METRO GUIDEWAY: AN INTEGRATED URBAN TRANSPORTATION SYSTEM

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The greatest need of future urban transportation is for improved arterial transportation facilities in larger metropolitan areas. To provide for these needs by conventional means, including additional urban freeways, expressways, arterial streets, and public rapid transit systems, will entail the expenditure of large sums of money and will create social and environmental impacts that will limit the public acceptability of the new facilities. It may be possible to reduce such economic and social costs through the development and implementation of new arterial systems. An integrated urban transportation system called the Metro Guideway is described. This would provide an automated roadway network accommodating dual-mode automobiles, personal and group rapid transit vehicles, and automated freight carriers. A brief resume is given of the current program of design, analysis, and evaluation of the Metro Guideway concept.

•THIS PAPER is intended to be a contribution to the discussion of future urban transportation needs and the potential of new system concepts including automated highways and personal rapid transit systems as solutions to those needs. Although much thought has been given to the assessment of future transportation needs [witness the considerable effort on the 1990 Transportation Needs Study that has been under way for more than a year by federal, state, and regional planners (1, 2, 3)], emphasis has been on the satisfaction of those needs by fairly conventional urban freeways and public transit. It will be argued here that new technological possibilities in urban transportation should be realistically evaluated in terms of specific anticipated needs and that national urban highway and transit planning policy should give added attention to new systems.

More specifically, this paper will discuss an integrated urban transportation system concept that is currently being investigated as a potential solution to what appear to be the most pressing urban transportation problems: the needs for improved arterial transportation facilities for public transit, for private automobile travel, and for goods movement within larger metropolitan areas. Called the Metro Guideway, the system represents a synthesis of certain previous concepts for dual-mode vehicle systems and personal rapid transit with certain new functions and capabilities. The paper describes how this system concept is being analyzed and evaluated relative to the projected needs of some 87 large urbanized areas of the United States.

[The term Metro Guideway is employed in order to avoid confusion with ambiguous terminology such as personal rapid transit and automated highways. The Metro Guideway is essentially a technological adaptation and synthesis of 4 modes of transportation previously described by Canty and others (4, 5) and is functionally similar to the technologically nonspecific concepts of NET-3 as described by Henderson and others (6), to dual-mode transit as described by Hamilton and others (7), to the integrated arterial mode described by Canty (8), and to the metropolitan guideway postulated by Doxiadis and his associates (9).]

ESTIMATION OF FUTURE URBAN TRANSPORTATION NEEDS

It should be appreciated that, in a forecast of urban transportation needs, an objective estimate is not possible. Transportation is not an end in itself but only a means for attaining other social and economic objectives that are more suitable to subjective evaluation rather than to absolute determination. Second, the estimates are subject to obsolescence as new data become available; in this case, the new data are in the forthcoming report to the Congress by the U. S. Department of Transportation on the 1990 Transportation Needs Study. Nevertheless, for the purposes of this discussion, one needs to proceed on the basis of the limited data currently available.

The results of the 1968 National Highway Functional Classification Study (10, 11) provide the best measure of current patterns of automotive travel in urban areas. Data obtained from the Federal Highway Administration on 1968 vehicle travel on various urban roadways by functional classifications are shown in Figure 1. Preliminary estimates prepared by General Motors Research Laboratories on the basis of information from a number of sources indicate an overall increase in the order of 110 percent in automotive travel in urbanized areas by 1990. [Sources include projections of aggregate population and travel data for urbanized areas as provided by the Federal Highway Administration in the National Highway Functional Classification and Needs Study Manual (2).] Figure 1 shows that the largest expected increases, both relatively and absolutely, are in travel on freeways, expressways, other principal arterials, and minor arterials that constitute the urban arterial highway system.

If one further analyzes the patterns of automotive travel in terms of the characteristics of the urbanized areas in which the travel would occur, one finds that more than 85 percent of both the present and anticipated urban travel occurs in 87 urbanized areas. (The selection of urbanized areas was by criteria considered as minimal for the consideration of areas such as locales for automated roadway networks or limited-access rapid transit facilities. Although the rationale for selection will not be discussed here, the criteria include a projected minimum urbanized area size of 170 square miles and a projected minimum population of 425,000, both as of 1985.) The changes during the 1968-1990 period in those 87 areas are shown in Figure 2; Figure 2a shows vehicle-miles of travel, and Figure 2b shows additional arterial roadway facilities judged to be necessary to accommodate this higher level of traffic. The cost of the new arterial roadway facilities in the 87 areas is estimated to be in the order of $175 billion (in constant 1970 dollars). [Estimates were made by Gustafson and Golob, General Motors Research Laboratories; however, unit costs for construction were obtained from Kasoff and Gendell (12).]

Only limited data exist on the needs for urban public transportation facilities. Indeed, one of the purposes of the National Transportation Needs Study is to inventory needs in the area of urban public transportation. In the interim, currently available information on prospects for capital investment in urban public transportation (13) may be employed as an indication of such needs (although it is acknowledged that perceived needs are not synonomous with investment plans). The estimates prepared by the Institute of Public Administration in 1969 of prospective capital investment during the 10-year period 1970-1979 are for a total of $32.8 billion (in constant 1969 dollars and no inflation in construction costs).

Of the total $32.8 billion, approximately 93 percent or $30.5 billion is expected to be needed in 29 urbanized areas that will have populations of more than 1 million as of 1980. Of that $30.5 billion, a very large proportion, or almost $30 billion, is for capital investment in fixed facilities and rolling stock for grade-separated systems: rail rapid transit, suburban railroads, and busway-guideway systems. No investments were seen for grade-separated systems in urban areas of less than 1 million population.

On the basis of the 10-year estimate by the Institute of Public Administration, a preliminary estimate of several tens of billions of dollars for urban rapid transit needs during the next 10 decades seems reasonable. That estimate coupled with the estimated need for some $175 billion in arterial roadway facilities (in 87 large metropolitan areas) gives a combined investment in public and private arterial transportation facilities in the 87 selected urbanized areas of approximately $250 billion. This, then, is the total "market" for urban arterial facilities in large metropolitan areas during the next 2 decades; some portion of that market may be suitable to the application of new system technology.

A public decision to expend an amount of money of this magnitude must be considered in light of other urgent national priorities. However, discussion of such relative priorities is beyond the scope of this paper. A more germane consideration is that, when such a

Figure 1. Daily vehicle-miles of travel on urban roadways by functional classification.

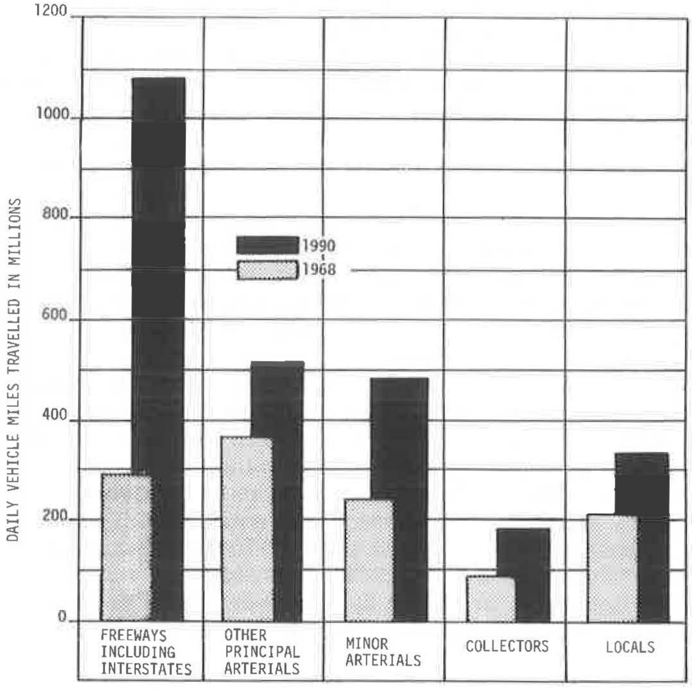
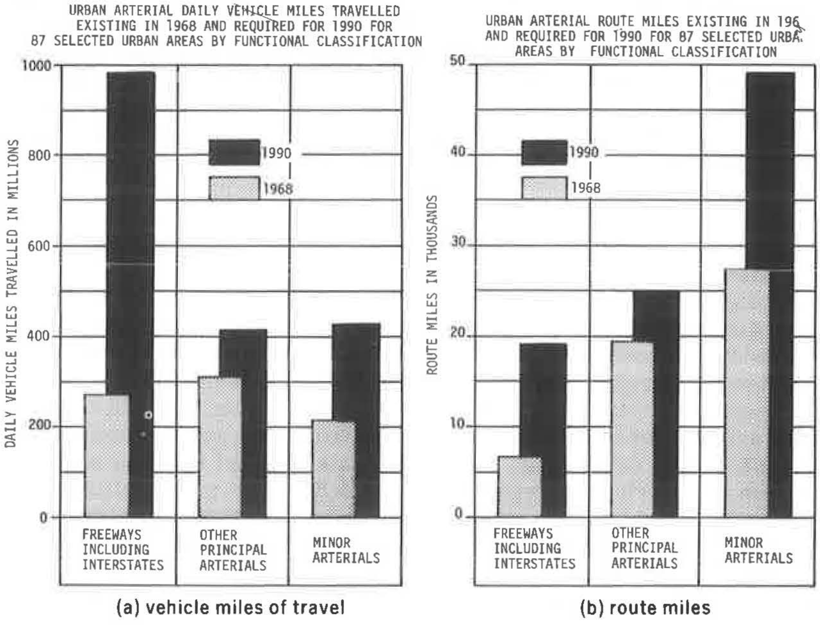


Figure 2. Changes in vehicle-miles of travel and route miles in 87 urbanized areas.



(a) vehicle miles of travel

(b) route miles

large investment is being considered, even a marginal improvement in system effectiveness, or a reduction of 1 or 2 percent in cost, can yield great benefits, measurable in billions of dollars. As a result, room exists for a serious and substantial program of research and development on new and improved systems of highway transportation and public transit. It is conceivable that a large research and development effort, totaling as much as several hundreds of millions of dollars, could be mounted in the expectation that a still greater level of benefit can be realized.

For a program of such magnitude, which has no real precedent in civil affairs, it is appropriate to reevaluate previous preconceptions as to what level of investment in research and development of new urban transportation systems may be considered as reasonable or as too expensive. Putting it another way, the program of construction of post-Interstate highways and public transit facilities in urban areas may become the greatest civil project in any nation's history, comparable in magnitude only to wartime military projects. Under such circumstances, it would be premature to categorize automated highway, personal rapid transit, or other new concepts as being too futuristic or as requiring excessive research and development before a more thorough evaluation is made of the costs and benefits of such new systems in light of national needs.

COMMENTS ON RELIANCE ON CONVENTIONAL FREEWAYS AND PUBLIC TRANSIT

In plans for meeting future urban transportation needs, primary consideration is usually given to the construction or extension of facilities for present modes of transportation, including conventional roadway networks and public transit. For arterial travel in large metropolitan areas, the relevant facilities are urban freeways and limited-access public transit (for rail transit or bus rapid transit). However, such facilities are limited in their acceptability.

The major barriers to acceptance of urban freeways are the perceived negative social, environmental, and economic impacts of those freeways on the communities through which they pass. The major design characteristic of urban freeways leading to such negative impacts is the significant land requirement. Land required for right-of-way, buffer zones, interchanges, and entry and exit facilities causes families to be displaced, neighborhoods disrupted, public buildings destroyed, park areas appropriated, and real estate removed from the tax rolls. These effects have already resulted in a number of citizen actions against the construction of urban freeways (14). To some extent, such opposition has been based on specific freeway design or location rather than the need for the freeway itself, but the lack of a consensus on design or location may have the same effect as opposition to the freeway per se (15). Such opposition will become more severe in the future as more urban freeways are proposed and as the methodology of protest becomes further developed. Consequently, the extent of construction of urban freeways may be considerably below that which is considered to be warranted on the basis of conventional user-related cost-benefit analyses.

In previous years, when the main warrant for highway construction was that user benefits outweigh right-of-way acquisition and construction costs, there was, in effect, a simple ceiling on congestion effects. Whenever travel time or accident rates became excessive, new facilities would be built (although administrative, planning, and construction delays might prolong the unacceptable conditions). However, as one considers various social and environmental impacts of roadway construction and internalizes these into the cost estimation process, one in effect raises the ceiling on user costs that are tolerable before new facilities are constructed. Consequently, the relief of nonuser social and environmental impacts of freeway construction must necessarily result in an increase in the expected value of user costs (e.g., travel time) as long as continued reliance is placed on conventional technology for highway transportation.

The situation regarding public transit is rather different. Whereas the major problem with urban freeways has been acceptability in regard to social and environmental factors, the major problem with transit has been its lack of attractiveness to users. In view of the prevailing and projected land use patterns in most of the metropolitan areas of the United States, most trips are, and increasingly will be, of a diverse pattern with regard to location of trip origins and destinations (16). Such a travel pattern is ill-suited to conventional public transit (17). This is reflected in a low level of transit ridership that tends to keep such systems from being economically self-supporting. Also, because such systems are patronized by a usually small percentage of the total population, obtaining necessary financial subsidies is dependent on the development of a conviction by the general public as to the value of social and environmental benefits of such public transit facilities, chiefly improved mobility for the disadvantaged or the negation of environmental impacts of proposed freeways, and on the evolution of institutional processes for decision-making in respect to urban public transportation (18).

Because of these largely subjective factors, it would be difficult to forecast the extent to which additional public transit facilities of conventional design will be built. However, in any event, because the expected patterns of travel demand are so mismatched with the service capabilities of public transit, it does not appear likely that more than a small fraction of total trips in most metropolitan areas can be served by public transit. As a result, it must be anticipated that most of the increase in urban area travel must be accomplished by automotive vehicles over an expanded highway network or by new systems of private and public transportation rather than by conventional public transit (17, 7).

The major effect of a continued reliance on conventional means of urban transportation would appear to be an increase in the total socioeconomic cost of transportation to the community. This increased socioeconomic cost comprises both the social and the environmental impact on local communities of urban freeways that are constructed and the increases in congestion-related user costs, such as travel time and accident exposure, in those areas where freeway construction is prevented because of its potential nonuser impact.

PRIMARY OBJECTIVES OF NEW URBAN TRANSPORTATION SYSTEMS

To provide an exhaustive list of objectives for new systems of urban transportation would be difficult if not impossible inasmuch as planners consider transportation to be a useful tool to achieve certain community sociological, economic, and physical planning goals as well as to directly satisfy transportation requirements. However, in light of the foregoing discussion of future urban transportation needs, a few primary objectives may be listed:

1. The cost of providing a given level of highway capacity or rapid transit performance should be reduced;
2. The social and environmental impacts of urban roadway facilities should be improved;
3. The user-related attributes of automobile-highway systems should be improved, particularly with regard to travel time and safety;
4. The user-related attributes of public transportation should be improved so that transit more nearly corresponds with automotive transportation and is available to all groups within the population at acceptable cost;
5. Better means of public transportation should be provided for all types of travel within metropolitan areas;
6. Technology should be made available that would make it possible for a community to establish for all members of that community a minimum mobility level, such as being able to travel almost door to door by public transit anywhere within the metropolitan area; and
7. Because of the great economic importance and environmental influence of goods movement within metropolitan areas, provisions should be included for more efficient movement of freight.

SUGGESTED APPROACHES TO A SOLUTION

It may be possible to achieve the previously outlined objectives by an approach to the design of a new system that embraces these design principles: Certain roadway facilities and vehicles should be automated; common roadway facilities should be employed for automobiles, public transit, and freight movement; and these facilities should be integrated into the urban environment by the utilization of techniques of joint development and multiple use.

There are several reasons for automation of roadways and vehicles:

1. Through automation, one intends to achieve greater roadway capacity as measured in vehicles per lane per hour. As a result of this greater capacity, fewer lane-miles of roadway are required to accommodate a given volume of traffic. Thus, fewer additional lanes need to be built in the future, less land needs to be taken for rights-of-way, fewer families need to be displaced, and so on. In some instances, one should be able to make more intensive use of existing rights-of-way and thus lessen additional land acquisition.
2. If the increase in roadway capacity is proportionally greater than the increase in cost due to automation, as one would intend, a cost reduction per unit of roadway capacity is achieved.
3. Automation enables a more stable flow of vehicles at higher operating speeds for a given separation distance. This benefits automobile users through a reduction in travel time and a decreased likelihood of accidents.
4. Automation of transit vehicles enables driverless operation within the confines of the automated network. This enables a saving in driver labor and a consequent reduction in transit operating costs. It also enables one to employ a multiplicity of small vehicles that have improved amenities over current public transit vehicles, that may be routed more directly between origins and destinations, and that do not require passengers to possess driving abilities.
5. Some freight movements should be automated, primarily for economic reasons. Automation would eliminate driver labor for certain types of unmanned freight carriers and reduce driver labor through the reduction in travel time for other types of freight movement where the driver remains aboard.

The reasons for integration of automobile, transit, and freight vehicles include the following:

1. Through economies of scale and elimination of duplications, the financial cost and the social and environmental impacts of construction of a combined facility would be less than the total of those for separate facilities;
2. A community can have a more extensive network of transit facilities than would be economically possible if separate transit facilities were employed;
3. Opportunities are created for flexibility in roadway pricing policy (for example, revenue from sources such as taxes or tolls on automobiles and freight vehicles may be utilized to financially support transit operations;
4. It is desirable, for reasons of social justice and for achievement of a consensus of community support, that new systems offer as much equality as possible in modal performance through the utilization of common facilities.

The principles of joint development and multiple use of transportation rights-of-way with other urban functions have been discussed by others (20) in the context of existing modes of transportation. The advantages of joint development and multiple use are especially applicable to new systems that are automated and that employ common facilities for automobiles, transit, and freight movement.

THE METRO GUIDEWAY SYSTEM CONCEPT

The approaches outlined above, principally those of vehicle-roadway automation and integration of modes, and, to a lesser extent, joint development and multiple use, lead to the Metro Guideway system concept. The Metro Guideway system would provide for the modes of urban transportation discussed below (Fig. 3).

Dual-Mode Automobile Transportation

Privately owned vehicles would be operated on both ordinary roadways and new facilities as directly as possible between origins and destinations; because the new facilities would be automated, dual-mode vehicle designs are required. The convenience and amenities of present automobiles are carried over to this new mode. The intended benefits of the new system to automobile users include reduced travel time, improved reliability of travel time, and improved safety. The intended benefits of dual-mode automobile transportation also include those resulting from more efficient use of rights-of-way, that is, minimization of the negative social and environmental effects of urban freeway construction.

Public Transportation Modes

Personal Rapid Transit—Personal rapid transit involves personalized small vehicles (accommodating 4 to 6 passengers) that would be publicly available at stations and automatically controlled over special roadway facilities within the system network. [In this sense, personal rapid transit corresponds to the generic category of systems labeled NET-2 by Stanford Research Institute (6); the demonstration system under construction at Morgantown, West Virginia (21) does not fall into this category because the system does not provide the personalized accommodations, the direct service, and the speed required for personal rapid transit throughout a metropolitan area.] The intended benefits of this mode derive from the following considerations:

1. The personal public transportation vehicles are sized to provide accommodations for individuals and families or other affined groups and thus extend the privacy and security amenities of automobiles to public transportation;
2. Because the vehicles are small and private, they may be routed directly from an origin station to a destination station without requiring intermediate stops or transfers, thus providing some of the convenience features of private automobiles, as well as higher average speed;
3. Because the vehicles are publicly available at stations within the network, the personal transportation amenities and convenience of this mode are made available to those who are not able to or who choose not to purchase private automotive vehicles; and
4. Because the vehicles are automated, the amenities and convenience of this mode are made available to those who are not able to or who are not trained to or who prefer not to drive automobiles.

Single-Mode Group Rapid Transit—This mode of public transit differs from personal rapid transit in that the group rapid transit vehicles are larger (accommodating 12 seated passengers) and, with the aid of computer routing and scheduling, make multiple stops at off-line stations on the automated roadway to pick up and discharge passengers while other passengers remain on board. [This transportation function corresponds to that which the Morgantown system (21) would provide when its vehicles are operated in single units under demand-responsive control.] When vehicles are shared, operational efficiency is improved and costs are reduced relative to those of personal rapid transit, but some sacrifice in privacy, convenience, and travel time results. In this sense, relation of this mode to the personal rapid transit mode would be analogous to the relation between demand-responsive jitney service (23, pp. 14-39) and conventional taxi service on ordinary streets.

Dual-Mode Group Rapid Transit—Group rapid transit can also be provided by dual-mode, jitney-sized vehicles that are operated on ordinary streets and roadways by professional drivers and on the automated network by automatic controls. Operation off the automated network corresponds to demand-responsive jitney or dial-a-bus service described elsewhere (4, Pt. G; 22; 23). Operation on the automated network is outlined in the preceding section. Algorithms and computer programs developed for allocation and routing of D-J vehicles on ordinary roadways are applicable to dual-mode group rapid transit including travel on both ordinary roadways and the automated network.

Dual-mode group rapid transit would enable high standards of mobility and accessibility to be established for urban public transit. Door-to-door public transportation with minimal transfer requirements would be possible throughout a metropolitan area, and reverse commuting needs could be readily accommodated.

Fixed-Route Transit Via Captive Vehicles—This mode of public transit is by larger vehicles, which may be coupled in trains, and provides fixed-route, frequent service along main lines of the automated network. [This service is similar to that provided by rail rapid transit, intended to be provided by the Westinghouse Sky Bus (24), and demonstrated by new systems such as the one at Morgantown, West Virginia, when operated under fixed-route, fixed-schedule control.]

Dual-Mode Bus Rapid Transit—This form of public transportation has been described (4, Pt. F) but does not currently exist in operational form. Motor coaches (accommodating 24 passengers) would be operated on ordinary roadways by drivers and on automated roadways by automatic control (with or without the driver being on board). Typical operation on the automated roadway would include express service, i.e., nonstop or with a small number of stops for access to major activity centers, and local service on the guideway within such activity centers for collection and distribution functions. The advantages of this mode include the following:

1. Relative to competing modal concepts such as rail rapid transit, bus rapid transit offers the potential advantage of elimination of the transfer requirements between the feeder mode and the rail transit mode and a resultant saving in transfer time and effort;
2. Relative to rail rapid transit, bus rapid transit offers the advantage of reduced travel time through express service (rail rapid transit trains must usually stop at many stations on the trunk line);
3. Relative to present forms of bus rapid transit, the dual-mode version would be more economical in that driver control would not be required (if the driver remained on board, he could devote his attention to other matters such as fare collection); and
4. Automatic control while on the guideway should result in less travel time, less variation in travel time, smoother operation, improved comfort, and greater passenger safety.

Freight Transportation Modes

Dual-Mode Freight Vehicles—The automated roadway would be designed to accommodate dual-mode trucks and vans (up to a maximum size or weight to be determined). The truck drivers would remain on board to resume vehicle control upon exit from the guideway. Economic savings would result from increased speed and the reduced amount of operator labor in the transport of goods.

Captive Freight Service—This mode of transportation provides for unattended movement of various types of freight among freight terminals adjacent to the automated roadway. In comparison with the dual-mode freight operation, the captive freight vehicle operation enables the saving of the total vehicle operator's wage in certain shipping operations. Examples of automated freight operations include shipment of mail among post offices and to and from airports; shipment of parcels from central warehouses to outlying points where they may be transferred to road vans; and shipment of solid wastes from local collection points to compacting facilities prior to rail shipment to disposal sites.

ALTERNATIVE CONFIGURATIONS

Various configurations of the Metro Guideway are possible. The principal difference is among the configurations involving alternative design choices with regard to the following functional subsystems: roadway geometry, network access, lateral guidance, longitudinal guidance, vehicle-roadway interface, propulsion, and network routing and scheduling.

A number of candidate system configurations are being analyzed at the General Motors Research Laboratories. This work is reported separately (25). Some of the elements in these configurations have counterparts in system proposals or experimental investigations by General Motors and other research groups too numerous to acknowledge individually. The intent of this current work is to eliminate or minimize the shortcomings of previously proposed subsystem techniques where possible, to develop new subsystem concepts where necessary or desirable, and to synthesize a practical and preferred system design. In regard to the latter, an evaluation procedure is being employed that is intended to be realistic and comprehensive as to the needs and objectives of the various actor groups in representative metropolitan areas.

PROGRAM OF STUDY

The foregoing discussion has emphasized the great magnitude of future urban transportation facility needs and the multiplicity of impacts that new systems will have on various system users and others in the community. Because of these considerations, it is necessary to analyze and evaluate the Metro Guideway system on a multifaceted basis and to consider technical, economic, environmental, social, and political factors and practical implementation planning.

An analytical case study approach is being followed by the General Motors Research Laboratories. This involves the classification of metropolitan areas, the identification of representative metropolitan areas, the design and analysis of a number of alternative Metro Guideway and conventional system configurations for each representative area, the evaluation and choice of preferred system configurations, and the extrapolation of case study results to the total set of metropolitan areas. This overall process has required the development of a number of new analytical tools.

The selection of case study locales has involved the collection and development of an extensive data base of economic, demographic, geographic, transportation, land use, and other characteristics of all metropolitan areas of the United States. It has also required the development of a new method (26) for the stratification and clustering of metropolitan areas into groups, the members of which are homogeneous with regard to urban area characteristics and with regard to the nature of their urban transportation requirements (Fig. 4). This enables the identification of preferred case study locales on the basis of statistical representativeness and of subjective factors including availability of planning data.

Base-line system definition documentation is being prepared for alternative configurations of the Metro Guideway system. These include design definition to a level of detail adequate for analysis of performance and cost and for specification of the environmental characteristics of the system (including land requirements). These base-line designs are adapted to the needs of the case study metropolitan areas at a future point in time.

A case study that is currently in progress is examining the application of the Metro Guideway concept to the arterial transportation needs of the metropolitan Detroit area as it is expected to appear in 1990. This includes an extensive network of automated roadway facilities: approximately 200 route-miles of dual-lane roadways; 180 sets of entry, exit, and station facilities; and 22 major interchanges among main lines.

The performance of the automated network is being assessed relative to the forecast patterns of travel in the Detroit area in 1990 by means of a digital computer simulation that follows the individual movements of each of the large number of vehicles that are in operation over the network and in the entry and exit areas. This simulation models the configuration design, particularly the software and hardware aspects of network routing, scheduling, and control, in such a manner that the feasibility, performance, and cost of alternative designs of centralized and decentralized methods for such routing, scheduling, and control can be ascertained. The procedures for this simulation effort are described elsewhere (27).

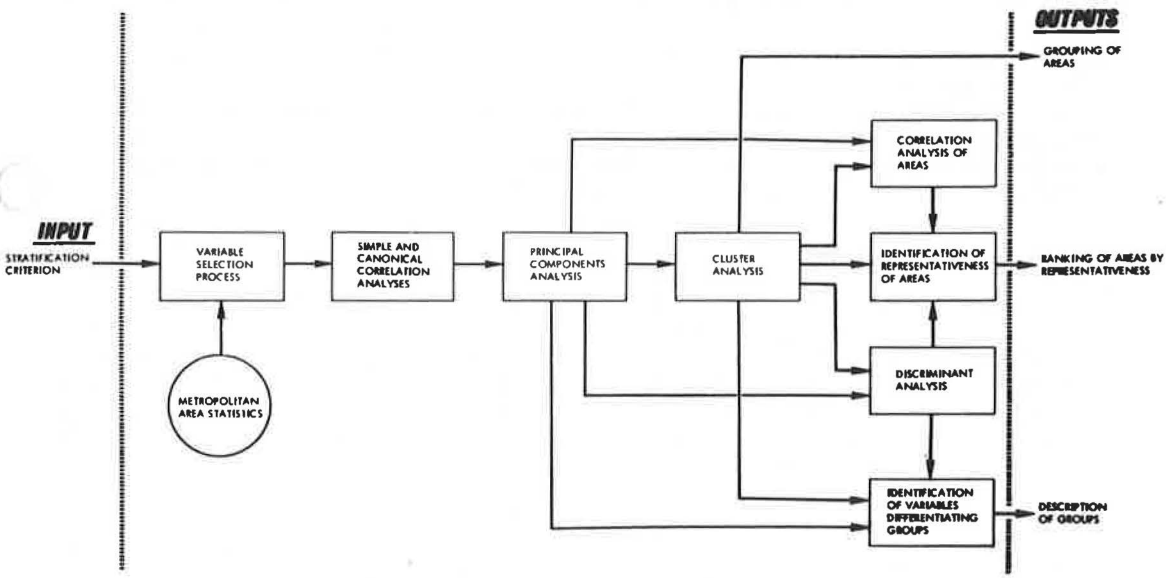
The potential effects of vehicle, roadway, and control mechanization subsystem failures are being investigated by means of 2 approaches. On a microlevel, the performance of various functional subsystems (e.g., lateral control and longitudinal control) is being simulated, during which various types of failures are assumed to occur. On a macrolevel, the network simulation process embodies IBM 2250 graphic consoles by means of which failure mechanisms may be introduced and the effects on network performance (e.g., link shutdown) may be observed and various adaptive strategies evaluated.

As previously indicated, the performance of the alternative Metro Guideway configurations is evaluated and compared with that of planned conventional transportation facilities including urban freeways and public transit. The evaluation and comparison

Figure 3. Metro Guideway functions.

		SINGLE-MODE VEHICLES (VEHICLES CAPTIVE TO GUIDEWAY NETWORK)	DUAL-MODE VEHICLES (OPERATE ON STREETS AND GUIDEWAY)
PRIVATE PASSENGER TRANSPORTATION		———	DUAL-MODE AUTOMOBILES
PUBLIC RAPID TRANSIT	PERSONAL TRANSIT	PERSONAL RAPID TRANSIT	(DUAL-MODE TAXICABS)
	GROUP TRANSIT	MEDIUM-SIZE TRANSIT CARS, DEMAND OPERATED	DUAL-MODE DEMAND JITNEYS
	MASS TRANSIT	MEDIUM-SIZE TRANSIT CARS, TRAIN OPERATED	DUAL-MODE BUS RAPID TRANSIT
FREIGHT TRANSPORTATION		TERMINAL/TERMINAL UNATTENDED CONTAINERS	DUAL-MODE LIGHT VANS

Figure 4. Classification methodology.



involves the analysis of the social and environmental impacts of the various designs on multiple actor groups. For example, estimates have been developed of the amount of land that would be required and the number of families, commercial establishments, and industrial plants that would be displaced by proposed new freeways in the case study area. In a similar manner, the amount and location of land required for off-line stations and dual-mode vehicle entry and exit facilities are being estimated to enable a comparative evaluation of the impacts of the Metro Guideway system. This is part of a process of evaluation that should lead to the identification and specification of the system, if any, that should be preferred and acceptable to the various actor groups in the metropolitan area and that may be implemented in a practical manner within institutional constraints.

Extrapolation of the results from selected case study areas to all metropolitan areas needs to be accomplished both to develop a total market estimate for the new systems and to enable an accounting at the national level of the overall costs and benefits of new system implementation. A method has been formulated and is outlined elsewhere (28) for the structuring and performance of sensitivity analyses and urban characteristic statistical analyses whereby the total market and total socioeconomic impacts may be estimated. Such a procedure is being followed in the Metro Guideway system study.

CONCLUSIONS

The future requirements for transportation within the metropolitan area of the United States are of sufficient magnitude to encourage, if not to demand, consideration of new systems of urban transportation in order to achieve desirable reductions in cost, improvements in performance, and improvements in social and environmental impacts of urban transportation facilities.

A system concept, the Metro Guideway, has been outlined as a potential solution to the transportation requirements of tomorrow's metropolitan areas. Metro Guideway provides for both private automobile vehicles and public transit vehicles on a common roadway network and also includes provisions for freight movement. Vehicles and roadways are automated, including lateral control, longitudinal control, and network routing and scheduling functions. The network accommodates dual-mode automobiles, captive public transit vehicles that provide a personal rapid transit function, dual-mode bus vehicles including demand jitneys, and both dual-mode and captive freight vehicles.

The Metro Guideway system concept is being investigated and evaluated at the General Motors Research Laboratories. A number of alternative configurations are being evaluated at this time. It is currently planned that these analyses and evaluations will be performed in a number of representative areas selected to enable the estimation of the total potential benefits and impacts of the new system and the total national market for subsystems and components.

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