid Transit (DART)	Yes	No[b]	N/A	Yes	Yes	Yes[b]	Yes[b]	Yes[b]	Yes (specialized and express services)	North Central Texas Council of Governments provides long-range forecast; DART submits TIP.
Virginia-Hampton-Newport News Peninsula Transportation District Commission (PENTRAN)	Yes	Yes	N/A	No	Yes	Yes	Yes	Yes	Yes (limited)	
Portland, Oregon Tri-County Metropolitan Transportation District (Tri-Met)	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes (door-to-door service taxis and vans)	Metro prepares long-range plans and travel forecasts
Seattle, Washington Municipality of Metropolitan Seattle (Metro)	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	No	PSCOG
Norfolk, Virginia Tidewater Transportation District Commission (TTDC)	Yes	Yes	N/A	No	Yes	Yes	Yes	Yes	Yes (door-to-door specialized and local fixed route)	
Washington, D.C. Washington Metropolitan Area Transit Authority (WMATA)	No	Yes	No	No	Yes	Yes	Yes	Yes	No	WashCOG—planning; NVTC—funding and coordination.

[a] N/A: Not applicable because only one major transit provider in region.
[b] Not currently, but will have responsibility once DTS is acquired.

- *Handi-Ride.* TTDC's Handi-Ride service is the centralized provider of specialized transportation for the region. TTDC contracts service to about 40 agencies using 50 lift-equipped vans and several buses. It also serves residents unaffiliated with any agency.
- *Maxi-Ride.* TTDC operates Maxi-Ride, a demand-responsive service in low-density residential areas that generally connects with the fixed-route bus service at a shopping center transfer point.
- *Community Van Program.* TTDC leases vans to communities. No capital costs are charged, only a per-mile maintenance cost ($0.11) and a monthly insurance charge ($150). TTDC assists with organizational and promotional efforts and the community operates the service.

Ridesharing is particularly important in the Tidewater area because of a high concentration of military bases and shipyards. TTDC began its ridesharing program in cooperation with local military bases in 1977 and now provides services to all regional employers. Vans (12- to 15-passenger) and buses (40-passenger) are purchased by TTDC and leased to employers. Capital, operating, and some administrative costs are recovered, so little public subsidy is required. TTDC also brokers private vanpools and provides employers technical assistance on ridesharing, such as matching programs and coordinator support.

Regional Organizations That Do Not Directly Operate Regional Public Transportation Services

The seven regional public transportation organizations reviewed in this project that do not directly operate public transportation services are identified in Table 2. The Washington, D.C., metropolitan area includes two regional public transportation organizations: WMATA and NVTC. An interesting characteristic of these organizations is that each was formed or significantly reorganized after 1980, with the exception of MTC in the San Francisco Bay Area (which was created in 1970). The three selected organizations discussed below represent recent efforts to redefine organizational relationships and responsibilities for regional public transportation services.

Chicago RTA

The Illinois legislature created the RTA in 1974 to address and, it was hoped, resolve numerous problems in the commuter rail, rapid rail, and regional and suburban bus services in the Chicago region (*1*). The transit services had declining ridership and increasing costs and deficits. When formed, the RTA received federal and state funds and had taxing powers. It was required to determine the level, nature, and kind of transit the region needed and was able to either enter into purchase of service contracts with carriers or operate transit directly, setting service levels and fares.

The legislature completely reorganized the RTA in 1983. The new Board took office in October 1984, and an executive director was hired in September 1985. The legislature's goals were the following:

- Reinstate an annual state subsidy for metropolitan Chicago transit, which had been abolished when the RTA was empowered to levy a sales tax;
- Give RTA strong budget oversight power;
- Give the suburbs more representation on the RTA Board of Directors; and
- Remove the RTA's operating authority.

As part of the reorganization, three service boards were defined. PACE (bus) and Metra (commuter rail) were formed from RTA's existing suburban bus and commuter rail divisions. The Chicago Transit Authority (CTA), defined as a service board in the RTA Act, was retained and structurally unchanged.

The restructured RTA is responsible for funding allocations, setting fare box recovery ratios, regional planning, and service regulation. Decisions about the level and nature of transit are now the responsibility of the service boards, as is the power to contract with transit providers. The RTA currently has significant financial authority through its budget review and its right to disapprove of labor agreements and reopen negotiations if costs are not properly budgeted.

RTA's board of directors are allocated geographically, rather than on the basis of population size. The mayor now appoints one-third rather than one-half of the RTA members, and the suburban areas have increased representation.

Minneapolis/St. Paul RTB

In 1982, the Metropolitan Council of the Twin Cities (a metropolitan planning organization) initiated a study of each of the metropolitan commissions that provide services in the Minneapolis/St. Paul metropolitan area, with special emphasis on transit (*2*). The Metropolitan Transit Commission (MTC), a public transit authority, had forecast a $40 million shortfall over and above the subsidy budgeted for the 1982–1983 biennium. This financial crisis brought into question the adequacy and equity of the current means of financing services, as well as the appropriateness of the services being provided. The conclusions of the study are summarized in Figure 1.

The study precipitated several significant changes in regional transportation services and organizational responsibilities:

- The MTC (the regional transit provider) became solely a transit provider, with no planning responsibilities.
- The RTB was established and given the responsibility to prepare short- and mid-range plans; initiate, approve, and monitor contracts with transit providers; and establish fare policies. More specifically, the RTB reviews and approves the MTC operational and capital budget to ensure it is consistent with the RTB's transit goals and policies and within the financial parameters; facilitates the establishment of new and alternative services and providers; reviews and approves all new route evaluations; restructures routes and approves all new route evaluations; restructures routes and bids them competitively; and contracts with a service provider for each new route (which is evaluated by RTB at 6- and 12-month intervals).
- Local communities were given the option to stop paying 90 percent of the taxes they paid for transit services or continue to pay these taxes but have them returned to fund independent services. (Communities must still contribute 10 per-

TABLE 2 REGIONAL ORGANIZATIONS THAT DO NOT DIRECTLY OPERATE PUBLIC TRANSPORTATION SERVICES

Regional Public Transportation Organizations	Planning Responsibilities	Financial Responsibilities				Responsible for Transit Services and Policies				Involvement with Other Regional Organizations
		Section 9 Recipient	Allocate Revenues	Dedicated Local Funds	Bonding Authority	Routes	Fares	Labor Agreement	Contract for Services	
Chicago, Illinois Regional Transit Authority (RTA)	Yes	No	Yes	Yes (sales tax)	No	No[a]	No[a]	No[a]	No	CATS is Section 9 recipient and does long-range planning
Los Angeles, California Los Angeles County Transportation Commission (LACTC)	Yes	No	Yes	Yes (sales tax)	Yes	No[b]	No[b]	No	No	SCAG
Minneapolis-St. Paul, Minnesota Regional Transit Board (RTB)	Yes	No (MTC receives Section 9)	Yes	Yes (property tax)	Yes	Yes (new routes)	Yes[c]	No	Yes	State legislature sets farebox ratio.
Phoenix, Arizona Regional Public Transportation Authority (RPTA)	Yes	No	No	Yes (must be approved by referendum)	Yes	Yes	N/A	N/A	N/A	
San Diego, California Metropolitan Transit Development Board (MTDB)	Yes (short range)	Yes	Yes	Yes (SanDAG raises sales tax; gas tax available also)	Yes	Yes/ No[d]	Yes/No[d]	No	Yes	SanDAG (planning)
San Francisco, California Metropolitan Transportation Commission	Yes	Yes	Yes	Yes (local sales tax)	No	No	No (fare coordination)	No	No	ABAG (planning)
Washington, D.C. Northern Virginia Transportation Commission (NVTC)	Yes	Yes	Yes	Yes (gas tax)	Yes	No	No	No	Yes (limited demonstrations)	

[a]RTA exerts influence through budget oversight authority.
[b]LACTC exerts influence through revenue allocation decision making and transit performance measurement program. Also negotiates disputes among operators.
[c]RTB has authority to establish fare policy; currently approves operator fares. RTB approves service and financial plan.
[d]Coordinates with transit operators.

The regional transit services provided by the Metropolitan Transit Commission (MTC) are cost-effective in the central cities, but not in the suburbs.

The operating cost of MTC services has escalated much faster than inflation, primarily because of the utilization of labor and the type of expansion service provided (suburban express).

Several service options such as contracting high cost services; making special labor arrangements; and using demand-responsive ridesharing and re-orienting existing routes to time-transfer points, could improve the cost-effectiveness of the transit service.

The local property tax (2 mills) is inequitable and funds a disproportionate amount of the total operating cost--and should be related to specified levels of service (from 1.25 mills for limited service to 2.00 mills for full service).

The state financial assistance should be stable and constitute 20 percent of the cost of operating metropolitan transit service.

There is no comprehensive short-range service plan and program that addresses the overall transit (including paratransit) needs of the metro area.

It is difficult for the MTC to objectively plan for service needs in areas unsuited for MTC service or for (private) providers that would compete with MTC service.

Legislative appropriations to the MTC are not based upon overall transit needs and a service plan and program to address those needs; there is no single entity that speaks (advocates) for transit in the legislature.

There is no agency or public review of the annual allocation of public funds for the provision of transit service in the metropolitan area.

Planning, programming, and coordination should be clearly separated from operations (service delivery) by the establishment of a new Regional Transit Board and the contraction of the MTC to a publicly-owned transit company.

Local units of government should have a strong voice in the planning and implementation of service for their area.

Source: Materials contributed by Lawrence Pellam, Director of Transportation Planning, Metropolitan Council of the Twin Cities Area to the "Minute Memo," a publication of the National Association of Regional Councils, July, 1984.

FIGURE 1 Study conclusions on the evaluation of MTC and public transportation needs of the Minneapolis-St. Paul region.

cent of transit taxes for regional services.) In addition, transit tax rates were lowered to reflect the level of service received, with lower rates in suburban areas that receive less service.

Key objectives of this reorganization of regional transportation responsibilities were to increase competition in contracting for public transportation services, to reduce the cost of transportation services, and to obtain a more equitable situation for suburban communities regarding the funding and receipt of public transportation services.

San Diego Metropolitan Transit Development Board (MTDB)

The San Diego region includes San Diego County and ten of its cities, including the city of San Diego. It is a rapidly developing area with considerable growth in the suburban areas and high automobile use. The San Diego Metropolitan Transit Development Board was created by the California state legislature in 1975 and empowered to plan, construct, and operate mass transit guideways and perform near-term planning. The agency has evolved into an umbrella organization having broad transit development, planning, programming, and financing power (*1, 3*).

The overall public transit network in the San Diego region is officially called the Metropolitan Transit System or MTS. MTS is not an agency; it is a name and logo/acronym used to represent all of the publicly subsidized transit operators in the San Diego metropolitan area. Thus the systems look similar and have coordinated services and fares, but they are operated by different organizations and coordinated and funded through MTDB.

MTDB directs the operation of six fixed-route bus operators, a light rail transit provider, four general purpose dial-a-ride systems, and a freight railroad. MTDB exercises varying degrees of control over these organizations.

MTDB owns the assets of three of these organizations, which operate as subsidiaries with day-to-day functions and labor requirements managed by separate operating corporations:

- *Public transit.* MTDB owns San Diego Transit Corporation (SDTC), which provides bus service, and San Diego Trolley, Inc. (SDTT), the light rail operator. These organizations are nonprofit corporations and are the largest public transportation operators in the region.
- *Freight rail service.* MTDB owns the San Diego and Arizona Eastern Railway Company (SD&AE), a Nevada railroad corporation that includes 108 miles of rail line and 2,000 acres of property. The rail right-of-way is used by SDTI.

Although MTDB does not have direct control of the suburban fixed-route bus operations or the public dial-a-rides, it influences route and service definition and fare structure for each operator through its powers to coordinate transit services and administer transit funding and program projects.

Public transportation in the San Diego region includes regional services (inter-city with longer trip lengths) and local services. The region contracts for much of its services:

Regional service. MTDB contracts with private operators for some regionally significant express routes. SDTC also provides most of the regional route service.

Local service. Three suburban cities contract for bus service with private operators. Service levels, fares, routes, and headways are determined by the communities. Service, fare, and transfer coordination are established regionally. Dial-a-ride services are provided in unincorporated parts of the county and some smaller cities through contracts with private operators. These include taxi and van service with transfers to MTDB buses.

Initially the MTDB included representatives of the governor, mayor, county supervisor, and cities. The suburbs shared delegates. In 1984 the board was expanded from eight to fifteen members, giving each suburban area its own representative. Currently, the city of San Diego has 80 percent of the region's population and four of the fifteen board members. It has a weighted vote (it needs only two votes other than its own to carry), but has not exercised it to date.

SUMMARY

This paper has identified and described various regional organizations for public transportation. We have noted similarities and differences in the responsibilities of organizations, the extent of their authority, their boards' membership and composition, the modes they operate, and their relationships to other regional organizations. Our research does not suggest that any particular type of organization performs better or worse than another. Factors other than organizational structure (such as management ability, organizational stability, community [public and private] support, and solvency) are more likely to determine the effectiveness of a regional public transportation organization.

Our research indicates that there are essentially two types of regional public transportation organizations: those that operate public transportation services and those that do not. The former were generally established in the 1970s during a period of consolidation and expansion of public transportation funding and service. In many areas fixed rail services were being initiated or expanded, fixed-route bus services were being extended in particular to suburban communities, and paratransit services were being introduced to serve the specialized travel needs of mobility-restricted persons.

Regional public transportation organizations that do not operate transit services are, by and large, more likely to have been established in the 1980s. Such organizations administer, guide, fund, and oversee diverse transportation services that are operated by other public or private organizations. They were formed to serve the following purposes: tailoring services to jurisdictional needs and priorities; increasing authority and decision making by suburban communities; increasing competition through contracting for services; reducing operating costs for transit by providing different levels of services in different areas; and redistributing public support for public transportation within regions.

REFERENCES

1. *Initial Review of Transit Coordination and Consolidation.* Draft report. Metropolitan Transportation Commission, Berkeley, Calif., Sept. 1986.
2. *Private Sector Brief: Minneapolis/St. Paul RTB.* Rice Center/UMTA Office of Private Sector Initiatives, 1982.
3. T. F. Larwin. Public Transportation Development and Coordination: San Diego Case Study. In *Transportation Research Record 1144*, TRB, National Research Council, Washington, D.C., 1987.

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Survey of Indiana State Legislators' Views of Transit

KUMARES C. SINHA, MICHAEL J. DOHERTY, AND JOHN N. PARSONS

This paper summarizes results of a survey of state legislators undertaken in Indiana to identify the goals and objectives of the state transit assistance program as well as to determine the possible direction of the state's involvement in the delivery of transit services. Eighty-three responses were received out of a total of 150. The survey concluded that the legislators felt that transit plays an important role in providing transportation service to disadvantaged groups and that there are several positive aspects of transit services in a community. However, legislators also felt that revenue for transit operation should primarily come from fare box and local subsidies, with the state supporting those systems that are most likely to remain viable in the face of reduced federal assistance.

Federal programs for assistance to urban transit systems are currently in an uncertain state. Federal operating subsidies at the present level may not continue in the near future. In an effort to reduce federal deficits, many domestic programs are expected to be heavily reduced. Mass transportation is often mentioned as one of the programs to be reduced. It is argued that the responsibility of operating transit systems basically lies with state and local governments.

To carry out an orderly transition from the present heavy dependence on federal assistance along with the attendant federally dictated guidelines for transit operation to a situation where federal presence is less than what it is today or even minimal, it is imperative that states and local agencies critically review their transit programs and plan for future actions to meet the challenge arising from a possible cut in federal programs. This planning must be viewed as contingency planning so that all possible actions and their consequences are given appropriate consideration before a particular strategy or policy is found desirable. Furthermore, it should be noted that possible actions may depend on the extent of reduction of federal assistance. For example, if federal operating assistance is reduced by 10–25 percent, all transit systems may continue to operate with a reduced level of service, assuming all state and local funds and their allocations do not change. However, if the reduction is much deeper, many of the systems may not be able to continue to provide any viable service. At this point the following questions would need to be answered: How are the available limited state public transportation funds to be distributed? Should the state continue to distribute the funds among all systems proportionately, or should the situation be taken as a case of "triage" where only systems with the highest chance of survival in terms of ridership and local support be sorted out for continued funding?

In addressing the various issues involved, especially in determining goals and objectives of a state transit subsidy program, a survey of state legislators was conducted in Indiana to determine how clearly funding decisions were perceived with respect to the overall goals of public transit. This work was part of a larger study to evaluate state transit subsidy policies in response to possible reduction in federal assistance (*1*).

INDIANA TRANSIT CHARACTERISTICS

In Indiana, 31 transit systems are subsidized by the state. There are fixed-route and demand-responsive systems and one commuter rail system. Five systems serve areas with population of 150,000 or greater, nine in areas with between 50,000 and 150,000 people, and another seventeen in areas with a population below 50,000. The rail system provides commuter service to Lake, Porter, LaPorte, and St. Joseph Counties along the northern corridor of the state. Seven of the thirty bus systems essentially serve areas in counties while the remaining 23 serve various cities and their surrounding areas.

As a result of the recent change in state transit subsidy allocation procedure (*2*), the Indiana transit systems have been divided into four groups for the purpose of allocating State Public Mass Transportation funds. These groups cluster the transit systems such that systems within a group are nearly homogeneous (similar) and the systems of different groups are heterogeneous (dissimilar). The division of systems into groups was based on population, peak hour fleet, average operating speed, wage rate, and type of service with the expectation that systems within a group could then be compared equally. This analysis resulted in four general groups, which are shown in Table 1. The first group includes the relatively large systems; Group 2 consists of medium sized systems; and Group 3 includes small fixed-route, fixed-schedule systems. Group 4 is composed of all demand-responsive systems, some of which are county-wide and primarily intended for elderly and handicapped people.

DESCRIPTION OF THE PUBLIC MASS TRANSPORTATION FUND (PMTF)

The Indiana State Public Mass Transportation Fund is a special revenue fund created by the 1980 Indiana General Assem-

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TABLE 1 SELECTED CHARACTERISTICS OF INDIANA TRANSIT SYSTEMS BY GROUP: 1985

System	Population	Ridership	Annual RVM	Annual Expenditure ($)	Fare + Other Revenue ($)	Federal Subsidy ($)	Operating Ratio
Group 1							
Ft. Wayne	236,479	1,577,647	1,411,392	4,266,981	910,141	1,165,093	0.54
Gary	151,953	3,700,723	1,579,276	5,615,338	2,347,244	1,256,401	0.63
Indianapolis	711,539	15,083,909	5,897,739	19,214,946	8,097,601	5,750,666	0.53
NICTD	171,371	2,419,923	1,562,067	15,521,035	6,121,300	2,173,060	0.42
South Bend	149,928	4,200,969	1,866,015	5,144,776	1,172,560	1,229,244	0.62
Total/Average	1,421,270	26,988,171	12,316,489	49,763,076	18,648,846	11,574,464	0.52
Group 2							
Anderson	66,910	354,106	349,837	1,035,815	105,782	464,030	0.25
Bloomington	52,044	361,489	338,394	870,799	151,091	331,041	0.37
Evansville	130,496	1,593,180	686,166	1,397,277	615,575	443,277	0.47
Hammond	93,714	386,984	385,770	891,042	147,494	371,774	0.35
Lafayette	91,380	1,124,226	903,530	1,834,531	428,012	700,215	0.49
Muncie	77,216	1,233,293	814,627	1,923,140	487,722	623,388	0.51
So. Indiana	73,487	185,489	182,325	608,414	72,170	268,122	0.27
Terre Haute	63,931	474,291	535,291	909,452	179,482	364,985	0.33
Total/Average	649,178	5,713,098	4,195,940	9,756,692	2,187,328	3,566,832	0.41
Group 3							
Bedford	14,410	39,558	93,195	154,380	16,652	68,864	0.26
Columbus	30,614	171,849	227,262	287,292	50,470	118,411	0.31
East Chicago	39,787	459,362	142,384	673,463	0	294,400	0.27
Laporte	21,796	106,282	215,926	324,411	60,203	132,104	0.36
Marion	35,874	139,117	133,647	305,222	31,865	136,678	0.25
Michigan City	36,850	213,173	170,815	365,570	73,166	146,202	0.33
Mitchell	4,641	8,975	10,496	44,615	4,204	20,206	0.25
New Castle	20,056	106,215	126,316	315,408	27,938	139,975	0.29
Richmond	41,349	190,844	217,510	306,945	91,023	107,961	0.41
Washington	11,325	22,214	32,760	33,535	7,355	13,090	0.35
Total/Average	256,702	1,448,614	1,370,311	2,810,841	362,876	1,177,891	0.31
Group 4							
Goshen	19,665	7,557	19,001	24,353	5,765	9,294	0.36
KIRPC[a]	76,238	28,906	90,638	180,451	6,605	85,916	0.21
Kosciusko Co.	59,556	96,102	163,898	353,030	53,365	149,833	0.29
LCEOC	51,422	160,911	463,423	567,002	157,334	204,834	0.44
Madison Co.[b]	72,426	1,188	12,422	34,868	2,486	16,191	0.23
Monroe Co.	51,114	42,371	159,577	300,386	15,594	142,396	0.21
Trade Winds	51,422	117,914	430,803	553,363	265,308	167,823	0.50
Union Co.	6,860	13,709	47,841	68,826	5,678	31,574	0.24
Total/Average	388,703	477,633	1,387,603	2,082,279	512,135	807,861	0.37

[a]All service statistics are from January 1985 to June 1985.
[b]Service began September 15, 1985.

bly to assist public transportation in the state. According to statute, funds in the PMTF are to be used solely for the promotion and development of public mass transportation.

The PMTF evolved from a state grant program established by the legislature in 1975. Part of the program called for annual general fund appropriations designed to aid local units of government in matching public transportation grants provided under the Federal Urban Mass Transportation Act of 1964, as amended. It was strictly a matching grant program to augment local matching funds at a time when municipal corporations were under financial constraints imposed by the property tax control program. Presently the PMTF consists of a dedicated 0.76 percent of the state's 5 percent general sales and use tax. The PMTF allows any municipal corporation that receives a federal mass transit grant to apply for state subsidy. Since July 1985, the Indiana Department of Transportation (IDOT) has used a formula based on service area population and system performance to allocate funds (*2*).

SURVEY OF STATE LEGISLATORS

Although Indiana has had a transit assistance program for more than a decade, the goals and objectives of this program were never clearly identified. The initial legislative intent for the transit assistance program was to provide support to the local governments in meeting matching funds for receiving federal transit assistance. However, as the level of state subsidy is now larger than the total amount of local subsidy and as the certainty of federal assistance is becoming questionable,

it is clear that the state cannot continue to be a passive participant in the delivery of transit services in Indiana. It is imperative that the State examine critically the current and future role of the PMTF and how the limited PMTF can be allocated should federal funds be reduced or completely eliminated.

To identify the goals and objectives of the state transit assistance program, as well as to determine the possible direction of the state's involvement in the delivery of transit services in Indiana, state legislators were surveyed on their views on state transit assistance. This survey was the first attempt to identify the collective view of the legislators with respect to transit.

SURVEY DESIGN AND PROCEDURE

A simple mail-back questionnaire was designed for the survey and is provided in Figure 1. The survey form was mailed out to all 150 state legislators in April 1986. The survey was straightforward in design and sought to measure the relative

SURVEY TO ASSESS DISTRIBUTION OF STATE FINANCIAL ASSISTANCE TO PUBLIC TRANSPORTATION SYSTEMS

A. For the following seven statements, please indicate whether you agree with the statement (TRUE), disagree with the statement (FALSE) or are in any way unsure (UNDECIDED).

The primary goals of a local public transportation system are to:

1.	Relieve congestion in the central business district.	TRUE	FALSE	UNDECIDED
2.	Provide transportation for the elderly and disabled.	TRUE	FALSE	UNDECIDED
3.	Reduce pollution generated by auto traffic within an area.	TRUE	FALSE	UNDECIDED
4.	Enhance the overall quality of life in an area.	TRUE	FALSE	UNDECIDED
5.	Provide transportation to the economically disadvantaged.	TRUE	FALSE	UNDECIDED
6.	Conserve fuel.	TRUE	FALSE	UNDECIDED
7.	Serve the work trip.	TRUE	FALSE	UNDECIDED

B. As federal funds are reduced, the IDOT may have to redefine its policy on granting state financial support. The IDOT will most likely support only those systems located in areas that have demonstrated that transit is an important local public service. There are numerous measures that the IDOT could use in defining this level of importance.

Good measures for defining the relative importance of transit to an area are:

1.	Number of passengers carried.	TRUE	FALSE	UNDECIDED
2.	Percentage of passengers that are elderly or disabled.	TRUE	FALSE	UNDECIDED
3.	Percentage of worker trips.	TRUE	FALSE	UNDECIDED
4.	Percentage of low income passengers.	TRUE	FALSE	UNDECIDED
5.	Lack of an available alternative.	TRUE	FALSE	UNDECIDED
6.	Number of passengers carried compared to the service area population.	TRUE	FALSE	UNDECIDED
7.	Percentage of system operating costs recovered from local taxes and farebox revenue.	TRUE	FALSE	UNDECIDED

FIGURE 1 The questionnaire used in the legislators' survey.

C. **For each question, please circle one and only one answer which best describes your answer. In some cases, none of the options will seem an adequate choice; in these cases it is still IMPORTANT that you circle one answer as the best in that particular choice set.**

[Please leave no questions unanswered]

1. What category of information should the IDOT use in judging a transit system's performance?

   a. amount of service
   b. ridership
   c. financial condition

2. Where is state subsidized transit most appropriate?

   a. Systems that carry the most passengers.
   b. Systems that carry the most work trips.
   c. Systems that recover most of their costs from passenger fares and local taxes.
   d. Systems that carry a high percentage of elderly, disabled, or economically disadvantaged riders.

3. Which of the following represents the greatest benefit derived from having public transportation service?

   a. reduced pollution
   b. fuel conservation
   c. transportation for the economically disadvantaged
   d. reduced traffic congestion
   e. service for the elderly and disabled
   f. alternate means of getting to work
   g. improved personal mobility which directly affects a local economy

4. Local taxes and fare box revenues should cover _____ per cent of operating expenses?

   [Please select an answer which should fill in the blank.]

   a. 30 per cent
   b. 50 per cent
   c. 75 per cent
   d. 90 per cent
   e. 100 per cent

5. State support should be directed primarily to systems that:

   a. Offer inexpensive transportation to the disadvantaged (elderly, disabled, low income groups).
   b. Offer transportation at a reasonable cost in an economically efficient manner, where fares and local money support most of the system.
   c. Serve the work trip, which directly affects the economy of a community.
   d. Offer a transportation option in large metropolitan areas, with populations in excess of 50,000.

If there are other concerns which you feel have been left out, please use the space at the bottom of the page to list those. Thank you very much.

FIGURE 1 *continued*

importance of issues associated with transit systems. The returned questionnaires were not identified, thus survey responses were anonymous. In some cases, however, the respondents intentionally indicated their identity in the completed questionnaire.

The survey instrument was presented in three parts, two true-and-false sections and one section of forced-choice answers. The first true/false section dealt with what the respondent felt were the primary goals of transit systems. The second section examined the types of measures which could be considered in determining the importance of transit services to a given area. The last section combined goals and measures and was used to determine answer consistency and to gain a perspective on the relative importance of the information collected in the first two sections.

The value of this particular survey design lies in the ease of completion for the respondent and the fact that it is graduated in the degree of difficulty as the respondent progresses through the form. The true and false sections do not require difficult choices from the respondent, yet do begin the process of establishing the context of the questions. Thus, by the time a respondent gets to the third section of the survey, he or she

is aware of the different and conflicting issues associated with public transportation decisions.

Eighty-three surveys were returned for a response rate of 55.3 percent. Usually mail-back questionnaires have a return rate of 25–33 percent. This indicates the issue was considered to be important by many legislators. The returned surveys were analyzed according to frequency of responses in the various categories with special attention given to detecting inconsistencies in responses.

SURVEY RESULTS

Primary Goals of Public Transit

The results of the first section dealing with the primary goals of public transportation are presented in Table 2. Overall, these goals were found to be agreeable to all respondents as can be seen by the agreement rate of 60 to 80 percent for all categories. This same trend can be seen in responses related to section two of the survey, which deals with measures for defining importance of transit to an area and the results are presented in Table 3. However, whereas the goals with the highest rating were associated with serving special types of riders (i.e., the economically disadvantaged, elderly, and handicapped), measures using these types of riders were ranked near the bottom of all items. The measures felt to be most appropriate dealt with area-wide characteristics, such as the number of passengers and the lack of other transportation alternatives. These types of apparent inconsistencies underscore the conflict between goals and performance measures that is now commonplace in public transportation funding decisions. Nevertheless, the inconsistencies also show that probably no unique measure exists and that a combination of factors constitutes a more acceptable basis for decision making.

Relative Importance of Goals and Performance Measures

The relative importance of the goals and measures is more clearly defined when examining the results of section three of the survey. Table 4 presents the results of questions dealing with the type of information the state should use to judge system performance and the criteria used to determine where state monies should be allocated. It is interesting to note that where the financial condition of a transit system is rated as the least desirable indicator of performance, the degree of locally derived income is chosen as the most important criterion for determining a system's share of state monies.

TABLE 2 PRIMARY GOALS OF PUBLIC TRANSIT

Statement	True (%)	False (%)	Undecided (%)
Relieve congestion in the central business district	70.4	17.3	12.3
Provide transportation for the elderly and disabled	76.5	11.1	12.3
Reduce pollution	67.9	19.8	12.3
Enhance the overall quality of life within an area	64.6	20.7	14.6
Provide transportation for the economically disadvantaged	79.0	14.5	6.0
Conserve fuel	63.0	23.5	13.
Serve the work trip	64.1	17.9	17.9

TABLE 3 GOOD MEASURES FOR DEFINING IMPORTANCE OF TRANSIT TO AN AREA

Measure	True (%)	False (%)	Undecided (%)
Number of passengers carried	86.4	6.2	7.4
Percentage of E&H passengers	64.9	20.8	14.3
Percentage of work trips	71.4	14.3	14.3
Percentage of low income riders	63.6	20.8	15.6
Lack of available alternative	78.0	15.9	6.1
Number of passengers carried compared to service area	74.4	11.5	14.1
Percentage of operating costs recovered by local revenues	73.8	12.5	13.8

Role of State Transit Assistance

Table 5 shows the attitudes of the respondents toward appropriate measures for determining state subsidies and the percentage of local support that should cover operating expenses. Ridership, the percentage of disadvantaged riders, and the amount of locally derived income were about equally chosen as good measures for determining state subsidies. Only the use of work-related trips was felt to be an inappropriate measure. A consensus of the degree to which a transit system should be locally supported appears to be in the 50–75 percent range, with a slight skew toward the higher range. These results are consistent with those seen in Table 4(b). Table 6 presents what the respondents saw as the greatest benefit of public transit. Here again it is seen that area-wide considerations are felt to be the most important, as benefits to the

TABLE 4 FACTORS TO BE USED IN EVALUATING SYSTEM PERFORMANCE AND STATE SUPPORT

Choice	Percentage
(a) Category of Information That Should Be Used for Judging Performance	
Amount of service offered	22.0
Ridership	67.1
Financial condition	11.0
(b) State Support Should Be Directed Primarily to Systems That:	
Offer inexpensive transportation to the disadvantaged	15.9
Offer transportation at a reasonable cost, efficiently, with high level of local financial support	58.5
Serve the work trip, affecting the local economy	8.5
Offer transportation in large areas with populations > 50,000	17.1

TABLE 5 APPROPRIATE MEASURES FOR DETERMINING STATE SUBSIDIES AND DESIRED LEVELS OF LOCAL FINANCIAL SUPPORT

Choice	Percentage
(a) Where is State Subsidized Transit Most Appropriate?	
Systems that carry the most passengers	26.8
Systems that carry the most work trips	12.2
Systems that recover most of their costs locally	31.7
Systems that carry a high percentage of E&H and low-income riders	29.3
(b) Percentage of Expenses That Local Taxes and Farebox Revenues Should Cover	
30%	11.1
50%	29.6
75%	27.2
90%	14.8
100%	17.3

local economy and the reduction of congestion account for two-thirds of the responses.

After breaking the survey into five basic categories of concern, totaling the number of responses pertaining to each category and normalizing the weight of each category to the total number of responses, a crude weight of the relative importance based on the sample can be determined. These results are presented in Table 7. Using this technique, it is clear that ridership is still important, but that the degree to which disadvantaged riders are served is also a factor which needs to be considered.

DISCUSSION OF RESULTS

It should be emphasized that the results of the survey are not to be used as a predictive tool, but rather as a means to gauge the prevailing attitudes. The objective of this survey was to determine how clearly funding decisions are perceived with respect to the overall goals of public transit. The results presented here would seem to indicate that while the primary goals of public transit are perceived to be equity related, funding decisions should be based on more practical economic measures. Legislators considered many factors relevant in providing public transportation services. However, when confronted with the task of selecting systems where subsidies should be given, the overwhelming response is to support the systems with high recovery of expense through local taxes and fare box revenues.

A potential inconsistency discovered stems from the fact that while the degree to which a transit system is locally funded is considered a major factor for determining the amount of state subsidy a system is entitled to, the most appropriate measures are felt to be related to service characteristics, such as total ridership. If locally derived income and total ridership are closely correlated, this inconsistency is not a problem. However, if for a particular system these two factors diverge, conflicts will arise and the potential for a uniform set of funding criteria is diminished. One possible solution to this problem would be to develop a weighted measure using both total ridership and locally derived income and perhaps other factors.

TABLE 6 GREATEST BENEFIT DERIVED FROM PUBLIC TRANSPORTATION

Benefit	Agreement (%)
Reduced pollution	1.2
Fuel conservaton	0.0
Transportation for economically disadvantaged	14.6
Reduced traffic congestion	23.2
Service for the elderly and handicapped	4.9
An alternate means of getting to work	12.2
Improved personal mobility that directly affects the local economy	43.9

CONCLUSIONS

The survey of legislators identified the directions in which the state transit assistance should go. The basic conclusion of the survey was that the legislators felt that transit plays an important role in providing transportation service to disadvantaged groups and that there are several positive aspects of transit services in a community. However, revenue for transit operation should primarily come from fare box and local subsidies, with the state supporting those systems that are most likely to remain viable in the face of reduced federal assistance.

The possible response of a system to reduced federal assistance is therefore primarily to follow a combination of the following measures: cut service, raise fares, or secure a higher level of local assistance. Because an increase in local assistance is beyond the control of a transit management, a transit operator can consider only service reduction and fare increase as the two major actions. However, small systems are much more vulnerable than large systems, if a drastic service reduction or fare increase needs to be undertaken. Because of the heavy dependence on federal assistance, systems in Groups 3 and 4 would be severely affected by even a relatively small reduction in federal assistance.

REFERENCES

1. K. C. Sinha, M. J. Doherty, R. W. Muncey, and J. D. N. Riverson. *Evaluation of State Transit Subsidy Policies in Response to Reduc-*

TABLE 7 RELATIVE IMPORTANCE OF VARIOUS FACTORS ASSOCIATED WITH PUBLIC TRANSIT

Category	Variable Included	Relative Weight
Importance of serving special riders	E&H ridership, low-income ridership	.227
Importance of serving the public good	Relieve congestion, reduce pollution, conserve fuel	.120
Importance of local financial support and enhancing local economy	Farebox revenues, locally derived income, effect on local economy	.213
Importance of population-related factor	Service area population, total ridership, passenger measures	.271
Importance of service characteristics	Number of work trips, amount of service.	.169

tion in Federal Assistance. Report No. CE-TRA-86-1, School of Civil Engineering, Purdue University, West Lafayette, Indiana, September 1986.
2. K. C. Sinha, J. N. Parsons, D. T. Barnum, and E. A. Sharaf. Development and Implementation of a Performance-Based State Transit Subsidy Allocation Formula for Indiana. In *Transportation Research Record 1076*, TRB, National Research Council, Washington, D.C., 1986.

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State Modal System Plans as Technical Issue Documents—A New Role

DOUGLAS S. MCLEOD

Traditionally state modal system plans deal with the physical arrangements and needs of modal networks and are dominated by short-term work programs. However, in the development of Florida's modal system plans, statewide direction setting issues for each respective mode are also analyzed, leading to specific recommendations for policy, procedural, or statutory changes. As an example, the Florida Highway System Plan addressed nine major highway issues facing Florida: (a) state, regional, metropolitan and local plans coordination, (b) highways as a growth management tool, (c) level of service standards, (d) right-of-way protection/advanced acquisition, (e) access management, (f) traffic analysis procedures, (g) major site improvement developments, (h) modal linkages, and (i) hurricane evacuation. Task teams were formed to analyze and make recommendations on each issue. Using modal system plans as umbrella documents to address statewide transportation issues helps the Florida Department of Transportation to better determine its role in the different modes and the overall state planning process. Recommendations also lead to more cost-effective use of the Department's resources and can help drive program budgets leading to project implementation. The system plans are proving to be important decision-making documents.

Traditionally transportation modal system planning deals with the physical arrangements of modal networks with emphasis on the whole system rather than individual parts. Frequently state modal system plans reflect network needs and are dominated by short-term (five-year) work programs. However, Florida's modal system plans are unique for three reasons. First, the modal system plans are being developed in a policy framework based on policy direction from the Strategic Transportation Plan (*1*), the State Comprehensive Plan (Chapter 187, Florida Statutes), and the Florida Transportation Plan (*2*). For instance, Florida's proposed controlled access and interregional highway systems in the Florida Highway System Plan (FHSP) (*3*) are based on the policy of "preserving and enhancing interstate and interregional mobility."

Second, the modal system plans are crucial to the Department's planning process. The modal system plans provided initial input into the development of the Department's Strategic Transportation Plan. Furthermore, they are not final products; rather they help drive program plans and budgets and, ultimately, project implementation. Projects do not form the system plans; the plans drive the development of projects.

Third, and most important, the Florida modal system plans are the primary instruments in which statewide direction setting issues are analyzed and addressed for each respective mode. For example, the Florida transit system plan (*4*) is the umbrella document for the most important direction setting issues and needs facing Florida's transit systems. Addressing direction setting transportation issues is not unique to Florida. What is unique is that they are addressed in a comprehensive fashion in the respective modal system plans or on a piecemeal basis.

The Strategic Transportation Plan is the Florida Department of Transportation's direction setting document emphasizing strategies, reforms, and facilities needed. The Florida Transportation Plan encompasses the Department's Functional Plan of the State Comprehensive Plan. The transportation modes section of the 1986 Florida Transportation Plan requires the development of transportation modal system plans. In 1987 the Department was developing the following modal system plans: aviation, bicycle and pedestrian, highway, rail, and transit. Each modal system plan is to include the following:

1. Goals and policies consistent with the Florida Transportation Plan;
2. A determination of statewide needs and issues based on the movement of people and goods;
3. An analysis of financial resources;
4. A functional classification process;
5. An analysis of institutional, physical, operational, and financial linkages with other transportation modes; and
6. An analysis of the roles and responsibilities of state and local governments and the private sector in provision of transportation services.

This paper shows how the Florida modal system plans and, more specifically, how the FHSP serves as a decision-making issue document. The FHSP process is discussed and major findings and recommendations from the issue analyses are presented. The focus of this paper is not to provide a detailed discussion of any one of the issues in the FHSP; rather the major issue findings and recommendations are used to illustrate how important modal system plans can be to the transportation planning process.

FLORIDA HIGHWAY SYSTEM PLANNING PROCESS

Two major components make up the Florida Highway System Plan. First is the highway system needs section covering the state's controlled access, interregional, regional, and urban systems. This is the more traditional section of a statewide highway system plan dealing with the physical arrangement

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and interrelationship of the state's highway system. Second is the highway system issue section, which is the subject of this paper.

The Florida Department of Transportation is a highly decentralized organization. The Department's Districts are directly responsible for the transportation planning and implementation of projects in their areas and, in general, collectively are responsible for coordinating projects for the state. To a large extent the Department's Central Office assists in the coordination effort and is responsible for the development of minimum policies, standards, and guidelines. Thus, in Florida, District input is essential to address overall statewide issues. In September 1986, Central Office staff visited each District to discuss major highway issues facing the State. The issues were briefly discussed, and in October 1986, eight issues were selected to be analyzed in the first edition of the FHSP. District and Central Office Steering Committees were formed which by February 1987 added two issues and deleted one of the original issues. The final nine selected issues were the following:

1. State, regional, metropolitan, and local plans coordination,
2. Highways as a growth management tool,
3. Level of service standards,
4. Right-of-way protection/advanced acquisition,
5. Access management,
6. Traffic management procedures,
7. Developments of regional impact (major site improvement developments),
8. Modal linkages, and
9. Hurricane evacuation.

Task teams were formed to address each issue. Membership consisted of approximately six of the most knowledgeable Department personnel on each issue, and, as appropriate, the membership was supplemented by the representatives of the private sector, leading transportation scholars, and other state representatives as ex officio members. At least one District representative served on each team, and all the Department's seven Districts had at least one representative directly involved in writing the FHSP. The intent was to bring together representative working groups of Department experts who could effectively analyze major statewide highway issues in a timely fashion.

Each team's major task was to analyze its specific issue by developing technical issue papers and reports. These were summarized into no more than seven pages in the FHSP text. The text of each issue consisted of a problem statement, a goal statement, background and analysis, and recommendations. In addition, the teams recommended policy changes to the Florida Transportation Plan and suggested recommended legislative changes.

TASK TEAM FINDINGS AND RECOMMENDATIONS

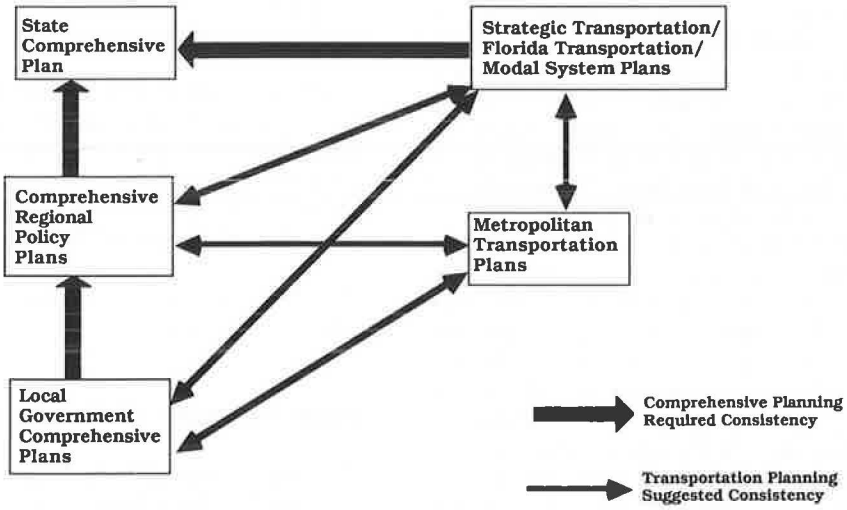
The following are excerpts of the teams' major findings and recommendations.

State, Regional, Metropolitan and Local Plans Coordination

The 1984 Florida Legislature significantly revised Florida's transportation planning statutes to enhance the policy and planning activities of the Department. The Florida Transportation Plan and the Florida Highway System Plan are directly linked to the legislation. The creation and operation of transportation planning organizations, Metropolitan Planning Organizations (MPOs), for all urbanized areas is also mandated in Florida statutes.

The 1984 Legislature also passed the State and Regional Planning Act (Chapter 186, F.S.) which required the development of the State Comprehensive Plan, State Agency Functional Plans, and Comprehensive Regional Policy Plans. Chapter 163, Florida Statutes, requires the development of Local Government Comprehensive Plans, including traffic circulation elements.

Local Government Comprehensive Plans must be consis-



Source: Bureau of Multi-Modal Systems Planning, Florida Department of Transportation, 1987.

FIGURE 1 Relationship of comprehensive and transportation plans.

tent with Comprehensive Regional Policy Plans (prepared by regional planning councils) which in turn must be consistent with the State Comprehensive Plan (Figure 1). State Agency Functional Plans, and more specifically the Department's Florida Transportation Plan, must also be consistent with the State Comprehensive Plan. However, Florida's growth management and comprehensive planning legislation provides only an indirect link between regional and local comprehensive plans and the Florida Transportation Plan and other related transportation plans.

Since the adoption of Florida's growth management and comprehensive planning legislation, much of the debate over consistency between agency functional plans and regional and local comprehensive plans has occurred in the transportation arena. The specific issue was who should (or who has the authority to) set level-of-service standards for the State Highway System in a local jurisdiction. The fundamental question as to who sets levels of service could have occurred in education, environment, or other areas. For instance, the specific issue could have been over the question of who should (or has the authority to) set environmental standards for waters of the state in a local jurisdiction. From a planning viewpoint, the general consistency issue is over balancing area-wide planning (e.g., local jurisdiction) with functional planning (e.g., transportation, environmental). From a political perspective, the general issue may be viewed as balancing the desirable concepts of "local government control" with "protection of state resources."

The Department's position was that neither form of planning nor political consideration should take precedence over the other. Interested parties with opposite viewpoints should build flexibility into their positions so that a consensus could be reached. An example of this flexibility is the Department's concept of Special Transportation Areas where the Department may allow a lower quality level of service on important state resources (i.e., the State Highway System) if the overall needs of the local government outweigh the specific need to protect a state highway. The primary concept is to reach a consensus of opinion among the parties when conflicts arise. Success will be measured by how well the concerns of all the parties are met. If this process fails, legislative changes would be necessary.

Major recommendations of this task team included the following:

1. Recognition by the Department that area-wide planning performed by local and regional entities is mandated by Florida law, is important, and should be a part of the Department's planning and work program development process.
2. Recognition by the Department; legislature; and regional, metropolitan, and local officials that conflicts will occur over construction and operation of the State Highway System within regional, metropolitan, and local jurisdictions. These conflicts should be resolved in a cooperative manner with consensus reached.
3. The MPO long-range transportation plans should be one of the primary inputs for the urban component of the Florida Highway System Plan.
4. Establish within each District and the Central Office a local government technical assistance work group available to work with local governments in their development of the traffic circulation element of their comprehensive plans.
5. Assist local governments to develop innovative land development regulations, including impact fee ordinances and right-of-way protection provisions intended to protect, preserve, and foster the expansion of the State Highway System.

Highways as a Growth Management Tool

Although a wealth of information exists in Florida that explains what growth management is by discussion and example, a concise legal definition of growth management, especially as it relates to transportation system development, is not clearly stated in Florida law. The team investigated the growth management legislation and determined that the following five major issues form the framework for transportation to serve as a growth management tool:

1. Infrastructure concurrent with the impact of development;
2. Coordination of state, regional, and local plans;
3. Attracting desirable development;
4. Encouraging development within urban areas and within transportation corridors; and
5. Managing development in coastal areas.

Subsequently, for the FHSP the team defined growth management as "The implementation of state goals and Department policies, objectives, and standards to obtain maximum benefit from environmental, physical, social, and economic use of land by working with local governments to control the timing, nature, and location of growth into preferred development patterns."

The team determined that highway project types that significantly affect land use patterns are those that provide substantially improved access. These types of facilities include the following:

1. Interchanges on limited access facilities,
2. New highways/bridges to areas with currently severely restricted access, and
3. Substantially improved (i.e., unpaved roads to multilane) highways.

Although major in scope, multilaning highway improvements (e.g., two to four lanes) predominantly reflect traffic and land use demands. They are primarily a result of or a reaction to growth rather than facilities that guide or direct growth. "Access" is the key word relating growth management and highways. The three types of highways listed above significantly affect land use patterns by providing access to new areas. On the other hand, capacity improvements increase access to existing areas.

The Department has considerable potential to implement growth management because (a) most major highways that provide new access are state facilities and (b) the Department has statutory authority to construct, operate, and maintain the State Highway System.

The task team made the following recommendations:

1. Thoroughly analyze Department projects that provide new access for secondary (indirect) impacts to ensure coor-

dination with regional and local comprehensive planning efforts. A lesser level of analysis, particularly for secondary impacts, should be acceptable for upgrading established transportation corridors and existing transportation rights-of-way. This latter effort should primarily focus on minimizing direct impacts to adjacent properties.

2. Separate funding for growth management type highway projects (e.g., the interregional facilities, new interchanges for approved developments) and urban highway projects.

Level-of-Service Standards

Keys to the Department's success in implementing growth management intent are to define and apply comprehensive level-of-service standards for the State Highway System and then to work with regional planning councils, MPOs, and local governments in using those standards. Although the impetus to examine level-of-service standards in Florida stemmed from growth management issues, other factors also indicated the desirability of establishing standards. These factors included reviews of major site development improvements, development of new traffic flow, measurement and evaluation techniques (e.g., the 1985 Highway Capacity Manual [5]), and better reporting techniques.

The Department's level-of-service standards for the State Highway System appear in Table 1. These standards, or higher standards adopted through formal agreement by MPOs, regional planning councils, and other local governmental entities, also are to be used by the Department to assist the Florida Department of Community Affairs in the review of Local Government Comprehensive Plans and major site development improvements as they relate to the State Highway System.

The Department's standards incorporate (*1*) the direct correlation between urban size and acceptance of some highway congestion as a trade-off for other urban amenities, (*2*) the different roles (i.e., mobility versus access) the state's facilities provide, and (*3*) local flexibility in determining Special Transportation Areas. Special Transportation Areas may include central business districts and outlying business districts, and regional activity centers; however, they do not apply to strip development along highway corridors.

The level-of-service standards reflect minimum acceptable levels of service. Desirable levels-of-service are considered to be B in rural areas and C in urban and urbanized areas.

The basic document for capacity analyses is the 1985 Highway Capacity Manual (HCM). With the assistance of William McShane, one of the principal authors of the HCM, a generalized average daily traffic volume table for varying levels of service was developed to accompany Table 1.

The task team made the following recommendations:

1. The Department should continue to promote its adopted level-of-service standards to be consistent with the growth management concept of providing "infrastructure concurrent with the impact of development" and to preserve and enhance interstate and interregional mobility.
2. By January 1989 the Department should implement level-of-service standards to determine deficiencies and backlogs and to assist in determining project priorities.

Right-of-Way Protection/Advanced Acquisition

The importance of protecting and acquiring needed future right-of-way is demonstrated by the escalating costs and length of time for acquisition. Recent estimates in Florida indicate that right-of-way costs vary from approximately $100,000 per mile in rural areas of north Florida to $77 million per mile in urbanized areas in southeast Florida.

Florida lags behind other states in protecting and acquiring right-of-way in a timely and cost-effective manner. Local governments, the state, and the Department rarely undertake right-of-way protection and acquisition for major roads in a comprehensive fashion. Seldom has the Department actively pursued, with staffing or funds, long-range right-of-way protection for its facilities. Exceptions do exist where right-of-way protection and acquisition have succeeded in Florida. Noteworthy is Broward County's Trafficways (right-of-way thoroughfare) Plan which was instituted in 1962.

TABLE 1 STATEWIDE MINIMUM ACCEPTABLE OPERATING LEVEL OF SERVICE STANDARDS FOR STATE HIGHWAY SYSTEM (1)

Roadway Type[a]	Rural/Urban With Population Less than 50,000	Urbanized Areas With Population 50,000 or More	Special Transportation Area[b]
Freeways	C	D	E
Rural arterials and extensions of rural principal arterials into and through urban areas	C	D	E
Other urban arterials not included above	D	E	E

NOTE: The operating levels of service designate lowest quality operating conditions for the design hour (peak hour with 20-year planning horizon). They are not design standards. Design levels of service are rural/urban areas: B (desirable), C (acceptable); urbanized areas: C (desirable), D (acceptable). Level-of-service standards for specific areas within the state for planning and analysis of development impacts will be adopted through formal agreement among the Department, Metropolitan Planning Organizations, and Regional Planning Councils when the adopted standards incorporate these statewide minimum standards. To fully evaluate operating conditions, these level-of-service standards will be used in conjunction with intersection volume to capacity (V/C) standards.

[a]Roadway type is based on Functional Classification categories as presented in Chapter 334 F.S. Freeways are limited access facilities.

[b]Special transportation areas and the levels of service for roadways within them are to be recommended by appropriate local government entities and approved by the Department. Level-of-service standards for such areas may range from A to E to accommodate specific environmental and/or land development issues. Special transportation areas may include central business districts, outlying business districts, approved area-wide DRIs and regional activity centers.

techniques similar to National Cooperative Highway Research Program Report 255 (8) and other appropriate sources.

3. The Department should undertake more research and field work in support analysis of highway capacity and congestion. The factors needing more research include K factors, saturation flow rates, running speeds, and peak hour factors.

Developments of Regional Impact (DRI)

A DRI is "any development which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county, ..." The DRI program is a growth management process designed to provide a comprehensive assessment of and decision-making tool for Florida's large scale developments.

The Department's responsibility in this complex process is to provide specialized technical review and comments on the development's impacts on the transportation system. The Department has no statutory or regulatory authority to require compliance with its findings or recommendations. The Department's strongest option, when agreement cannot be reached with local government, is to request the Florida Department of Community Affairs or the regional planning council to appeal the Development Order. The Department does control access to the State Highway System through the driveway permit process, which can provide additional leverage where such access is critical to the development. The Department's most significant asset in the DRI process, however, is the technical transportation expertise of its staff. The value of this expertise is generally recognized by government planners, developers, and professional transportation consultants.

The task team made the following recommendations:

1. More emphasis should be placed on the use of computerized regional systems models that have a detailed impact area network and zone system analysis rather than simple manual trip distribution and assignment.
2. Each District is recommended to form a Development Review Committee as a forum for multi-discipline development review by District staff.
3. Levels of impact analysis should reflect distance from the DRI site. In general, the level of detail of the analysis should be greater when it is performed closest to the site and in the earlier phases of development.
4. Arterial analysis should be emphasized more than intersection analysis.
5. To determine a developer's proportionate share contribution, the Department recommends a percent trips formula. The formula is understandable, easy to implement, reinforces Florida's growth management legislation, and is equitable. The Department's level-of-service standards should be used in the calculation. Preconstruction donations (e.g., right-of-way) should not generally be credited in the proportionate share contribution. Where preconstruction donations are credited, the proportionate share costs should include all preconstruction costs.
6. A statewide standard method of calculating DRI economic impact on the State Highway System should be adopted.
7. Wherever possible, the developer should design and construct the needed improvements rather than provide funds for use by the Department in constructing such improvements.
8. Training for Department DRI coordinators, management, and other staff should be developed immediately upon finalization of the Department's minimum standards and guidelines. The prompt availability of this training is vital to the effectiveness of the effort to improve DRI review quality and consistency statewide.

Modal Linkages

In the past, inadequate consideration has been given to the physical, institutional, and financial relationships between highways and other transportation modes. Results have included poor timing between airport access improvements and airport terminal facility expansion, unsafe rail/highway grade crossings, inadequate use of transit as an alternative to highway expansion, and failure to accommodate the needs of bicyclists and pedestrians in highway development and improvement projects.

The task team made the following recommendations:

1. Place more emphasis when planning and developing highway capacity expansion on service airports. Highway improvements should be made prior to or concurrent with air terminal modifications which increase surface transportation requirements.
2. Reaffirm the Department policy of setting aside one and one-half percent of highway preservation program funds to finance the adopted program objectives for rail/highway grade crossing improvements, crossing closures, and grade separations.
3. Modify Department policy to ensure that transit options will be considered in all corridors identified in state, regional, or local transportation plans where the projected level-of-service is equal to or below the Department's statewide minimums.
4. Reaffirm the Department policy of allocating at least 10 percent of state motor fuel tax proceeds to public transportation.
5. Accommodate to the extent practicable the needs of bicyclists and pedestrians on all major urban roadway projects as well as other locations where bicycle and pedestrian travel is likely and where such facilities tie into a total urban system.
6. Allocate special funds to retrofit substandard state highway facilities in urban areas near community facilities such as schools, parks, community centers, shopping centers, and libraries to accommodate bicyclists and pedestrians where such retrofitting can be reasonably accomplished within existing right-of-way.

Hurricane Evacuation

During a hurricane evacuation a large number of vehicles have to be moved across a road network in a short period of time. The number of vehicles leaving becomes a big problem for an area such as the Florida coast, where there are many urban areas and isolated barrier island communities. The number of evacuating vehicles varies depending on the number of

Beyond actual right-of-way donation, the Department believes the most effective way to hold down long-term state highway project right-of-way costs is to identify long-range right-of-way needs for every state facility, coordinate with every county and city on implementing thoroughfare plans, and incorporate the thoroughfare plans into local government comprehensive plans and land development regulations. The process incorporates the concepts of constrained corridors, maximum through-lane standards, ultimate highway buildout, thoroughfare plans, local government comprehensive plans, and land development regulations.

If implemented effectively, the above process is appropriate for right-of-way protection for most state highway facilities; however, some facilities warrant special consideration. The state's interregional system built on new alignment will need corridor studies to begin in order to set realistic preliminary alignments. With the preliminary alignments, local governments can begin to protect the right-of-way and the Department could initiate advanced acquisition of selected parcels. Commencement of the project corridor studies is especially important in urbanized areas. Many of the interregional facilities and some of the state's other major facilities may warrant special land use/development coordination under the Department's proposed transportation corridor program. In the corridor program concept, not only is the state facility considered, but parallel local roads and adjacent development that directly influence the operation of the state facility are also considered. The intent of the program is to bring about a mutually binding state/local/private corridor development program.

The task team made the following recommendations:

1. Link the concepts of (a) constrained corridors; (b) maximum through-lane standards; and (c) ultimate buildout with local government thoroughfare plans, MPO plans, comprehensive regional policy plans, and local government comprehensive plans to assist right-of-way protection and acquisition.
2. Promote and assist in the adoption of thoroughfare plans in each county and city.
3. Develop and implement a transportation corridor program to protect right-of-way and establish coordination between local land use planning and transportation investments.
4. Develop a Department policy stating that local governments protecting, acquiring, or donating right-of-way for state facilities will be given preferential treatment in the Department's project priority process.
5. Begin, by January 1989, corridor studies on all the State's new interregional facilities.

Access Management

Florida's highway network plays a dual role in providing (a) access to property and (b) travel mobility. Access is a fixed requirement at both ends. Mobility, along the path of such trips, can be provided at varying levels of service. The concepts of access and mobility naturally lead to a hierarchy of highway classes with local streets primarily serving land access, and freeways primarily serving mobility. State facilities, while serving some access desires, should primarily be designed, constructed, and maintained to serve mobility desires. Preserving highway capacity by managing access is one of the best methods of assuring safe and efficient travel.

The task team made the following recommendations:

1. The Department should help write enabling legislation which would give the Department the power to alter access to the State Highway System for the purpose of safety and roadway functional integrity.
2. When reconstructing or widening a roadway, consideration should be given to combining access points to adjoining land use to reduce the total number of driveways directly accessing the highway.
3. The Department should develop standards for minimum driveway and signal spacing based not only on safety but also on effects on arterial level of service.
4. All major commercial driveway applications should be reviewed by the District Traffic Operations Engineer and Planning before final approval.
5. A benefit cost analysis with multiple land use scenarios should be part of a total interchange justification study. Effects on the freeway level-of-service and other goals should also be included in the justification report.
6. The Department should set the following specific interchange spacing standards:

- Recommended average minimum spacings for new or future interregional freeways are (a) urban areas, 5 mile spacing; (b) suburban areas, 8 mile spacing; and (c) rural areas, 10 mile spacing.
- Allowed average minimum spacing with appropriate justification (for established freeways) are (a) urban areas, 2 miles; (b) suburban areas, 4 miles; and (c) rural areas, 8 miles.
- Absolute minimums are no new interchanges within 1 mi of an existing or approved interchange.

Traffic Analysis Procedures

Over the past ten years the technology of transportation planning models has changed drastically. More accessible and faster computers as well as the move to microcomputers have revolutionized the models the Department uses. In reviewing the traffic analysis procedures used by the Department, it was found that many of the Department's models and analyses were outdated. The models and analyses are outdated because (a) the great number of available models has made choosing the most appropriate ones more difficult and (b) the great amount of training necessary to become proficient at using any of these models is a large investment.

The task team made the following recommendations:

1. Effective January 1, 1988, the definitions for level-of-service and capacity in the 1985 Highway Capacity Manual shall be the standard for the Department's planning work. The procedures and techniques contained in Circular 212 (6) and the 1965 edition of the Highway Capacity Manual (7) are to be considered superseded. Their use will constitute poor practice. Projects scheduled to begin before January 1, 1988, should be discouraged from using these techniques.
2. A Florida Design Traffic Manual should be developed by January 1, 1989. This manual should be based on the

residents, intensity of the hurricane, direction of approach, and the number of tourists.

Evacuation of hurricane-vulnerable people is largely a transportation problem. This problem has three major elements: (a) physical capacity—number of lanes, (b) structural—drainage and washouts, and (c) traffic management—signals and managing accidents. Emergency management officials must couple the hazards data provided by the National Hurricane Center with clearance time information calculated from transportation analyses. By considering these sources of timing data, officials can determine when a strong evacuation advisory or order must be issued to allow people time to reach safe shelter.

Many problems surface in the transportation system during hurricane evacuation: congestion, high winds, downed power lines, and sometimes slowdowns due to the collection of tolls on an evacuation route.

The task team made the following recommendations:

1. No major roadway improvement (widening or new road) should be built strictly due to hurricane evacuation needs.
2. The concept of armoring, protecting, and moving coastal highways for evacuation purposes should be considered only on a case-by-case basis. The random event of a hurricane is such that it is usually cheaper to rebuild roads as needed than it would be to move or rebuild large portions of our coastal highway system.
3. The Department should not fund construction or planning for any facility that intrudes into a Federal Coastal Barrier Resource System.
4. The Department should eliminate toll collections during a hurricane emergency. Specific language should be added to all new bonding terms of indenture so that suspension of tolls is legal and understood.

CONCLUSION

Nine of the major statewide technical highway issues facing Florida were analyzed in the Florida Highway System Plan. Other major statewide transportation issues are being addressed in Florida's other modal system plans. Analyzing major statewide transportation issues in comprehensive documents rather than piecemeal is being found to be an effective decision-making process. Within the Florida Department of Transportation the addressing of the statewide transportation issues is believed to be best handled in the respective modal system plans. Policy direction is taken from the Department's Florida Transportation Plan and the modal system plans' technical analyses and recommendations feed directly into the Department's programming and budgeting activities.

Other states should consider expanding the role of their modal system plans. Certainly modal system plans should continue to address the issue of preserving and enhancing interstate and interregional mobility by emphasizing the physical arrangement and needs of their transportation networks. However, the usefulness of state modal system plans can be greatly expanded by analyzing other major transportation issues facing the states.

The contents presented in this paper reflect the views of the author and do not necessarily reflect the official views of the Florida Department of Transportation.

REFERENCES

1. Florida Transportation Plan. Florida Department of Transportation, Tallahassee, Florida, 1986.
2. Florida Highway System Plan (Draft). Florida Department of Transportation, Tallahassee, Florida, 1987.
3. Statewide Transit Needs Plan. Florida Department of Transportation (by Kimley–Horn and Associates, Inc.). Tallahassee, Florida, 1986.
4. *Special Report 209: Highway Capacity Manual*. TRB, National Research Council, Washington, D.C., 1985.
5. *Transportation Research Circular 212: Interim Materials on Highway Capacity*. TRB, National Research Council, Washington, D.C., 1980.
6. *Special Report 87: Highway Capacity Manual–1965*. HRB, National Research Council, Washington, D.C., 1965.
7. *NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design*. TRB, National Research Council, Washington, D.C., 1982.

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Multi-Modal and Highway Systems Plan

ROBERT F. KENNEDY AND KOZMAS BALKUS

Current major statewide transportation planning issues are associated with the integration of separate modal agencies into multi-modal state Departments of Transportation (DOTs). Inherent in the creation of DOTs was an unspecified commitment for comprehensive multi-modal policy planning. As a consequence of this integration, a multi-modal transportation systems outlook emerged, and the transportation planning and management assumed a statewide character. The degrees of freedom for carrying out this new task in different states depends on the prevailing style of the general state planning. Since the creation of state DOTs, there has been a trend of shifting toward the "management planning model." This model has been fully implemented in Florida. The state planning procedures in Florida require the DOT to prepare a functional transportation policy plan in strict conformance with the state policy plan. To do this, physical systems studies and planning and multi-modal policy planning are required. This dual planning process requires a common conceptual understanding about three major issues: (a) multi-modal policy role and its scope, (b) statewide modal systems, and (c) the role of modal transportation in multi-modal system. In the process of developing perspectives about its statewide planning tools, Florida DOT also conducted a survey of other state DOTs about their planning activities during the last two decades. The survey results indicated that transportation policy planning differs from state to state. The approaches to statewide highway systems planning are also diverse, suggesting the presence of different understandings as to what such systems are to encompass. The survey also disclosed the presence of confusion about the multi-modal systems planning. On the one hand, the transportation planners firmly believed in the potential of a multi-modal transportation system. On the other hand, as staff members of state DOTs, the planners have done very little to justify such a belief. In conclusion, the survey indicates the need for concentrating research and analysis capabilities, as well as resources for defining the major elements of the new style of multi-modal transportation planning.

A national survey of state departments of transportation was conducted by Florida DOT during the first quarter of 1987 with the purpose of inquiring about planning activities during the 1970s and the 1980s. The survey was part of a Florida DOT effort to appraise its statewide multi-modal planning tools as to their utility in current planning environment. At the core of these tools was the multi-modal forecasting procedures manual, issued in 1979 (*1*), but never used as published.

In the internal appraisal of the proposed procedures, a Delphi (*2*) panel, composed of Florida DOT staff members, indicated doubts about the practicality and reliability of the multi-modal forecasting procedures. Also the panel members agreed that the "multi-modal comprehensiveness" effort complicated the analysis to the extreme, and the panel concurred that extreme complexity is self-defeating in pursuing comprehensiveness in planning. Regarding immediate Florida DOT needs, the manual was found to be deficient in that the procedures failed to address the fundamental statewide highway systems planning issue of how to analytically separate the travel on statewide facilities from local travel.

Among the Delphi panel responses surfaced an interesting contradiction. In spite of the agreed-upon shortcomings of the simultaneous multi-modal systems analysis, more than half of panelists reversed their previous stand by voting that the chances were high for a future need of simultaneous multi-modal statewide systems travel forecasting.

The seeming contradiction between the appeal of the utopian and mainly metaphoric multi-modal systems idea on the one hand and the limitation of operational realities on the other hand appeared to be deeply rooted in the minds of transportation planners. There are reasons to believe that this contradiction has affected transportation planning decisions nationwide during the last two decades. In Florida, the possession of the multi-modal travel forecasting procedures manual, indeed, represented an achievement in terms of the multi-modal philosophy. But the fact that these procedures have not been utilized for two decades indicates that a price was being paid for that contradiction.

The results of the nationwide survey are too sketchy to be used to pinpoint specific impacts of the contradiction in other locations. An overall assessment of the responses, however, indicates "directionless" and limited progress in creating new planning techniques for statewide transportation planning during the two decades. Meaningful insights may be gained from the survey about the statewide multi-modal systems by means of a reference framework that depicts the major transformations of the statewide transportation planning and management environment in recent decades.

REFERENCE FRAMEWORK FOR THE INTERPRETATION OF SURVEY RESULTS

Such a reference framework is depicted in Figure 1, which shows the changes in the transportation planning and management philosophy that have been taking place since the creation of state DOTs. The diagram starts with the metropolitan planning which began in the early 1920s. The major impact that this early planning experience produced upon the formation of planning philosophy was the message that urban areas consisting of contiguous municipalities must be regarded in planning as integrated wholes. This conclusion applied not

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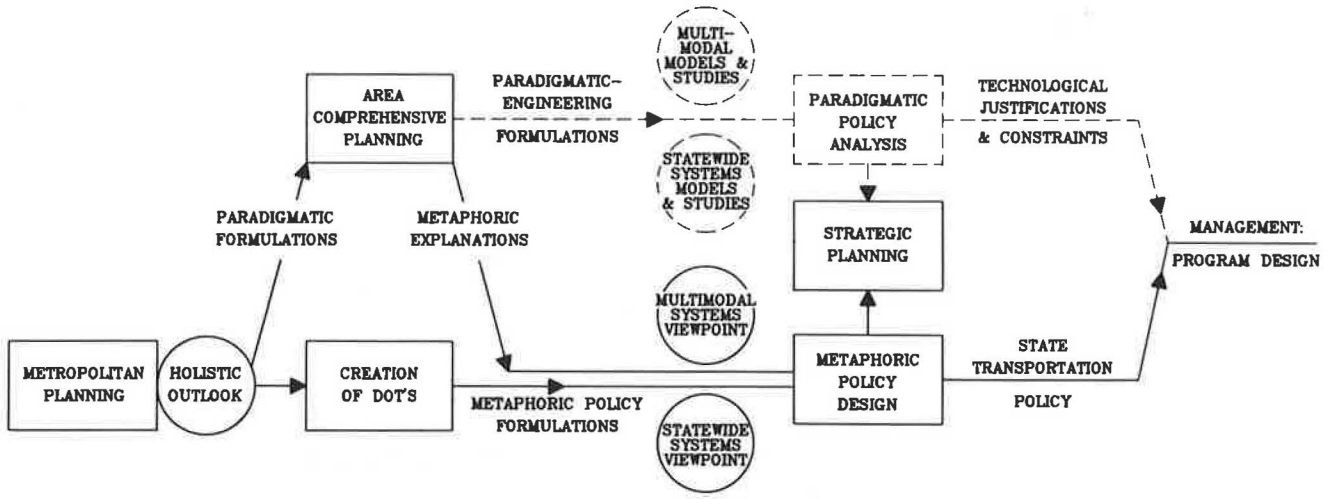

FIGURE 1 Reference framework for the interpretation of survey results.

only to comprehensive development planning but also to planning of individual urban functions such as transportation. Following this holistic outlook, a number of metropolitan studies were initiated soon after World War II. As a result of political resistance, however, the metropolitan self-governance idea did not materialize in the United States, nor did the metropolitan comprehensive planning get off the ground. It was up to transportation studies, a decade later, to assume the task of comprehensive metropolitan planning, which was necessary to study the existing travel demand as well as to forecast future transportation needs.

The demonstrated need for dealing with metropolitan areas as wholes initiated the holistic outlook. Since then this outlook has remained as one among other large area planning and management principles. In Figure 1 the holistic outlook is represented by a circle on the left side.

In conformance with the holistic outlook, rigorous rational models were developed for various aspects of comprehensive metropolitan planning. According to Kuhn's explanation of scientific progress (*3*), these rigorous models and the explanations that these models provided about the metropolitan phenomenon may be regarded as paradigms. Thus, paradigms were formulated for land-use planning and trip generation/forecasting/distribution, as well as travel assignments to facility networks. Figure 1 also shows the process of the paradigmatic formulations as the basis for metropolitan comprehensive planning.

Also, as a consequence of the holistic outlook, a convincing argument was gaining ground: For dealing with the transportation function as a whole, and to make it more efficient, a single transportation department that includes highways, mass transit, rail, air, and water modes for moving people and goods should be established. It was envisioned that the purpose of such departments would be to develop and implement unified transportation policies. In 1967 the U.S. Department of Transportation and similar departments in three states were created (*4*). The decade of creation of other state DOTs coincided with the maturation of the ongoing metropolitan and regional transportation studies. The phasing out of the federal support for large area planning programs followed the transfer of modal transportation systems planning and management to state DOTs.

At the time the comprehensive planning programs were disbanded, they had served their purpose. By means of their "paradigmatic" knowledge and techniques, metropolitan planning had compiled a mass of information on population dynamics, urbanization, travel generation, travel distribution, and others. The initially detected urbanization and travel parameters turned out to be valid in most locations. Discoveries of new knowledge by successive studies were diminishing, and the available knowledge abounded to those capable of accessing it. However, before planning knowledge could be communicated to the individuals who were not planners, the technical paradigmatic language of engineers, in terms of mathematical equations, computer language, and language of relations, had to be rearticulated into a "metaphoric" mode, or the mode of interdisciplinary and interprofessional communications. In this rearticulation the paradigmatic formulations became metaphoric explanations (*5*). Beyond their poetic meaning, metaphors represent verbal expressions denoting implicit and explicit knowledge underlying them or knowledge analogous to the metaphor. The role of models and metaphors in the sciences is an issue of the philosophy of sciences (*6*). All scientific knowledge must be transcribed into metaphoric explanations before the population can relate this knowledge to its organizational and communications frames of reference. For instance, the acronym AIDS (acquired immunodeficiency syndrome) is a scientific paradigm dealing with a particular issue of body chemistry. Upon transferring it to the metaphoric domain, this acronym becomes a metaphor relating the general scientific evidence about AIDS to the individuals' and societal issue domains. Societal issues of the same subject are very different from paradigmatic issues. This difference is reflected by the language used for representing them.

Thus, before the traditional comprehensive planning lost its significance, it had delivered its knowledge in popular relative terms (metaphoric) about household behavior, activities, effects of urbanization forms on travel, patterns of travel choices, and the like. The legacy of comprehensive planning provided the essential set of metaphoric explanations required for further expansion of knowledge into different areas of societal interests. By this, the comprehensive planning legacy

also paved the way for the transformation of planning thinking. The old practice of large area plan making superseded itself.

As shown in Figure 1, this transformation has resulted in dual-track comprehensive planning: the upper track stands for logically rigorous inquiries employing the scientific paradigm approach. This track is identified in Figure 1 as "paradigmatic-engineering formulations." The lower track represents the policy planning that is conducted on the basis of metaphoric knowledge gained from rearticulations of rigorous inquiries and other sources.

In discussing statewide transportation planning in 1982, Creighton also found that it is organized in two parts. The rigorous part he called "substantive" and the policy part a "management" content (*7*). Since then some states have been moving toward the managerial state planning system that requires functional planning for their agencies. Functional planning consists of policy planning on one side and operations planning on the other. The terminology, which has been selected to represent the two tracks of planning shown in Figure 1, depicts more closely the functional planning process than other designations and enables analyzing not only the contents of the process but also the nature of the process itself.

Under the new dual planning process the role of policy planners is to come up with policy designs based on broader than technical planning knowledge. Along the technical planning track, the planners are to come up with logically rigorous planning alternatives taking into consideration technological justifications and constraints. The synthesis of the two tracks is to be accomplished through strategic planning with the participation of the organization's decision makers. As shown on the right-hand side of Figure 1, the ultimate policy formulation is the result of strategic planning. Under such policies the program designs are politically desirable and technologically feasible.

SURVEY ISSUES

The new element of transportation planning on the creation of state DOTs was an integrated transport systems policy planning. Initially it was conceived as a metaphor. Most people had a notion as to what it entailed, but there were few precedents to refer to and follow. Obviously, the policy plan was to be neither a product of a supermodel nor a set of inferences from survey data. Instead it was to be a design of policy statements constructed in response to the prevailing and future multi-modal transportation issues on the basis of available knowledge. Existing metaphors give rise to new metaphors. The integrated transportation departments also increased the awareness of statewide systems. As a result of this awareness, the process of policy planning gave rise to two major issues and two major metaphors: the statewide highway system, the most important component among transportation modes, which is required for pursuing state goals, and the multi-modal system. On the metaphoric track these issues are shown in solid-line circles and are labeled as viewpoints. On the engineering track these same issues require modeling and studies and are shown in Figure 1 by broken circles. Without rigorous investigations by the engineering track the metaphoric viewpoints remain as metaphors about which we possess only general knowledge. On the other hand, if the dual planning tracks worked in tandem, the emerging metaphoric issues would be analyzed by rigorous investigations of the engineering track. Hence, as shown in Figure 1, new metaphoric viewpoints become major paradigms for the rigorous investigations track. The following three major components of the dual planning process constituted the main issues in the survey design of state DOTs:

- the scope of transportation policy planning,
- the statewide highway systems viewpoint, models and plans; and
- the multi-modal systems viewpoint, models, and planning procedures.

ANALYSIS OF SURVEY RESULTS

Of the 49 questionnaires mailed out, 43 state DOTs responded. Regarding Figure 1, the survey primarily addressed the paradigmatic-engineering track of planning and the analysis of the survey results. The survey results will concentrate primarily on three major issues: transportation policy planning, statewide highway system, and multi-modal systems planning. The analysis of each issue is presented in two parts: summary of survey results and the interpretation of these results. Conclusions will cover all three issues together.

Policy Planning

Survey Results

- In the 1970s, 16 states derived transportation policy recommendations from plans, and 8 states did not. In the 1980s, 23 states are anticipating policy alternatives to result from planning, 12 states are not, and 7 are in doubt.
- At the time of the survey, 18 states possessed a comprehensive state transportation policy plan and 19 states did not. Of the remaining states some looked on the existing transportation plan as a policy plan, others experienced problems in having the proposed policy plans accepted.
- Ten states possessed specific goals for their transportation plans in the 1970s, and this number increased to 32 in the 1980s.

Interpretation

The practice of utilizing plans for the promulgation of policy alternatives has been increasing. This is the old style of policy planning, however. Such a policy approach must be used in the absence of metaphoric policy designs. If a well-designed strategic planning were utilized for policy formulation, a comprehensive transportation policy could be developed primarily through physical and strategic planning.

In some states the goal strategy was consistent with the existing state policy, and it may be regarded as one of the means for pursuing state policy goals through planning. In other states, the goal strategy served as a surrogate for lacking policy. The increased usage of specific goals is one of the most significant characteristics of transportation planning in this decade. A specific goal is a force that shapes a specific

plan, such as statewide highway systems for state economic development.

Neither the increased use of goals for focusing transportation planning nor the increasing number of DOTs anticipating policies to surface from plans indicate the growth of a formal transportation policy design process. The fact that only 18 states possessed comprehensive transportation plans at the time of the survey suggests that the increasing number of goal-oriented planning is utilizing goals as a surrogate for the absence of explicit statewide policy plans. For major investments of resources, a comprehensive policy plan in most cases would identify a set of goals rather than a single goal.

Statewide Highway Planning

Survey Results

- Nineteen states are either considering updating or have updated the existing statewide plans prepared prior to the 1980s; 17 states prepared new statewide plans in the 1980s; 7 states have done no statewide planning. Of these, 14 have done statewide planning by regions, and 29 have been engaged in other types of planning.
- The gravity model has been used most commonly for trip distribution. The Federal Highway Administration's network loading programs have been favored in the 1970s and 1980s. However, the number of states altering and rewriting federal packages under different names has increased from 8 in the 1970s to 15 in the 1980s.

Interpretation

The use of planning tools during the last two decades indicates that the paradigmatic-engineering track of transportation planning produced no significant innovations in travel analysis techniques. Neither focusing on specific goals nor policy expectations from planning have required new analysis formulations.

The fact that 14 states have done statewide highway planning by regions and 29 states have been engaged in other types of planning by means of long-established tools and procedures indicates that the statewide highway systems metaphor remains only a metaphor. The system has not been redefined to reflect the commitment of DOTs for statewide multi-modal transportation management. The conceptions of such statewide systems range from a network of state level facilities as treated by Manheim and Neumann in their resource papers to the 1979 Conference on State Transportation Planning (*8*) to Creighton's suggestion that statewide highway planning has existed for at least 50 yrs (*7*), which implies the inclusion of most roads in the state. For the dual track planning process, transportation analysis would require a functionally stratified state road system, at the highest level of which would be included facility networks of state critical concern. The stratification would go a step further than the present functional classification practices and issues. The statewide highway system would have to be defined so that it could be analyzed independently as well as managed independently for upkeep, quality of services, hazard management, and future statewide transportation systems development. The system should be accessible to policy concerns: ". . . there is a general feeling that the issues emerging at the state level are of an order of magnitude more complex than urban, regional, or perhaps even national issues" (*9*).

Multi-Modal Systems Planning

The contradiction, which surfaced among the staff members in the internal evaluation of Florida DOT planning procedures, also reappeared in the survey of other state DOTs. This contradiction indicates a gap between expectations and the reality regarding statewide multi-modal transportation systems. The questionnaire asked the respondents, "what does the multi-modal concept mean to you?" and it provided several alternative answers ranging from a very high expectation to very low. The respondents were asked to indicate whether or not they agreed with the answers.

Survey Results

Question: What does the multi-modal concept mean to you? Answers:

- A potential for an integrated transportation system
  Yes (37) No (2)
- A coordinated system to the extent that it materializes as a result of observing economies and other inducements in making travel choices.
  Yes (34) No (1)
- An objective, but not implementable because of competing technologies and different ownerships.
  Yes (10) No (18)
- Just a concept with no practical relevance.
  Yes (2) No (28)

The performance of states with respect to multi-modal systems planning is as follows:

—20 states passed and 18 states did not pass legislation requiring multi-modal planning
—11 states have and 28 have not promulgated rules and procedures for coordinating multi-modal travel services
—16 states have and 24 have not considered preparing a simultaneous multi-modal study
—3 states possess and 40 do not possess manuals for multi-modal transportation studies.

Interpretation

The responses indicate an overwhelming belief in the multi-modal philosophy and all that the metaphor implies. This belief is indicated by 37 positive responses. The next characterization is also positive, but, instead of being categorical, it includes a play of factors that can influence the shaping of the system. The number of positive responses for this characterization dropped from 37 to 34. The third answer or characterization of beliefs includes potential obstacles for achieving an integrated multi-modal system. The concurrences with the answer dropped to 10 and the disagreements increased to 18. The negative view of the multi-modal systems received

only negligible support, namely 2, and the disagreements rose to 28.

The thrust toward creating multi-modal transportation systems, however, has been much less than the planners would have wished for. The fact that responses from 40 states indicated that no manuals have been prepared for this purpose raises an interesting question. Perhaps the evidence indicates that it did not make sense to prepare such manuals.

Referring to the dual track of transportation planning, the policy planning track is likely to confront a bottleneck at the stage at which the policy design addresses statewide highway and multi-modal systems. The paradigmatic engineering track is to explicate these supersystems and to turn the metaphors into knowledge of reality so that the systems could be subjected to strategic policy designs and rational management. However, as things stand now, the stage of strategic planning—where the decision makers, policy analysts, and engineers are to meet for strategic considerations of the overall transportation policy—the policy designers and engineers as yet have little to offer about the two supersystems. This condition stifles the progress of the dual track transportation planning.

CONCLUSIONS

The survey results indicate the need for modeling statewide transportation planning and policy making. Alternative approaches for initiating and organizing the two-track transportation planning are to become a paradigm of research and discussions at Transportation Research Board meetings and similar other research activities.

There is a need to return to the functional classification of highway facilities from which would emerge alternative models of a statewide highway system. The definition of statewide highway facilities network should be linked with the techniques for their analysis and management.

The multi-modal systems idea needs to be reassessed. The idea should stress new transportation technologies. Like commercial aviation, these technologies are to extend the travel parameters on the account of their innovations; competition with the automobile may not be the major issue in statewide multi-modal systems planning.

The points identified in this paper should be regarded as major issues of transportation planning of this and coming decades.

REFERENCES

1. *Person Travel Forecasting Procedures User's Manual*. Florida Department of Transportation, Division of Transportation Planning, June 1979.
2. P. Martino. *Technological Forecasting for Decision Making*. American Elsevier Publishing Company, Inc., New York, 1972, pp. 20–63.
3. S. Kuhn. *The Structure of Scientific Revolutions*. The University of Chicago Press, Chicago, 1962.
4. *Special Report 189: State Transportation Issues and Actions*. TRB, National Research Council, Washington, D.C., 1980, p. 2.
5. K. Balkus. Societal Knowledge Formation through Paradigm Metaphor Metathesis. *Proceedings of the Ninth European Meeting on Cybernetics and Systems Research*, Vienna, Austria, 1988.
6. W. H. Leatherdale. *The Role of Analogy, Model and Metaphor in Science*. American Elsevier Publishing Co., Inc., New York, N.Y., 1974.
7. *NCHRP Synthesis of Highway Practice 95: Statewide Transportation Planning*. TRB, National Research Council, Washington, D.C., 1982, pp. 3, 7.
8. *Special Report 189: State Transportation Issues and Actions*. TRB, National Research Council, Washington, D.C., p. 78.
9. *Special Report 146: Issues in Statewide Transportation Planning*, TRB, National Research Council, Washington, D.C., 1974, p. 103.

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Integrating Planning Theory in Graduate Transportation Education

C. J. KHISTY

Based on current literature on transportation education and training, it is evident that transportation professionals need to have a basic knowledge of planning theory because the obligation to understand and apply planning theory has become pervasive in transportation planning, as it is practiced today and will be in the future. Information is presented about the goals of transportation education and the challenges facing educators in training high-quality professionals for the future. It is argued that one of the essential parts of the kit of a transportation professional's education should be a knowledge of substantive and procedural planning theory. Such knowledge will enable transportation professionals to become more involved with the political, social, and economic systems within which they operate, and enhance their chances of playing leadership roles in transportation. This paper discusses the contents of such a course and presents a topical course outline.

Transportation professionals need to study planning theory because the obligation to understand and apply planning theory has become pervasive in transportation engineering and planning. In their enthusiasm to acquire tangible tools and techniques, most transportation professionals lose sight of the need for the more synthetic skills of reasoning and conceptualization provided by the normative theories and concepts about the purpose and legitimate functioning of society, as expressed through laws, public policy, and political authority (*1*).

This paper examines the current and future directions in transportation planning and the need for transportation professionals to understand the important components of planning theory. The first section traces the attitudes and perceptions of the transportation professional in view of the changing environment. The second section investigates the following major dimensions of planning as it pertains to transportation: substantive theory, procedural theory, and planning doctrine. Finally, the paper discusses the contents of a course on planning theory and presents a topical course outline.

THE CHALLENGE

The urban transportation planning process is probably the foremost example throughout the world of the application (better in some countries than others) of the general concepts of planning. However, it must be noted that, although an informed public decision making process has been in place for at least two decades, based on the preparation, analysis, and evaluation of alternative plans, new challenges and changes have since occurred, making it necessary to take a fresh look at the connection between planning theory and practice (*2*).

Today, the biggest challenge facing transportation professionals in the United States is the rebuilding of the infrastructure and its expansion to serve future growth. For men and women who seek to be professionals in the transportation industry it is not enough to be just technically proficient. In addition, they must understand what it takes to manage large-scale systems, to succeed in the ambiguous world of politics, and especially to be able to make decisions that involve the allocation of limited resources (*3*).

An overall sense of the attitudes and perceptions of the profession is captured in the following conclusions reached in a special conference of the Transportation Research Board (TRB):

(1) The transportation professional faces significant challenges that will tax the technical, political, and managerial abilities of everyone involved. Although transportation education faces serious problems, these challenges should be viewed as a significant opportunity to redefine new directions for program development.

(2) It is almost certain that transportation professionals will face more change in the next 20 years than that which has occurred during the past 20.

(3) The transportation professional must have the ability to communicate effectively with the public, with professionals in other fields, and with elected officials (*4*).

Because the practice of transportation planning raises numerous questions closely connected with planning theory, it is essential that transportation professionals be capable of understanding and developing postures and arguments not only to guide their own independent decision-making responsibility, but also to assist other public officials and the general public to develop and clarify precise normative positions (*1*).

GOALS OF TRANSPORTATION EDUCATION

"The primary objective of transportation education is to prepare the student to enter practice as a transportation planner or engineer, which includes providing him/her with technical and quantitative skills required to carry out complex assignments, and a broad understanding of the social, economic,

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and political context within which he/she will work" (*5*). The latter part of the objective implies that students acquire definitional, substantive, procedural, and normative knowledge of planning. Yet very few graduate programs in transportation in this country require a student to take one mandatory course in planning theory.

Some topics in planning theory are marginally included in courses such as "Transportation Policy and Administration." Also a small percentage of transportation graduates take one or more courses in regional and city planning, where such courses are available. In such cases, a course in planning theory is sometimes included. Thus, the probability of a transportation graduate having taken a formal course in planning theory is rather remote.

There are some who argue that planning theory is, at best, a weak and irrelevant subject, and that there is little need for it. They insist that since theory is deeply embedded in professional practice, one can learn planning theory by doing it. There are severe limitations to this argument, particularly in view of the tremendous expansion in planning theory in recent years. A brief tour of planning theory as described in this paper will indicate the complexities of the subject. Surprisingly enough, it has been observed that those planners who consider themselves least explicitly involved in theory are likely to be the most bound into one.

THEORY, PRACTICE, AND PRAXIS

Theories, in general, provide explanations. Planning theory has to do with defining and understanding the contexts, practices, and processes of planning and how they have evolved from their respective historical and cultural bases. Theory feeds on practice, and practice feeds on theory. It is this cyclical relationship between theory and practice which is known as "praxis." It distinguishes itself from practice as a self-critical activity that recognizes that the external world, including the practitioner, is the product of normative interaction. For transportation planners this concept of praxis is particularly important because planning, unlike the pure sciences, is ultimately a prescriptive activity (*6*).

DIMENSIONS OF PLANNING

The practice of city and regional planning takes several forms, one component of which is transportation. Such practice is connected and in many ways dependent on procedural planning theory and regional planning doctrine. Doctrine, in turn, is fueled by substantive theories based on the social and environmental sciences. Procedural planning theory, planning doctrine, and substantive theories in planning feed on certain

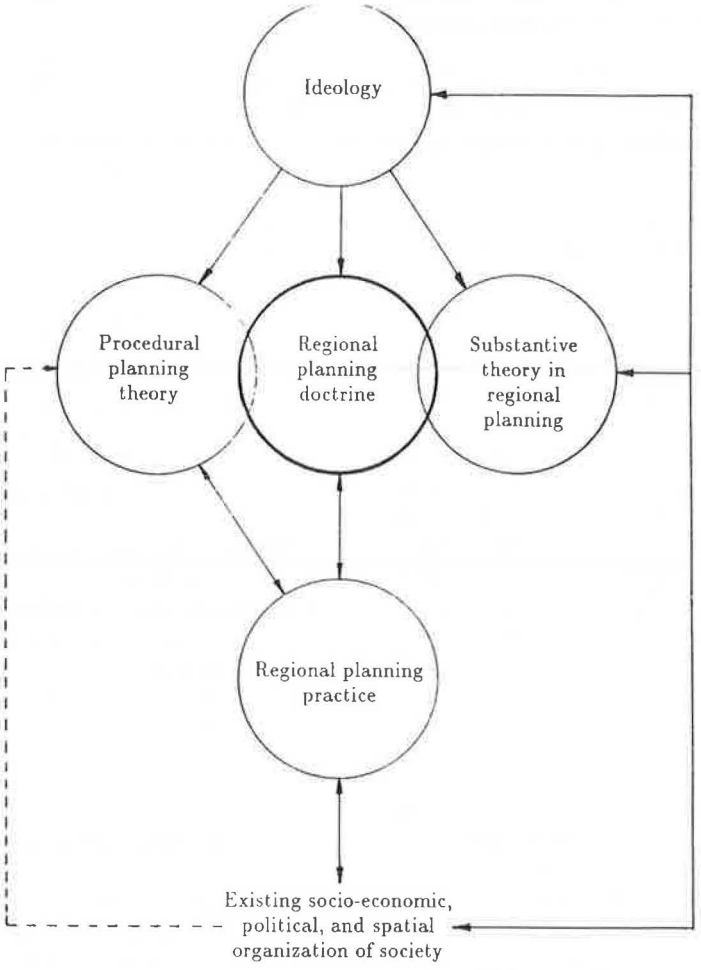

FIGURE 1 Principal dimensions of regional planning and their interrelations.

ideological assumptions. Figure 1 shows the internal relationships among the five major dimensions. Of these, at least three dimensions of planning are relevant to transportation engineers: planning doctrine, procedural planning theory, and substantive theory (*7*). According to the original concepts of planning doctrine, regional planning was considered to create conditions that would establish a harmonious relationship between human beings and nature. In the 1930s, planning doctrine was reinterpreted as the integrated development of natural resources for human use. River basin projects such as Tennessee Valley Authority, for example, were considered the most appropriate means for achieving this purpose. More recently, planning doctrine has come to be supported by what is generally known as regional science (*7*). Transportation planners need to have an overall idea of planning doctrine to be able to handle such questions as the following:

- Why have growth centers not grown the way they should have?
- Why has poverty continued to accumulate in cities?
- Why have inequalities remained ingrained as deeply as ever in the transportation field, in spite of conscious efforts made to the contrary?

Friedman and Weaver capture the ideas of doctrine thusly (*7*):

> Doctrine is the stock-in-trade of professional planners, the sum and substance of what they know and perpetrate upon the world. As such it serves not only to illuminate the practice of regional planning but to provide a focus from which the remaining dimensions of planning can be conveniently explored.

The substantive dimension is the work of geographers, economists, regional scientists, sociologists, and political scientists. Substantive theories refer to specific problems, such as rural development policies, theories of poverty, and energy policies (*7*).

The central questions answered by the substantive dimension concern the nature of the good or just society. There are various ways in which we may concern ourselves with this question. The first concern focuses on the meaning and function of the concepts characteristic of practical discourse (good, right, ought, must, etc.). The second concern is one of method. How do we determine what considerations are relevant, and in what way, in evaluating competing practical options? The third concern is that of application, that is, actually deciding on an option or policy. For instance, what actions or organizational forms are good or right (*8*)?

One area that is of immediate importance in planning theory and one which impinges heavily on transportation planning is the theory of justice. The concept of justice as fairness or as equity has been discussed quite frequently in the last decade (*9, 10*). Problems connected with the distribution of funding among regions, the location of highway facilities, and exclusionary zoning have been documented. When planners consider the notion of justice, they generally think in terms of groups of people who have more or less similar goals and objectives with respect to an issue.

While some believe that there is a single concept of justice, it has been demonstrated that there are indeed several concepts of justice, each encapsulating a different way of distinguishing between just and unjust states of affairs (*11*). The general account of justice—"to each his due"—is helpful in bringing out the distributive character of justice. However, the notion of justice can be considered from three viewpoints. First, the notion of conservative justice can be interpreted as that to which he has a right or is entitled. It may thus be expressed in the form "to each according to his rights."

Second, ideal justice is the principle of desert: people ought to be rewarded according to their deserts, i.e., depending upon the actions and personal qualities of the person said to be deserving. Thus a person's deserts may be measured by his moral virtue, his productive efforts, his capacities, and so on.

Third, the criterion of need is more central to ideal justice than the notion of desert. Thus, there are three conflicting interpretations of justice which may be summarized in the three principles: to each according to his rights, to each according to his deserts, to each according to his needs. Rawls and others have elaborated on these issues in terms of net good and maximizing benefits for the least advantaged in society (*11–14*).

Contemporary planning issues involve a number of parties whose interests or objectives conflict. The concepts of justice, including "justice as fairness," require that consideration be given to the distribution of benefits and losses that are implicit in alternative transportation planning decisions. Berry and Steiker (*9*) and Beatley (*10*) have examined these concepts in much detail in the framework of traditional benefit-cost analysis and the "maximin" strategy.

Procedural planning theory deals with making and implementing plans. It is concerned with the processes and techniques employed by planners in theory work as well as the operating modes of planning. Consequently, it is overwhelmingly focused on the means of planning and not the ends (*7*).

In transportation planning the predominant concern has generally centered on the tradition of rational comprehensive planning, also known as the synoptic tradition. Despite the great intellectual appeal of synoptic planning, there have been several major problems with this model, with the result that modifications and adjustments have since been introduced. For instance, should planning be comprehensive or incremental, centralized or involved with localized decision units, technocratic or participatory, long-term, middle-term, or just short-term? These choices pose major organizational and methodological problems that must be faced by transportation planners. For one, transportation planners do not plan in isolation but interact heavily with members in their team who come from diverse backgrounds—land use, environmental, energy-related, housing, etc. (*15, 16*).

Hudson (*15*) and Dzurik and Feldhaus (*16*), among many others, provide excellent summaries of the technical, social, and political adjustments that have been introduced in recent years to compensate for the shortcomings in the traditional synoptic planning model. Hudson critically examines the five well-known planning theories (or adjustments) labeled by the acronym SITAR—synoptic (*17–19*), incremental (*20, 21*), transactive (*22*), advocacy (*23–26*), and radical (*27–30*). Using six criteria as filters, Hudson points out the similarities, differences, strengths, and weaknesses of these theories. There are, of course, several other schools of thought beyond the SITAR package, and all of these ideas have been vigorously used at one time or another, some individually and others in combination (*31–34*).

DISCUSSION

All professions periodically take stock in the academics of their field because professions tend to change as their scientific foundations develop and as their technical apparatus is modified for economic, social, and political reasons (*35*). Transportation planning is no exception. Educators try hard to reduce the growing incongruity between transportation education and transportation practice. In a recent study, Vaughan and Pollard concluded that "if planning is to assume a central role in influencing public capital investment, it is important to ensure that the people doing the job have experience of how agencies operate and understand the day-to-day problems faced by those managing public programs and facilities" (*36*).

Transportation planning has finally come of age, and therefore the need to be intellectually and professionally defensible is felt keenly throughout the profession. One of the effective ways of satisfying this need is of incorporating planning theory in the graduate transportation curriculum (*35*).

Learning planning theory through a theoretical discourse about the planning process in general, and its impact on transportation planning, is a powerful means of improving professional understanding. This theoretical discourse can embrace a broad range of activities, including the abstraction of generalized processes from dense historical accounts of planning, and the identification of similarities between apparently dissimilar planning thrusts, the justification of outcomes, the creation of elaborate axiomatic theories, and the empirical testing of discrete causal propositions (*37*).

A legitimate question that may be asked is: What should be included in a course in planning theory? This is a tough question. Considering the breadth of planning theory, it would be quite in line for a graduate student to be able to answer a majority of the questions posed below after taking a course in planning theory:

- What do planners do?
- What do planners do for a client?
- What is the relationship between a planner and his/her client?
- What planning procedures are currently used?
- What is the sequencing of steps in each of these procedures?
- What problems are likely to be experienced in planning, evaluating, revising, adopting, and implementing these procedures?
- How do these various procedures and problems differ?
- What is the form and structure of organizations, communities, cities, and regions?
- Can restructuring these entities improve the situation?
- How can one choose a particular planning strategy for a community or city?
- How do different kinds of planning processes respond to variations in settings?
- What are the concepts of justice and fairness?
- What implications of equity are we dealing with in transportation?
- How can the traditional benefit-cost analysis procedure be modified to account for justice at the individual, group, or community level?
- What are the alternative communication and information processing approaches available to planners?
- Who controls power, and what do persons who attain power do with it (*37*)?

It is quite possible for this course to be taught through a set of case studies and readings. It is also possible that parts of this bundle of knowledge could be incorporated into other mandatory courses, although this strategy may not be as simple as it sounds.

SUGGESTED COURSE OUTLINE

The diversity in planning theory has indicated the need to advance synthesis and integration in presenting the subject to students and practitioners of urban planning. Such a framework will enhance the profession's ability to perform more prudently and efficiently (*38, 39*).

In a recent paper Lim suggests that planners ought to have three types of competencies: technical, interpersonal, and critico-ethical. Technical competency refers to the planners' ability to apply sound technical knowledge to their tasks. Interpersonal competency is a function of negotiatory, mediatory, political, and legal skills of planners. Critico-ethical competency refers to the planner's ability to examine the validity of goals, methods, instruments, and resources for planning. These competencies are essential to understand the political, social, economic, and environmental structure of society in which planners carry out their professional tasks (*40*).

A general topical outline and pertinent details for a three-credit course on planning theory for transportation professionals follows.

Outline

The Field of Planning and the Place of Transportation in the Planning Process
Conceptional Foundations of Planning
The Role of Government in Planning
The Role of Planners: What Do Planners Do?
Models of Planning Theory
  Synoptic—Rational Planning
  Satisficing, Incremental, Mixed Scanning
  Transactive Planning
  Advocacy Planning
  Radical Planning
  General Systems Theory
  Critical Theory and Planning
  Ethical Planning
  Planning as Social Learning
Values, Choices, and Purposive Behavior
Case Studies of Planning Theories and Transportation
Planning Successes and Planning Disasters
Summing Up: From Theory to Practice

Suggested Reading

Texts

Alexander, E., *Approaches to Planning*, Gordon and Breach, New York, 1986.

Altshuler, A., *The City Planning Process*, Cornell U.P., 1965.
Burchell, R.W., and G. Sternlieb (eds.), *Planning Theory in the 1980s*.
Clavel, D., et al., *Urban and Regional Planning in an Age of Austerity*, Pergamon, 1980.
Faludi, A., *Planning Theory*, Pergamon, 1973.
Faludi, A., *A Reader in Planning Theory*, Pergamon, 1973.
Hall, P., *Great Planning Disasters*, Weidenfeld and Nicolson, London, 1980.
Wachs, M. (ed.), *Ethics in Planning*, Rutgers, 1985.

Journals

Journal of Policy Sciences
Journal of Planning Education and Research
Journal of American Planning Association
Journal of Policy Analysis and Management, Environment and Planning
Transportation Research Record
Journal of Architectural and Planning Research

Format and Evaluation

The course would be taught through a combination of formal lectures, discussions, task assignments, and student presentations of term projects. Final evaluation may be based on class discussions (25 percent), assignments and take-home examination (25 percent), and term project (50 percent). Note the emphasis on class discussions and the term project.

RECOMMENDATIONS AND CONCLUSIONS

Theory accounts for planning: how it happens, how it ought to be done, and why planners plan at all are legitimate questions. Planning practice would be severely limited if answers to these questions were not available (*41*).

Reservations and disagreements have been expressed by theoreticians, academicians, practitioners, and other serious observers about almost every facet of the transportation planning process. This is a good, healthy sign. Controversy enriches the way planners think about the planning process. At the same time, because of the alternative styles of planning needed, transportation planners need to understand and be sensitive to constituent concerns. Thus, the ability to apply methodological procedures, buttressed by a knowledge of the substantive content of planning theory, should form an essential part of the kit of a transportation planner's/engineer's education.

It is evident that, at a minimum, all graduate students in transportation planning take at least one course in planning theory because planning, designing, constructing, operating, and maintaining transportation facilities represent annual commitments of hundreds of billions of dollars and involves meeting, influencing, and assisting a vast spectrum of public officials in crucial decision making. A much greater emphasis on the substantive and procedural content of planning theory in graduate planning education is therefore necessary. Such knowledge will enable transportation engineers to become more involved with the political, social, and economic systems within which they operate, including the ability to mediate, negotiate, and serve as an effective agent of planned change in transportation. This involvement will also enhance their chances of playing leadership roles in planning (*42*).

REFERENCES

1. Timothy Beatley. Planners and Political Philosophy. *Journal of the American Planning Association*, Vol. 53, No. 2, Spring 1987.
2. David Boyce. A Silver Jubilee for Urban Transportation Planning (editorial). *Environment & Planning*, Vol. 12, No. 4, April 1980.
3. Richard S. Page. Transportation Education and Meeting the Challenge. In *Transportation Education and Training*, Special Report 210, TRB, Washington, D.C., 1985, pp. 11–17.
4. *Special Report 210: Summary and Recommendations, Transportation Education and Training*. TRB, National Research Council, Washington, D.C., 1985, pp. 3–10.
5. Lester A. Hoel. Transportation Education in the United States, *Transport Reviews*, Vol. 2, No. 3, 1982, pp. 279–303.
6. Ernest R. Alexander. Planning Theory. In *Introduction to Urban Planning* (A.J. Catanese and J.C. Snyder, eds.), McGraw-Hill Book Company, New York, N.Y., 1979.
7. J. Friedman and C. Weaver. *Territory and Function—The Evolution of Regional Planning*. University of California Press, Berkeley, Calif., 1979.
8. Alan Brown. *Modern Political Philosophy—Theories of the Just Society*. Penguin Books, Middlesex, United Kingdom, 1986.
9. D. Berry and G. Steiker. The Concept of Justice in Regional Planning: Justice as Fairness. *Journal of the American Institute of Planners*, Nov. 1974, pp. 414–421.
10. Timothy Beatley. Applying Moral Principles to Growth Management. *Journal of the American Planning Association*, Vol. 50, No. 4, Autumn 1984, pp. 459–469.
11. David Miller. *Social Justice*. Clarendon Press, Oxford, United Kingdom, 1976.
12. John Rawls. *A Theory of Justice*. Harvard University Press, Cambridge, Mass., 1971.
13. T. Honderich and M. Burnyeat. *Philosophy As I See It*. Penguin Books, Middlesex, United Kingdom, 1979.
14. R. P. Wolff. *Understanding Rawls—A Reconstruction and Critique of "A Theory of Justice."* Princeton University Press, Princeton, N.J., 1977.
15. Barclay M. Hudson. Comparisons of Current Planning Theories. *American Planning Association Journal*, Oct. 1979, pp. 387–428.
16. A. A. Dzurik and R. L. Feldhaus. Evolution of Planning Theory and Practice, Engineering Implications. *ASCE Journal of Urban Planning and Development*, Vol. 112, No. 2, Dec. 1986, pp. 37–45.
17. E. C. Banfield. Notes on a Conceptual Scheme. In *Politics, Planning, and the Public Interest*, M. Meyerson and E.C. Banfield (eds.). Free Press, Glencoe, Ill., 1955, pp. 303–329.
18. J. K. Friend and W. N. Jessop. *Local Government and Strategic Choice*. Tavistock, London, United Kingdom, 1973.
19. N. Lichfield et al. *Evaluation in the Planning Process*. Pergamon Press, Oxford, United Kingdom, 1973.
20. C. E. Lindblom. The Science of Muddling Through. *Public Administration Review*, Vol. 19, No. 1, 1959, pp. 70–99.
21. A. Etzioni. Mixed Scanning: A Third Approach to Decision Making. In *A Reader in Planning Theory* (A. Faludi, ed.), Pergamon Press, Oxford, United Kingdom, 1973.
22. J. Friedman. *Retracking America—A Theory of Transactive Planning*. Doubleday-Anchor, Garden City, N.Y., 1973.
23. P. Davidoff. Advocacy and Pluralism in Planning. *Journal of the American Institute of Planners*, Vol. 34., No. 2, 1968, pp. 331–338.
24. L. Peattie. Reflections on Advocacy Planning. *Journal of the American Institute of Planners*, Vol. 34, No. 2, 1968, pp. 80–87.
25. S. D. Alinsky. *Rules for Radicals*. Vintage Books, New York, N.Y., 1972.
26. A. Heskin. *Crisis and Response—An Historical Perspective on*

Advocacy Planning. No. DP-80, UCLA, Los Angeles, Calif., 1977.
27. E. F. Schumacher. *Small is Beautiful*. Harper and Row, New York, N.Y., 1973.
28. R. Goodman. *After the Planners*. Touchstone Books, New York, N.Y., 1971.
29. S. Grabow and A. Heskin. Foundations for a Radical Concept of Planning. *Journal of the American Institute of Planners*, Vol. 39, No. 2, 1973, pp. 106–114.
30. I. Illich. *Tools for Conviviality*. Harper and Row, New York, N.Y., 1973.
31. R. Bolan and R. L. Nuttal. *Urban Planning and Politics*. D.C. Heath and Co., Lexington, Mass., 1975.
32. H. Rittel and M. Webber. Dilemmas in a General Theory of Planning. *Policy Sciences*, Vol. 4, No. 2, June 1973, pp. 155–169.
33. A. Altshuler. *A Decade of Change in Urban Transportation Planning*. Harvard Graduate School, May 2, 1974.
34. D. Rondinelli. Urban Planning as Policy Analysis. *Journal of the American Institute of Planners*, Vol. 39, No. 1, 1973, pp. 13–22.
35. J. W. Dyckman. Three Crises of American Planning. In *Planning Theory in the 1980s* (R. W. Burchell and G. Sternlieb, eds.), CURC, Rutgers University, New Brunswick, N.J., 1978.
36. R. J. Vaughan and R. Pollard. *Rebuilding America: Planning and Managing Public Works in the 1980s*. Council of State Planning Agencies, Washington, D.C., 1984.
37. S. J. Mandelbaum, *Planning Theory and Institutions*. Class notes, University of Pennsylvania, Spring 1982.
38. E. R. Alexander. After Rationality, What? *Journal of the American Planning Association*, Vol. 50, No. 1, 1984, pp. 62–69.
39. R. E. Klosterman. Contemporary Planning Theory Education: Results of a Course Survey. *Journal of Planning Education and Research*, Vol., No. 1, 1981, pp. 1–12.
40. G. C. Lim. Towards a Synthesis of Contemporary Planning Theories. *Journal of Planning Education and Research*, Vol. 5, No. 2, 1986, pp. 75–85.
41. M. H. Krieger. Some New Directions for Planning Theories. *Journal of the American Institute of Planners*, May 1974, pp. 153–163.
42. C. J. Khisty. Is Urban Planning Education Necessary for Civil Engineers. In *Transportation Research Record 1045*, TRB, National Research Council, Washington, D.C., 1986.

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Accuracy and Other Factors Affecting a Continuous Vehicle Occupancy Monitoring Program

CY ULBERG AND EDWARD MCCORMACK

During the next 15 to 20 yrs, the primary methods available to manage the nation's freeways will involve increasing the average occupancy of vehicles using the freeways. Because existing vehicle occupancy measurement is typically project specific and sporadic and uses different collection procedures, it is often difficult to evaluate the effectiveness of programs intended to increase the average vehicle occupancy (AVO). The research discussed in this paper was designed to address the lack of consistent and ongoing AVO measurement in the Seattle area. Because a literature search revealed that little had been published concerning the methodology of collecting vehicle occupancies, the research attempted to determine what factors lead to inaccurate or unusable data and how much data are necessary for accurate counts. A number of observation sites, including six freeway sites, were selected. Three people counted occupancies in the same lane at the same time for 111 15-min periods. Portable computers were used for data collection. The observations were time stamped to match the counters' observations on a vehicle-by-vehicle basis. By examining the agreement or disagreement among the counters, researchers determined the error levels and related them to a variety of factors, including weather, time-of-day, light levels, speed, observation location, counter comfort, vehicle weaving, and length of time counting. Significant relationships between error rates and these factors were used to identify elements that influence the accuracy of a counting program. The research used the error rates to estimate the statistical accuracy of an AVO sampling procedure. The study then examined the cost and administrative feasibility of implementing a continuous automobile vehicle occupancy counting program.

During the next 15 to 20 yrs the primary methods available to manage the nation's freeways will involve increasing the average occupancy of vehicles using the freeways. Current demand is taxing the capacity of the freeways, and undoubtedly that demand will increase during the next decades. Because in many areas major investments in new freeway construction and rail systems are not anticipated, the challenge is to make the existing freeways more efficient.

To evaluate the effectiveness of programs intended to increase the average vehicle occupancy (AVO) on freeways and arterials, a method must be developed to measure AVO on a consistent and continual basis. Measurements generally have been conducted on a sporadic and project-specific basis. This frequently means that no consistent data base is available for program evaluation.

In addition, different research designs and field collection methods have often been used to measure AVO. As a result, historical AVO data cannot be used to evaluate past programs and trends. For example, the relationship between AVO and economic factors such as employment and the price of gasoline is not well understood.

The research project discussed in this paper was designed to address the lack of consistent and ongoing AVO measurements in the Seattle metropolitan area. The collection of reliable AVO information can be expensive, especially when information is needed on a geographically disaggregated basis. However, because a great deal of money and energy are being invested in programs to increase the AVO, and because many agencies are interested in having such data, implementing such a data collection effort is important.

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OVERVIEW OF THE STUDY

The research was carried out during the first half of 1987. The first step was to review existing methodologies for automobile occupancy monitoring. Very little literature was uncovered that dealt with the methodology of automobile occupancy monitoring. Many studies exist that use AVO data, but little has been written to investigate the best ways to collect the data.

The second step was to design a data collection method that would give information about a number of factors that influence the accuracy of AVO counts. These factors included weather, time-of-day, light levels, speed, observation location, speed, counter comfort, weaving, length of time counting, and many others.

The third step was to test the field collection methods. From early May to early June 1987, data were collected in the field using three people counting at the same locations at the same time. By examining the agreement or disagreement among the counters, researchers determined the error levels and could relate them to the factors under study.

The fourth step was to develop a suggested program for counting AVO that accounted for the possible sources of error and minimized the cost while producing the most useful AVO data.

This report contains the results of these four steps in the next four sections.

LITERATURE REVIEW

A computer-based search of the literature concerning automobile occupancy counting methodology was conducted.

Although the search resulted in 79 references using automobile occupancy counts, only seven were related to the methodology of counting occupancy. Exploration of the bibliographies for these articles and telephone calls to authors confirmed that very little has been done to develop a methodology of automobile occupancy counting.

Four of the references related to an effort funded by FHWA around 1980. Ferlis conducted the original research (*1, 2*). Ferlis recommended a sampling approach to measuring automobile occupancy and laid out procedures for determining sample size and for drawing the samples. By employing accepted survey techniques of stratification and sampling, reliable automobile occupancy data can be collected at a lower cost than the traditional approaches.

The techniques presented in the Ferlis report have been employed in several places. Two of the articles discussed the application of the sampling techniques. One chronicled the experience using Ferlis' methods in Atlanta (*3*). Another discussed the results of the techniques used in the Detroit area (*4*). In both cases, the sampling technique was found useful in obtaining reliable data in a cost-efficient manner.

One very short article discussed a technique for correcting automobile occupancy data collected in a parking study to account for the fact that passengers are sometimes dropped off in other locations (*5*).

The other two studies reviewed for this project discussed variations in automobile occupancy collected at different times. A study conducted in the Minneapolis area concluded that there were significant differences in automobile occupancy on different days of the week, but that the differences depended on the location (*6*). The study found that there are probably seasonal variations as well, but because the study was conducted during the 1974 oil shortage, other factors made the results difficult to interpret.

Another study of factors influencing automobile occupancy, which was conducted in the Seattle area, found no predictable patterns or trends in automobile occupancy by type of facility, traffic volume, level of transit service, distance to the central business district, season, day of the week, or time of day (*7*).

The last two studies had some contradictory results. However, both studies may have suffered from a lack of data over a long period of time, and other influences on automobile occupancy may have overridden the differences they were trying to detect.

The main theme emerging from the review of past studies was that little is known about the factors that influence the accuracy of automobile occupancy counts. No study dealt with human performance issues such as weather conditions, speed of traffic, fatigue, light levels, or the like. Variations in automobile occupancy due to time of day, day of week, or season are not well established and probably will not be very well understood until data are collected on a regular basis over a long period of time. The literature did show that a sampling method employing some stratification yields statistically reliable results in a cost-efficient manner.

DATA COLLECTION DESIGN

The data collection for this study was designed to answer some of the questions that have not been answered in previous research relating to recommendations for a regular data collection methodology. In order to propose a system for regular collection of AVO data, two kinds of information are necessary. First, it is necessary to understand what kinds of factors may lead to inaccurate or unusable data and to develop a plan that will minimize the influence of these factors. Second, it is important to know how much data will be necessary to provide the accuracy required to use the data.

Factors Influencing Accuracy

The most common method used to conduct automobile occupancy counts has been to have observers watch vehicles and record the number of people in each one. In this study, the research focused on that method. However, other methods were considered.

Methods Other Than Human Observations

Several methods employing mechanical measures are possible, but were not feasible to explore in depth in this study.

Photographs of vehicles may be taken automatically or manually and interpreted for occupancy later. The advantage of using this method is that the observer can take as much time as necessary to make a judgment about occupancy. It is also possible to use films that can enhance the visibility of images. One disadvantage is that it would be very difficult to take pictures from the several angles that might be necessary to determine how many people are in a vehicle. A second drawback is that analyzing photographs would take as much time as counting the occupancy in person. These same comments apply to videotape as well.

Highly sensitive infrared radiation sensors are able to sense hot spots caused by people in a vehicle. However, because of the heat coming from the engine and other sources, the accuracy of this method is unlikely to be very high.

Data from photoelectric cells can be interpreted using computer-aided figure recognition techniques to determine the number of human-shaped objects visible above the windows of a car. However, the logistics of placing photoelectric cells on major highways and the cost of developing and using sophisticated computer programs probably make this approach infeasible. Furthermore, technology requires that vehicle occupants be silhouetted against the windows.

Sophisticated equipment for weighing vehicles in motion is under development. The weight on each of the wheels of a vehicle can be obtained and the weight distribution within the vehicle determined. By knowing the weight distribution of empty vehicles it would be possible to derive the probable location of loads in the vehicle and to infer the number of occupants. However, even if the equipment to weigh the vehicle were highly accurate (which it currently is not), the interpretation of the data would be very difficult.

Automobile occupancy data can be collected through mail or telephone surveys. Trip diaries have been used in a number of research efforts to get detailed information about people's transportation choices. However, respondents are unable to give very accurate data about their trips for more than a few days before they are asked. To collect automobile occupancy data over a geographically dispersed area, thousands of surveys would have to be conducted to obtain accurate infor-

mation. Because the most expensive part of a survey is contacting the respondent in the first place, the cost of this method would be prohibitive.

Human Observers

People can do a fairly good job of determining the number of people in a vehicle if they are motivated to do so and if the conditions are favorable. The questions that this research addressed were (a) what motivates attentiveness in observations, (b) what conditions are important to obtaining good data, and (c) what level of accuracy can be expected?

The measurement of observer motivation can be done directly only on a qualitative basis. However, accuracy can be measured under various conditions to determine when motivation might be a factor. The influence of objective conditions can be measured quantitatively. After paring down an initial list of factors influencing accuracy to take into account the time and financial limitations of this study, the following factors were deemed possible to measure:

- fatigue,
- weather conditions,
- speed of traffic,
- observer comfort,
- amount of light,
- traffic density,
- average occupancy,
- traffic weave, and
- time of day.

Use of Computers

One of the known factors influencing data collection is the mechanical means used to record data. The traditional method used to count AVO employs a paper and pencil. The observer records the data on a piece of paper. Someone enters the data into a machine-readable form and the data are transferred to a computer for analysis.

In this study, the use of portable computers to collect data was a focus of the research. Several potential advantages exist for their use:

- The chance for errors in transcription of the data is decreased.
- Consistency checks can be conducted while the data are being collected.
- Data can be quickly transferred to a computer for analysis to detect problems early.
- Some aspects of the supervision of observers can be conducted by checking recording times and the like.

In this research, the use of computers was essential, because the methodology required knowing the exact time that an observation was recorded.

The portable computer used for this research was programmable using the BASIC language. A program was written that allowed the observer to simply press one key to record a category for each vehicle. A "beep" as well as a display on the computer screen provided feedback to ensure positive contact with the key. The program automatically recorded the time of the observation. The program also allowed the observer to easily make corrections on past observations. Data were compressed so at least three hours of observations could be stored in a computer with 32 kilobytes of random access memory (RAM). Another program was written in FORTRAN to expand the data after they were transferred to a larger personal computer.

Factors Influencing Amount of Data Required

The size of a sample required to attain a certain level of accuracy depends on the variability in the data. In the case of AVO data, an appropriate measure is the standard deviation of the AVO. The variability in the data depends on several factors, including the following:

1. The number of vehicles observed (determined by the density of traffic and the length of time of observation);
2. The distribution of vehicles with different occupancies;
3. The variation by time of day, day of the week, and season; and
4. The error rate in observation.

All of these factors will vary by location, but average levels can be determined to estimate requirements for a large-scale data collection program.

In the Seattle area, good data on the number of vehicles passing most points were already available. On most freeways, the peak hour volumes approach the maximum lane capacity possible, on the order of 1,800–2,000 vehicles per lane per hour. On high occupancy vehicle (HOV) lanes, the volumes are lower. Because good data already existed, this research effort was not designed to collect new data on this subject.

The distribution of numbers of vehicles can have an effect on the standard deviation. To illustrate with extreme examples, if all vehicles in a sample were single occupancy vehicles (SOVs) the AVO would be 1.00 and the standard deviation would be 0. If half of the vehicles in the sample were SOVs and the other half were 2-person carpools, the AVO would be 1.50 and the standard deviation would be .50. In actuality, the AVO and the standard deviation are usually between these two values. Distributions vary from place to place and the averages can be fairly well determined. The data from this research were used to supplement existing knowledge about these distributions.

Variations by time of day, day of the week, and season can contribute substantially to the standard deviation. However, peak hour variations tend to be rather small. Two of the studies reviewed for the literature search dealt with this topic and produced different conclusions regarding the predictability of variations. The manual written by Ferlis suggested values to use for some of the sources of variation (*2*).

If variations are predictable, their effect on the standard deviation can be obviated to some extent through stratification of the sample. Unfortunately, little new knowledge of these factors could be gleaned from the current research because of the limited number of observations and the lack of information on seasonal variations. The standard deviation from these sources can be estimated from other studies, but can

be confirmed only with a large-scale, regular data collection effort.

This research study design emphasized the objective of increasing the knowledge of the fourth factor influencing standard deviation. Variations due to observer error should be taken into account. An estimate of this influence can be made by analyzing the disagreements among the three observers conducting counts of the same lanes at the same times.

RESEARCH DESIGN

This research study was designed with two primary objectives: (a) determine the factors that influence errors and (b) determine the level of error in counting AVO. This section describes how the data collection was set up.

Vehicle Categories

The vehicle categories for this study were chosen to be consistent with categories used in previous Washington State Department of Transportation (WSDOT) vehicle occupancy studies. The following nine categories were employed:

1. SOV—any four-wheeled, personal vehicle (including automobiles, pick-up trucks, recreational vehicles, Jeeps, and vans that were not vanpools) with only one occupant,
2. Two-person carpool—any personal vehicle (as defined above) containing two people (including children),
3. Three-person carpool,
4. Four-plus person carpool—four or more people in a personal vehicle,
5. Vanpool—any van marked "vanpool" regardless of the number of people or an unmarked van with five or more people in it,
6. Bus—local, interstate, school, and tour buses,
7. Motorcycle with any number of people on it,
8. Two-axle truck, not including pickup trucks,
9. Three-plus axle truck—any truck with more than two axles or with a trailer.

The categories were discussed with the observers in the training sessions before the regular observations began and clarified during practice observations.

Types of Locations

Three types of locations were represented in this research: employment sites, arterials, and freeways. Figure 1 shows the locations. The research emphasis was on the freeway sites, with the employment and arterial sites used for observer training and machine testing. Six freeway sites were studied. Two were on either side of state Route 520 at the east end of the Evergreen Point Bridge connecting the Seattle urban area with the city of Bellevue and other smaller cities. The other four were on either side of Interstate 5 approximately 2 and 5 mi north of Seattle's downtown core.

The six freeway sites were not meant to represent all freeway sites in the region, but they do represent a cross-section of types of sites. Some of the differences include how close the observation points were to the traffic, whether the observers could sit down, how visible the observers were to drivers, the number of weaving movements in the traffic, and the angle of the sun.

Each location was selected for the following reasons:

- It had a shoulder or bank of the proper height to easily see the traffic lane (10–20 ft above the road's surface),
- It was close enough to the roadway to see into the vehicles (20–50 ft),
- It had a clear line of sight,
- It was safe for the observers while walking to the counting location and while counting,
- It was located so the observers were not a distraction to drivers, and
- It was convenient in terms of leaving a vehicle parked while counting.

Spacing and Timing of Trials

One of the factors of interest in this study was the influence of fatigue. To study this, observation periods were varied from

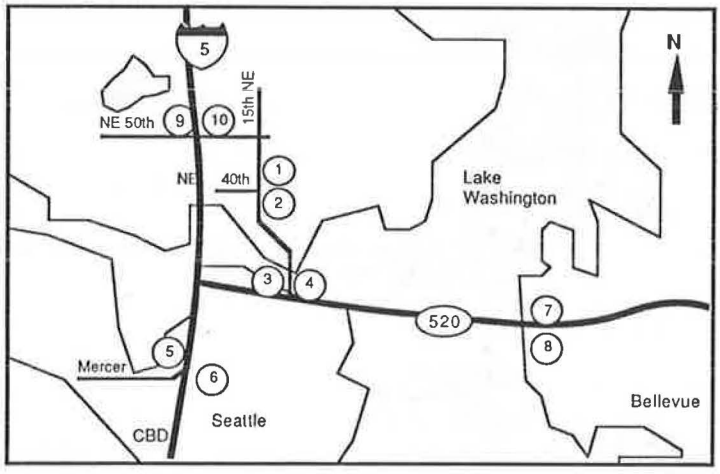

FIGURE 1 Location of observations.

session to session. The basic unit for observation was a 15-min period. Error rates were determined for each period using a process described in the next section.

To change the fatigue factor, different rest periods were used in each session. In some cases, each observation period was separated from the next by 15 min. In some sessions, two 15-min periods of observations were conducted without breaks between them, but the pairs were separated by 15-min rest breaks. In two of the sessions, no rest breaks at all were taken between 15-min observation periods.

Measuring Environmental Conditions

Five factors were measured during the course of this research: weather conditions, speed of traffic, observer comfort, amount of light, and traffic weave. Two factors (speed of traffic and amount of light) could be measured objectively; the others required subjective judgment by the researchers.

Because the amount of time for the research was rather short, it was impossible to sample randomly from different types of weather conditions or to test the influence of different weather conditions at each location or for each of the other factors that were under study. The researchers assumed that the range of weather conditions would be large enough to detect the effects. The researchers also recognized that it was possible that weather conditions could change within a 15-min observation period. The measure used for this factor in later analysis was a subjective judgment of the most common weather in a 15-min period using four categories: clear, partly cloudy, overcast, and raining.

Traffic speed was measured using a portable radar gun about five times during each 15-min period. The average among those speeds during an observation period was used to represent that factor. The averages were later allocated into five speed categories: stop and go, below 30, between 30 and 40, between 40 and 50, and over 50 mph.

Observer comfort was based on a subjective assessment. Two categories were used: comfortable and uncomfortable. The major determination of comfort according to the observers was whether or not they could sit. It also happened that the observation locations that required standing were closer to the traffic and thus were noisier and contained a significant amount of dust in the air.

The amount of light was measured about five times during each observation period with a foot-candle meter. The averages of the logarithms of foot-candles for each observation period were used in later analysis.

Traffic weave was not a factor that the researchers originally intended to test in the research. However, upon retrospect, it was deemed to be an important factor in some of the freeway locations. One location was near the end of an HOV lane and the other was near an on-ramp. In both cases, weaving movements occurred more often than in most mainline locations.

FIELD RESEARCH AND ANALYSIS

The research design issues were incorporated into a schedule for data collection that also took into account the limitations of time and budget for this project. Table 1 shows the schedules for the 16 sessions along with locations, time of day, timing, and number of 15-min periods during which AVO data were collected. In all, there were 111 15-min periods, or a total of 333 observation points.

Two instructions to observers were important in being able to compare observations. One was that a vehicle should be counted when it crossed a particular point in the pavement. This allowed comparison of times of observations at a later point. The second was that a vehicle that was entering or exiting the lane being counted should be recorded only if at least half of the vehicle was in the lane.

Use of Computers

To match the observations of three counters on a vehicle-by-vehicle basis, computers had to be used because the observations had to be timed to the second. The use of computers in a regular AVO data collection program is not required. However, the use of computers offers several advantages.

In general, the computers caused very little trouble. An effort was made to make their use as foolproof as possible by disabling all keys not used for counting. The observers had to spend some time learning the basics of using the equipment and the counting program. However, the learning curve was very steep and the observers were completely competent in their use by the middle of the first recording session.

One of the major advantages of using portable computers in this data collection was the ease of data reduction and analysis. Transferring the data from the three observers for a 3-hour period to machine readable form and conducting preliminary analyses to check for reasonability took less than 10 min. Observers could get immediate feedback on the types of errors they were making. The data analysis became a continuing training tool.

A second advantage of using computers in a regular AVO counting program is that they can act as a surrogate for a field supervisor. In this research, a field supervisor was always present. However, when AVO data can be time stamped and collected on an observation-by-observation basis, unreliable counts can be detected. Lapses in counting are obvious from the time stamps. The patterns and frequencies of each category of vehicle can be checked to see if they are reasonable.

A third advantage of using computers is that data can be transmitted over the phone lines. Observers do not have to travel to a common point each day to drop off data. Data can easily be transferred from their homes.

However, a few cautions about the use of computers should be noted. One is that batteries need to be replaced, or data may be lost. In most cases, batteries should be replaced on a regular schedule before they wear out rather than when the computer indicates that they are running low. Portable computers need to be protected from the weather. Some waterproof covering is necessary during rain and some method is also advisable to keep dust out of them. Software for the computer should be able to detect when an observer touches a key that should not be in use or when the observer accidentally rests a finger on a key.

In general, the use of computers was very successful. They should be considered for any regular AVO data collection program.

TABLE 1 SCHEDULE AND DESCRIPTION OF SESSIONS

#	Location[1]	Time of Day[2]	Timing[3]	No. of Periods	Date
1	1	AM	B	9	5/12
2	2	PM	C	7	5/12
3	6	eve	A	6	5/13
4	3	AM	B	7	5/14
5	4	PM	B	8	5/14
6	8	eve	A	6	5/18
7	5	AM	A	6	5/19
8	10	eve	A	6	5/20
9	5	AM	B	8	5/21
10	6	PM	A	6	5/21
11	7	AM	A	6	5/26
12	6	PM	B	8	5/26
13	8	PM	C	9	5/28
14	8	PM	B	7[4]	5/29
15	9	AM	A	6	6/2
16	10	PM	A	6	6/4

1. See Figure 1
2. AM = 6-9 a.m.; PM = 3-6 p.m.; eve = 6-9 p.m.
3. A = 15 min. periods with 15 min. breaks
   B = 30 min. periods with 15 min. breaks
   C = continuous counting
4. Data from one period lost due to machine problems

TABLE 2 MATRIX OF ACTUAL VS. OBSERVED CATEGORIES

		Actual									
		0 no vehicle	1 SOV	2 2 pers. carpool	3 3 pers. carpool	4 4 pers. carpool	5 vanpool	6 bus	7 motor cycle	8 2 axle truck	9 3+ axle truck
Observed	0	—	529	66	9	4	0	10	6	0	6
	1	340	61881	346	22	4	0	4	50	3	4
	2	65	337	13522	127	17	1	0	13	0	0
	3	14	19	175	1490	57	1	0	1	0	0
	4	4	4	11	43	649	0	0	0	0	1
	5	0	3	0	0	1	46	0	0	0	0
	6	2	6	2	0	0	0	497	1	0	0
	7	3	45	20	4	0	0	0	681	13	0
	8	5	3	2	0	0	0	2	10	964	0
	9	6	2	1	0	0	0	0	0	1	403
Total		439	62829	14145	1695	732	48	513	762	981	414
%		.5	76.1	17.1	2.1	.9	.1	.6	.9	1.2	.5

missed vehicle (.8%)
undercount (.7%)
misclassification
overcount (.7%)
extra vehicle (.5%)
correct (97.1%)
misclassification (.2%)

Interpretation of Errors

The primary variable of interest in this research was the error rate. To compute an error rate for each of the 333 observation periods, observations among the three observers were compared. A custom-written computer program was developed to aid in the comparison process. An error was said to occur when one of the observers was the "odd man out." In other words, when two observers agreed with each other, but the third observer did not agree with him, the third observer was said to have committed an error. Although one person could have been right and the other two wrong, the former interpretation was probably the correct one in the vast majority of the cases.

The following five types of errors were recorded:

1. Undercount—when an observer counted too few occupants in a personal vehicle,
2. Overcount—when an observer counted too many occupants in a personal vehicle,
3. Classification—when an observer classified a vehicle wrongly (other than occupant count differences),
4. Missed vehicle—when an observer failed to record a vehicle,
5. Extra vehicle—when an observer recorded a vehicle that was not there.

These errors were collapsed into the following three basic types for the final analysis:

1. Total error—all the above types of errors plus those few cases in which all three observers disagreed,
2. Count errors—the total of the first two types of errors defined above,
3. Existence errors—the total of the last two types of errors defined above.

Table 2 shows a comparison of observed category and actual category. Different types of errors are indicated on the matrix.

Error Analysis

Figure 2 shows the average error rates for each of the 16 observation sessions. The analysis focused on freeway counting sites, so locations 1 through 4 are not used in the following analysis. Furthermore, location 9 had a much higher error rate than the others. This was due primarily to significant weaving movements. Therefore, that location is also not used in the analysis described here. Excluding locations 1 through 4 and 9 leaves 11 locations remaining, with a total of 74 15-min time periods, or 222 separate observations. The overall observer error rate for these sessions was about 3.0 percent.

The primary method of analyzing the data was multiple regression analysis. The three major classifications of errors were the dependent variables, and the following factors were the independent variables:

- weather—four dummy variables,
- comfort—dummy variable,
- weave—dummy variable,
- time of day—dummy variable,
- speed—continuous interval variable,
- light—continuous interval variable,
- location—dummy variable,
- traffic density—continuous interval variable, and
- average occupancy—continuous interval variable.

The variables weave, comfort, and time of day (which is tied to the direction of peak hour travel) were determined entirely by the location and were thought to be the primary distinguishing characteristics.

First, an attempt was made to relate location to error rate. Less than 10 percent of the variance in total error rate could be explained by location alone (13 percent of the counting error and 6 percent of the existence error). For this reason, the regression analysis used the three variables that were thought important in the distinction among locations.

Table 3 shows the results of the regressions using the three types of errors as the dependent variables and nine independent variables. The results can be interpreted by focusing on the statistically significant regression coefficients.

Weather

All of the weather-related dummy variables are significant. However, the differences among the coefficients are the most important aspect of the analysis. The higher the coefficient,

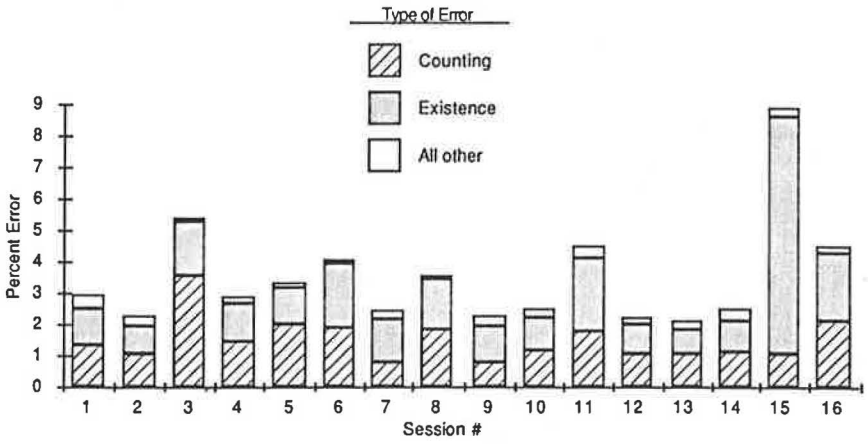

FIGURE 2 Error rates by session.

TABLE 3 REGRESSION ANALYSIS RESULTS

Variable	Type	Coefficients		
		Total Error	Counting Error	Existence Error
Clear weather	Dummy	10.78*	4.96*	5.42*
Partly cloudy weather	Dummy	10.12*	4.58*	5.20*
Overcast weather	Dummy	10.46*	4.90*	5.21*
Rainy weather	Dummy	11.82*	7.12*	4.39*
Lack of comfort	Dummy	-0.14	.11	-0.26
Weaving	Dummy	.59	.33	.25
Evening	Dummy	.46	.45*	.09
Speed	Interval	.06	-0.08	.14*
Light (log of foot-candles)	Interval	-0.09	-0.05	-0.03
Traffic density (veh./min.)	Interval	-8.60*	-4.83*	-4.42*
AVO	Interval	-3.33	-1.08	-2.05
R^2		.28	.35	
Number of obs.		222	222	
F-statistic		8.38	11.26	

* Significant at .05 level

the greater the contribution of each kind of weather condition to the error rate. Partly cloudy and overcast conditions tended to produce the fewest errors. Clear and rainy conditions produced the most errors, especially for counting errors. The differences are insignificant, however, except for the effect of rainy conditions on counting errors. Because it was raining during only two observation periods, other factors, not fully accounted for in the regression, may account for this difference. The observers felt that counting was not overly difficult during the rainy periods. The primary complaints were voiced when the sun was bright and the glare made seeing into the vehicles difficult.

Comfort

Comfort level did not have any significant effect on any of the errors (at the 95-percent confidence level). However, the coefficient for existence errors approached significance (two-tailed significance = .16). Negative coefficients imply that the fewest errors were made when the conditions were most uncomfortable. Because part of the definition of "uncomfortable" was that observers had to stand, the best interpretation of the negative coefficient is that the observers were probably able to distinguish lanes better when they had to stand. Otherwise, comfort level had little influence on accuracy.

Weave

Weaving movements, which were judged to be influential at three of the locations, did not have a significant effect on any of the error rates. However, positive coefficients support the hypothesis that weaving movements have the effect of increasing the error rates. Also, remember that one location was left out of this final analysis because the weaving effects apparently had very significant effects on error rates. Weaving sections should be avoided in selecting counting sites.

Time of Day

Time of day had a significant effect on counting error rates. The positive coefficient implies that the most accurate counts occurred in the morning. This result probably means that observers are fresher and more alert in the morning than in the afternoon.

Speed of Traffic

The only significant effect of speeds on error rates was on the existence errors. The faster the traffic, the more likely observers were to miss vehicles or record vehicles that did not exist. However, surprisingly, speed did not seem to affect the ability to count occupants of vehicles.

Light

The amount of light influences the ability to distinguish characteristics of objects. Lower light levels were expected to lead to more errors in observations. Although the coefficients are in the right direction to support the hypothesis, none approach statistical significance. This may be due to the fact that counts in extremely low light conditions were attempted in only one of the 15-min time periods. As long as there is some light, counting accuracy is not severely affected. A further discussion of the limitations that light levels impose on counting is presented in another section.

TABLE 4 COMPARISON OF TWO CONSECUTIVE COUNTING PERIODS ($N = 36$)

Type of Error	Error Rate (%) 1st Period	Error Rate (%) 2nd Period	Difference	Standard Error of Difference	Probability of Difference from Zero (one-tailed)
Total	2.16	2.48	.31	.20	.05
Counting	.96	1.05	.09	.10	.19
Existence	.92	1.19	.27	.17	.05

Traffic Density

The original expectation was that higher traffic density would lead to a higher level of observation errors. The regression analysis shows just the opposite. There was a strong and significant tendency for more accurate counts to be conducted when there was more traffic. One explanation for this outcome is that when there are large spaces between vehicles, the observers' attention may wander. With low density traffic, vehicles tended to come in groups. Within those groups, the density was generally as high as it was during the higher density time periods. At least for the short time periods that were used in this research, heavy traffic conditions tended to focus the observers' attention. The counters' comments corroborated this interpretation.

Average Occupancy

The researchers expected that error rates would tend to be higher with higher average occupancies, simply due to the fact that there is more chance for error with more multiple-occupant vehicles. The regression results indicate that there is no significant relationship between average occupancy and error rates. However, there is a slight tendency for higher occupancies to be associated with fewer errors.

Fatigue

Observer fatigue is an important issue in designing an AVO data collection program. An understanding of how long observers can count occupancies before error rates significantly increase is important. This variable was studied in this research by varying the number of 15-min periods that observers counted without a rest.

There were twelve pairs of counting periods which occurred without a break and under similar conditions. Table 4 shows the average error rates for the first and second periods along with the average pair-wise differences and the corresponding standard errors. For all types of errors, the second period had a higher error rate than the first. The differences are statistically significant for the overall error rate and the existence error rate. The difference for the counting errors is not statistically significant. While errors do not appear to increase drastically during the first half hour of counting, some care should be taken when continuous counting goes beyond that time period.

In retrospect, significant degradation in performance appears to occur only over a longer time period than 30 min. Had the researchers anticipated this, the research design would have included longer continuous counting periods. However, in one session, nine observation periods were conducted in a row without a break. Figure 3 shows the average error rates (among three observers) for each period in that session. Accuracy tended to improve over the first hour or so and then start to get worse. The number of observations in this session was too small to draw any definitive conclusions, however.

Hours of Observation

In Seattle, due to the city's distance from the equator and its western location in the time zone, the sun sets and rises at relatively extreme times during the year. In the winter, the sunrise is so late and the sunset so early that it is not possible to accurately count vehicle occupancy during parts of the peak hours. Some of the results of this study can be used to determine the hours in which counting occupancies will be possible.

Two of the counting sessions occurred in the evening between 6:00 p.m. and 9:00 p.m. The sunset during this time was at about 8:30 p.m. and the length of twilight was about two-and-one-half hours (*8*). One of the evenings was clear and the other was overcast. On the clear evening, there was no noticeable impact on accuracy due to the sunset up to 9:00 p.m. On the overcast evening, however, the last counting period, occurring between 8:45 p.m. and 9:00 p.m., resulted in a

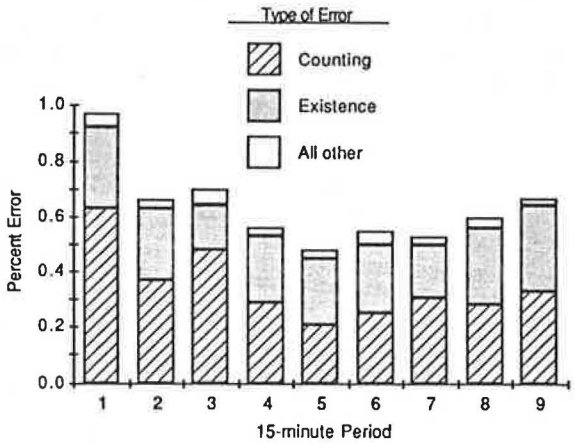

FIGURE 3 Errors in session 13 (nine consecutive counts without a break).

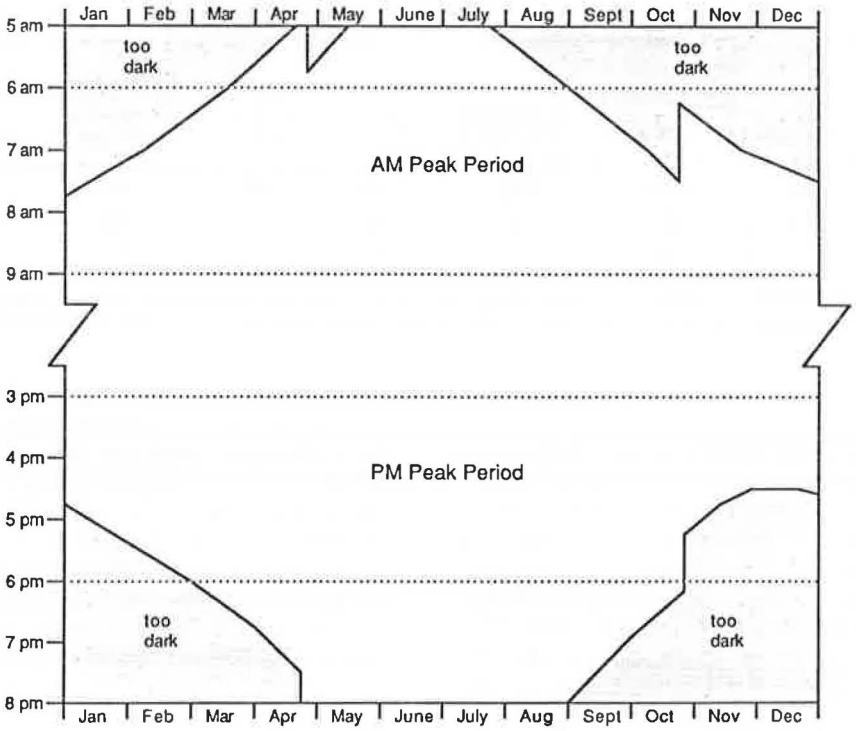

FIGURE 4 Analysis of light level sufficiency.

noticeable degradation in accuracy. However, it was not severe enough (in comparison with the earlier time periods that evening) to be unusable. The counters and the research supervisor concurred that the light level was the lowest it could be to still allow relatively accurate counts.

Graphs based on these results were constructed (Figure 4) and can be used to determine the hours when occupancy can be counted in the Seattle area during different times of the year. The lines were constructed by adding 20 percent of the length of twilight to the sunset and subtracting 20 percent of the length of twilight from sunrise to determine the times at which occupancy can be counted, even in overcast weather. In clear weather, one could expect to expand the possible counting times.

The morning peak three hours can be counted from March to August and evening peak three hours from March to September. In the other months, varying proportions of the peak period can be counted, with a minimum of 1½ at the worst times of year. Using data from each part of the peak hour from other times of the year, occupancy during the hours it was not possible to count could be estimated.

Sample Size

Ferlis discusses fairly completely determination of sample size in conducting automobile occupancy counts (*2*). However, the sources of error that he discussed did not include some potential sources dealt with in this research. Specifically, he did not deal with observer counting error or variations due to time of day. In addition, one source of error (he called "short counting") can be more precisely estimated using data from this study.

Table 5 shows five sources of error along with values from Ferlis (*2*), this research, and the values used to estimate required sample size.

TABLE 5 SOURCES OF VARIATION FOR 30-MIN COUNTING PERIODS

Source	Ferlis Recommendation	Research Finding	Value Used to Analyse Sample Size
Day of the Week	.015	na	.015
Seasonal	.015	na	.010
"Short Count"	.017	.021	.021
Observer Error	na	.006	.006
Time of Day (w/in each peak)	na	.017	.017

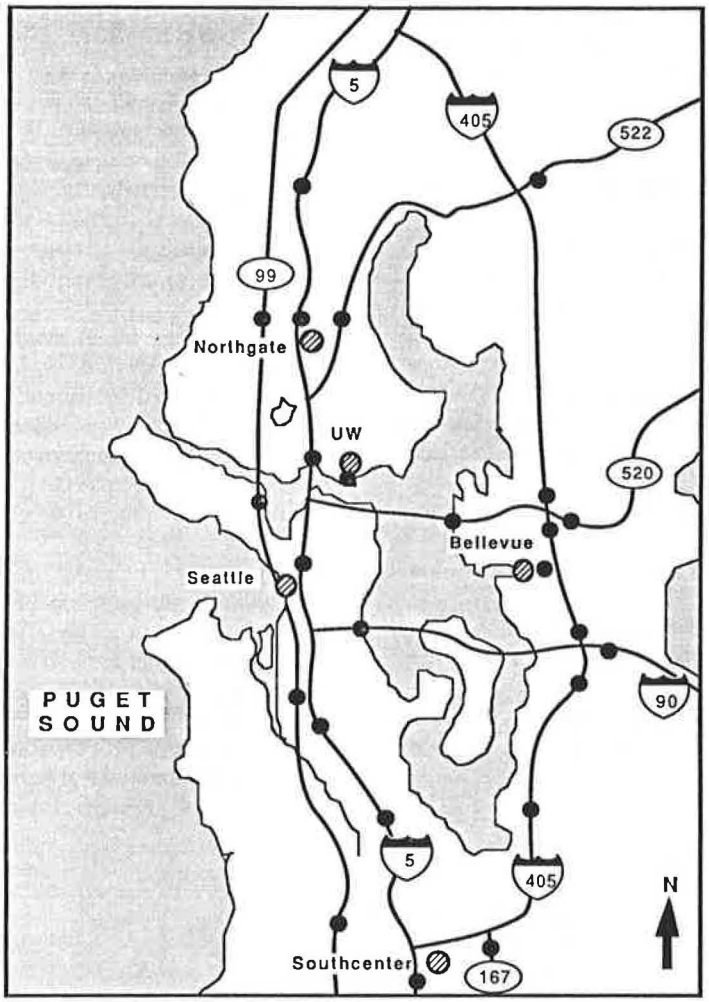

FIGURE 5 Recommended data collection locations.

AVO tends to vary by day of the week. It tends to be higher on Mondays and decrease through the week. Research has shown, however, that the pattern varies by location (*6*). A regular AVO data collection effort would probably be conducted on every day of the week and thus this source of variation should be taken into account. This research project did not involve the collection of enough data to determine the variability in the Seattle area, so the value employed here is that recommended by Ferlis.

AVO also varies across seasons and depends to some extent on location. The value Ferlis recommended is based on variation throughout the year. The recommended data collection program involves quarterly estimates. Because the variation within each quarter is likely to be smaller than that for the whole year, the estimated value for this source of variation is somewhat lower than that proposed by Ferlis.

The variation due to short counting takes into account the fact that there is random error in sampling automobile occupancy. If one were to count occupancy in the same lane, on the same day of the week, at the same time of day and at the same time of year, the occupancy would vary simply due to the fact that different vehicles passed by. While this is not a completely random sample (people tend to have regular patterns in commuting), the variation due to this source can be estimated. Using a Monte Carlo approach, the standard deviation of AVO for 800 vehicles (the approximate number passing in one lane during one-half hour) is slightly higher than Ferlis's recommended value.

Observer error contributes to variation. It was not treated in the Ferlis study. However, from this research, the level can be estimated. Using a Monte Carlo simulation and the error data from Table 2, the variation due to this source was estimated.

Ferlis also did not deal with variation due to time of day. Based on data collected in this research, the value shown in Table 5 reflects the variation within the peak hour due to this source.

The total standard deviation is the square root of the sum of the squares of each source of variation. For the values used here, that is .035. However, three of the sources of variation are predictable. They are (a) day of the week, (b) seasonal, and (c) time of day. When enough data have been collected, the effects of these sources of variation can be controlled for and essentially eliminated (with the assumption that the patterns do not change over time). The combined standard deviation for the remaining two sources is .022.

Using these two values for the combined standard deviation, we can estimate the accuracy that can be attained in a

regular AVO data collection effort. Assuming a sample size of 10 observations per quarter, the accuracy of the measured AVO will be somewhere between 1.1 percent and 1.7 percent at a 95 percent confidence level.

DEVELOPMENT OF AN AVO COUNTING PROGRAM

One of the results of this research was the knowledge that a continuous vehicle occupancy counting program can be conducted at a reasonable cost. A continuous program provides many benefits, including the following:

- data for the elevation of the typical long-term AVO programs as opposed to previous counting programs that have been typically conducted on a short-term and project-specific basis,
- consistent data due to a controlled collection methodology,
- the opportunity to train and utilize a pool of professional AVO observers, and
- the ability to explore the relationship between AVO and economic factors such as employment and gas prices.

The yearly cost of a program supplying useful data would be about the same as a clerical or secretarial position (including benefits and overhead).

The cost estimate is based on several assumptions:

- The sample will consist of ten 30-min counts conducted at each site during each peak hour.
- Twenty-five sites will be selected.
- Counters will be part-time hourly employees receiving $7.00 per hour, with no benefits other than half of their social security.
- Counters will be able to conduct three 30-min counts during each 3-hr peak period by working for 3.5 hrs (including travel time).
- The average travel requirement during each peak period for each counter will be 30 mi.
- A sample of 10 counts per quarter at each site during each peak hour will give sufficient accuracy to evaluate programs to change vehicle occupancy.
- One-fifth of a full-time equivalent (FTE) researcher (early grade) will be required to administer and supervise the program.

Figure 6 shows the resulting cost calculations.

Several jurisdictions could share in the costs of a regional AVO counting program. There are three reasons for this. One is simply that enough funds must be provided to sustain the project for a long period of time. Another is that the involvement of people with a wide variety of interests in the results should be promoted so that the data will be useful to the maximum number of people. The third reason is that the

Counters		
Wage (25 sites x 10 counts/site/quarter/peak x 4 quarters x 2 peaks x (3.5/3) hours/count x $7.00/hour)	$16,333	
Benefits (8%)	1,307	
Total Counters		$17,640
Supervision/Administration		
Wage (12 months x 20% x $2000/month)	4,800	
Benefits (34%)	1,632	
Total Supervision/Administration		6,432
Transportation		
Total Transportation (2000 counts x 10 miles/count x $.205/mile)		4,100
Miscellaneous		
Computer Depreciation (3 computers x $500/computer ÷ 5 years)	300	
Batteries and Other Supplies	1,000	
Other Computer Costs	200	
Report Writing	500	
Total Miscellaneous		2,000
Totals		
Direct	30,172	
Overhead (60%)	18,103	
Total Cost		$48,275

FIGURE 6 Typical cost calculation.

results of the data collection can be used as an educational tool for policy makers in the jurisdictions paying for the data. The awareness of occupancy data should promote interest in programs that are designed to increase AVO.

If multiple jurisdictions are involved in supporting the data collection effort, the data collection locations should be chosen to provide information specifically useful to the jurisdictions involved. Additional locations for special studies could easily be added to the data collection program. However, a consistent set of data collection is necessary to provide the continuity necessary to conduct data analysis.

ACKNOWLEDGMENT

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REFERENCES

1. R. A. Ferlis. Field Data Collection and Sampling Procedures for Measuring Regional Vehicle Classification and Occupancy. In *Transportation Research Record 701*, TRB, National Research Council, Washington, D.C., 1979, pp. 1–6.
2. R. A. Ferlis. *Guide for Estimating Urban Vehicle Classification and Occupancy*. Federal Highway Administration Final Report No. HS-032518, March 1981.
3. F. R. Fisher, G. J. Williams, and J. P. Boyd. Atlanta Vehicle Occupancy Monitoring. In *Transportation Research Record 779*, TRB, National Research Council, Washington, D.C., 1980, pp. 27–32.
4. R. C. Hupp and Carmine Palombo. Evaluation of the FHWA Vehicle Classification and Automobile Occupancy Sampling Manual. In *Transportation Research Record 779*, TRB, National Research Council, Washington, D.C., 1980, pp. 21–26.
5. K. J. Fehon. A Technique for Estimating Car Occupancy in a Parking Study. *Australian Road Research*, Vol. 12, No. 1, March 1982, p. 41.
6. R. J. Benke and R. A. Sjoberg. Auto Occupancy Parameter Variations. *Traffic Engineering*, Vol. 47, No. 3, March 1977, pp. 21–27.
7. M. Lester, J. W. Dare, and William T. Roach. Techniques for Monitoring Automobile Occupancy: Research in the Seattle Area. In *Transportation Research Record 701*, TRB, National Research Council, Washington, D.C., 1979, pp. 8–15.
8. *Farmer's Almanac*, 1987.

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