PREFACE (Including License to Download and Restrictions on Distribution) Prepared June, 2008, by the Author, Catherine G. Burke.

In 1979 Lexington Books (belonging to D. C. Heath and Company) published the book "Innovation and Public Policy: The Case of Personal Rapid Transit", based on research, carried on as part of the doctoral program at UCLA from 1973-1977. I had become acquainted with the research on PRT at The Aerospace Corporation, El Segundo, California, and wondered why such a seemingly attractive system was not being adopted.

I examined other research efforts in Japan, England, France and Germany and discovered their research began far more successfully, but in non-transportation agencies. As the projects appeared ready for implementation, the various Ministries and agencies controlling public transport took over the research and there they died. In the U.S., the only potential funding came from the US Department of Transportation or Transit Authorities, so Aerospace was also forced to abandon its highly promising project.

At the time of publication, Lexington Books/D. C. Heath was the copyright holder. Aerospace Corporation, MITI in Japan, Cabinentaxi in Germany, and MATRA in France gave me permission to use their photos and maps which were also part of the copyright. Several years later when the book went out of print, D. C. Heath assigned the copyright to me. At the time the book was published I waived my royalty rights to keep the price of the book at a minimum so that even impecunious students could afford it. I personally bought the remaining copies of the book which were given to interested parties and to College and University Libraries at a price that simply covered my costs.

I believe that Personal Rapid Transit (PRT) is the wave of the future, with its many benefits to the rider. It will be safe, rapid, private, and comfortable. It will be fully accessible to the physically handicapped, the elderly and young people without a car - at a reasonable cost. In the urban landscape, it is sized and automated for low capital and operating costs and designed to reduce congestion, pollution and noise. Its footprint would also contribute to optimal land use. Therefore, my purpose is to have the book read as widely as possible, because if enough readers feel as strongly as I do about the virtues of PRT, they could become the constituency which will stimulate the development and widespread installation of PRT systems.

For all these reasons, I am happy to have the **Advanced Transit Association** publish the book on the Internet. My consent Is conditional to the attachment of this Preface to the beginning of each installment, inasmuch as it grants the right to download, duplicate, and distribute the book subject to certain restrictions stated in the next paragraph.

Although the book was published in 1979, the issues and the analyses made then are still valid today--with the exception that costs have changed considerably over the nearly 30 years since publication. Some costs have come down like those of computer and control systems. Vehicle costs have risen, but possibly less than average costs because of the high degree of automation in their manufacture. The dominant costs, however, were guideway costs, and these might be considerably higher today than in 1979. Operating costs will also be higher, because of the labor costs in operation, maintenance, security and the higher prices for electricity.

Of course costs of building trains and buses have also risen to a great extent, so comparisons of PRT with rail and bus systems strengthen the case for PRT. The rising price of oil and gasoline reinforce the appeal of PRT as far less costly than driving an automobile.

Current cost estimates can be found on a number of web sites; the most comprehensive is maintained by Dr. Jerry Schneider at Innovative Transportation Technologies, http://faculty.washington.edu/jbs/itrans/ and by the Advanced Transit Association, http://www.advancedtransit.org/news.aspx

Because the book is about innovation and the problems in bringing a dramatically new technology on line, chapter six developed a model involving the degree of change based on the impact on different individuals and organizations. The model shows 4 levels of change, while more recent research indicates there should be five such levels. The additional level belongs in the middle just above the current level 2.

Any questions related to the downloading, the fonts to be used, the availability of installments, or questions related to the current status of PRT should be addressed to Bob Dunning at e-mail address: bob.dunning@gmail.com. Any questions regarding content may be addressed to the author. Requests to use any part of the book in a manner that does not conform to the license granted above should be addressed to the author at e-mail address: cburke@advancedtransit.net. -- Dr. Catherine Burke

Innovation and Public Policy

Catherine G. Burke

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Dr. Jack Irving and other members of the Aerospace Corporation, Urban Systems Division, were especially generous with their time and data. Others deserving particular thanks include Dr. Hermann Zemlin, former director of the Ministry of Research and Technology, Federal Republic of Germany; Dr. Yoshio Tsukio of Nagoya University and Dr. Takemochi Ishii of the University of Tokyo; Gérard Lévy, *Aramis* project manager, Engins Matra; Roy C. Baker of the British Aerospace Dynamics Group; Dr. J. Edward Anderson of the University of Minnesota; and Dr. Gretchen Kolsrud of the Congressional Office of Technology Assessment.

All these people, and many others, not only supplied their own views and data but also advised the author regarding who should be interviewed, often offering to introduce the author to people who might have been unwilling to speak freely to a stranger. There were far too many respondents to list them all, but the author is most grateful for their help. Most interviews are specifically acknowledged in the text, but in a few instances respondents requested that their name not be associated with particular statements, and the author has honored their wishes.

The author has also drawn on notes and observations made during personal participation in some of the transportation planning activities that have taken place in California and particularly Los Angeles. Because of this involvement, the author can make no claim to scholarly detachment. Rather than attempting a neutral stance, the author has endeavored to present a variety of perspectives on the issues to demonstrate the complexities of political reality and the problems of technological innovation. The final result is in part participant history and in part more traditional research and analysis. Responsibility for inaccuracies and interpretation is, of course, solely the author's.

John C. Ries and Gerald Caiden made many perceptive comments on an earlier draft of this book. Their suggestions were very helpful and contributed to whatever clarity in presentation the author managed to attain. William R. Burke and Catherine L. Graeffe gave special assistance and support that made the entire study possible.

It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things. For the initiator has the enmity of all who would profit by the preservation of the old institutions and merely lukewarm defenders in those who would gain by the new ones. The hesitation of the latter arises in part from the fear of their adversaries, who have the laws on their side, and in part from the general skepticism of mankind which does not really believe in an innovation until experience proves its value. So it happens that whenever his enemies have occasion to attack the innovator they do so with the passion of partisans, while the others defend him sluggishly so that the innovator and his party alike are vulnerable.

—Machiavelli, *The Prince* (1513)

Part I
Politics, Innovation, and Transportation

1 Introduction

The Problem of Innovation

There is a common cliché that expresses much of the frustration we commonly feel when confronted with our inability to solve some of the most urgent public problems of our time: "If we can put a man on the moon, why can't we . . . move people from home to work more effectively, find a cure for cancer, supply pollution-free energy, destroy the roots of poverty, make our cities more livable, build decent housing for everyone, and so forth?"

It matters little which public problem we select, there is a nagging feeling that we could do better—that there must be a better way to solve these pressing social issues. The cliché which answers these questions says: "It is easy to get a man to the moon; that is purely a technical problem. The problems you mention are social and political and therefore much more complex and difficult to solve."

There is an element of truth to this answer, but it ignores the fact that getting a man to the moon was a political as well as a technical problem and that many domestic social problems have technological components as well as political dimensions.[1] Almost every public service requires some aspect of technological expertise, and whether the scope for technology is limited or extensive, it is subject to manipulation, improvement, and innovation.

The real difference may be that space technology was entering into a new field. It initiated a new industry. Most of our pressing domestic issues are centered in existing arenas of power and influence dominated by older organizations and technologies, as expressed by Harvey Brooks: "Technology seems to progress most successfully when it fills a vacuum and to encounter the greatest resistance when it tries to penetrate an existing technostructure. It is this factor which makes innovation in the civilian sector most difficult."[2]

It is the nature of these difficulties that is of particular interest, as there appear to be particular public policy areas where technological innovation shows promise of making significant improvements in our lives. In making such a statement, one risks accusations of seeking a quick "fix" or a technological panacea. We seem to have gone full circle in our thinking, from blind acceptance of technology as progress to an automatic rejection of technology as a dehumanizing, enslaving force. Both of these approaches appear inadequate to the author, and they do not allow useful analysis of the issues surrounding technological innovation.

This book is based on the premise that in some instances we can make things better through the application of new technologies. Such a limited claim can be illustrated with the automobile. Auto makers have argued for years that it is not the automobile itself that is the problem, but "the nut behind the wheel." It is the human factor—not the technological factor—that is to blame for the high number of automobile-related deaths and injuries.

It can be shown, however, that better equipment can be developed and that it may save lives. In 1965, the year Congress passed auto safety legislation, 49,163 people died in motor vehicle accidents. In 1973, 56,000 died on the highways, but there were more people on those highways, and they were traveling farther. The National Highway Transportation Safety Administration estimates that if motorists were still dying at the same rate per mile as in 1965, more than 70,000 would have died in traffic accidents in 1973. For the first 7 months of 1974, the figure would have been 40,000 instead of the actual 24,661.[3]

Whereas it is not possible to demonstrate that better safety features in automobiles caused a reduction in potential fatalities, there is at least presumptive evidence that technological safety innovations kept a bad situation from becoming worse. In this case and in the case of other public problems, we may be able to benefit from technological innovation.

To the extent this is true, it then becomes interesting to inquire why such innovations are not applied. Why do we have such difficulty developing and applying new technologies to social problems? What are the conditions and constraints that hamper technological innovation? What are the forces that promote it? Why does it happen so often that when technological innovations are applied to public problems, they are employed so inappropriately, or done so clumsily, that the critics of technology and innovation have ample cases to prove their point?

The case of personal rapid transit is used as an illustration of one of a large class of domestic public policy issues that are characterized by a major technological component that must be a part of their description, analysis, and resolution. Other examples from the class include energy generation, pollution control, use of resources, housing, medical care, airports and air traffic control, waste disposal, information collection and retrieval, road construction, crime control, and a myriad of policies that fall under the general rubric of "the urban problem."

In this class of policies, technical issues are deeply intertwined with mechanisms of political and bureaucratic choice, as W. Lambright expresses:

> From the beginning to end, programs are implemented in a political environment. Political opposition can serve to enlarge the technological barriers by creating more stringent design specifications as the price of acceptance, while political support can remove technological barriers by easing the performance requirements. Technology and politics interact throughout the development cycle.[4]

Existing technologies support and are supported by the existing balance of organizational and political forces. New technologies offer differing threats and opportunities to different actors in the system and are thus part of a power equation that determines which choices ultimately are made.

Because of the many political actors involved and the absence of a government with sole responsibility for the transit problem, it is an extremely complex case in political decision making. At the local level the decisions must be made on a metropolitan basis due to the nature of the problem. In addition, the federal government has now chosen to intervene in the situation, creating new and largely unexamined relationships in the intergovernmental relations.

This book explores some new territory, which should be illustrative of other urban public problems in the future. As these political/technical issues become a more significant part of the public policy process, they demand greater attention and scrutiny. We can no longer dismiss the technological component of our policy processes as the sole province of the technical expert.

Political scientists must examine the political processes of technological innovation to enlarge our understanding and perhaps give a broader perspective to these processes. By understanding the dynamics of a particular policy function, it is hoped greater light will be shed on the more general interactions of public policy processes. Lambright discusses the federal government's new role in these processes:

> Since World War II the federal government has become a dominant force behind scientific and technological change in the United States. Private sector organizations perform most of the nation's technical work, but government increasingly provides research and development (R & D) resources and policy direction.[5]

Whereas the bulk of this research has been directed toward defense, space exploration, medical science, and the development of atomic energy, government is now responding to different pressures and moving into other areas of technological development such as housing, transportation, alternative energy sources, and so forth. Despite this change, there is little in political theory or research to explain how these policies are set and which directions are chosen. Technological innovation does not just happen. It is the result of human policy processes of decision and choice.

Political science has been concerned with questions of innovation and public policy, but there is a lack of connecting relationships posited between variables within the innovative process and variables of the political process that have impact on the innovative process. Yet one can scarcely talk with an official involved in transportation, or housing, or environmental protection without being informed of the "institution problem" that confronts him or her:

> When one asks the administrator . . . why better technology is not introduced to housing, transportation or pollution control, the answer

> is invariably "the institutional constraints." Institutional constraints are often used as a euphemism for politics—the democratic politics that provide access for a variety of groups capable of erecting roadblocks to new urban technologies.[6]

It is the nature of the institutional problem, the relationship between technological innovation and politics, which is the primary concern of this book.

Personal Rapid Transit

The case of personal rapid transit (PRT) has been examined as a means of illuminating the relationships between politics and innovation. A technological innovation was chosen for several reasons.

1. Once the innovation is clearly defined, it will be easy to know what it is we are talking about:

> . . . (It) rests upon mechanical devices. It therefore presents for study a concrete, durable situation. It is not like many other innovating reagents—a Manichean heresy, or Marxism, or the views of Sigmund Freud—that can be shoved and hauled out of shape by contending forces or conflicting prejudices. At all times we know exactly what (it) is.[7]

As we shall see, even a technical concept such as personal rapid transit can be distorted by contending forces, but it will still be possible to discern the variations that are introduced, the key elements of the actual system of concern, and the varying systems that from time to time assume its name.

2. As noted earlier, many of our public policy issues contain within them a technological component. This is not commonly noted in the literature (perhaps it seems too obvious), and the idea of technological choice and its consequences are even more rarely examined. One of the objectives of this study is to clarify the concept of technological innovation, examine its various meanings, and suggest more fruitful ways for analyzing its content and consequences.

3. Personal rapid transit appears to be a promising idea for improving public transit which has to this date been rejected. The reasons for this rejection and the political as well as technological hurdles new ideas must face are therefore clearly delineated. This delineation sheds considerable light on the political innovation process.

4. Personal rapid transit is what shall later be defined as a revolutionary innovation, comparable in many ways to Kuhn's idea of revolutionary change in science. This will be elaborated on in chapter 6.

Briefly, personal rapid transit is a small (four-to-six-passenger) private car, which operates on a slim monorail-like guideway, like a driverless taxi. It is electric, automatic, and operates nonstop from origin to destination. It might look something like the picture shown in figure 1-1. It is patterned after the automobile, retaining the auto's desirable features while excluding its undesirable ones. It offers private service to the individual (vehicles are only shared when small groups wish to travel together, such as friends and families); every passenger is seated; it is on call continuously 24 hours a day, 7 days a week; it travels directly from origin to destination, does not stop for other passengers, and can take alternate routes.

From a social perspective, it does not pollute; parking is not required; it requires little or no at-grade right-of-way; it prevents congestion with its automation; it is virtually accident-free, offers mobility to those who cannot drive automobiles, does not divide communities, and uses little energy and few earth resources.

A typical network in the Los Angeles area might look something like the system shown in figure 1-2. This represents only a rough calculation to show what might be built for half the cost of rail rapid transit proposals that were put forward in 1974 and 1976. This type of system takes into account the declining importance of central downtown areas and reflects the myriad of origins and destinations that now exist in major metropolitan areas.

It is a system of modular design, which can be built one segment at a time. Small communities, shopping centers, universities, and industrial parks could build their own small circulation networks, which could later tie into a regional network.

The user of the system enters through stations such as the one shown in figure 1-3, which can be as close as two blocks apart in densely populated areas, up to .5 miles apart in outlying areas (making a maximum walk of .25 miles to any station). In the station one selects a destination at a computer terminal, enters the vehicle, which is coded with the destination, and travels there by the quickest route at speeds that may vary from 20 to 60 miles per hour depending on distances and areas. All stations are on sidings off the main line, so there is no waiting for other people at intervening stops.

This concept will be analyzed more fully in later chapters, and the controversy surrounding it will be explored thoroughly. This abbreviated description is presented to give the reader a preliminary understanding of the concept to make what follows comprehensible. Because some of the terminology used in this book is peculiar to the transit industry, a glossary of terms and abbreviations is provided at the end of the book.

Objectives and Methods

One objective of this book is to present a theoretical framework in which the processes of technological innovation are linked with political processes. To do this it is necessary to define carefully ideas of technology and innovation and to

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Figure 1-1. PRT Model Superimposed on City Street.

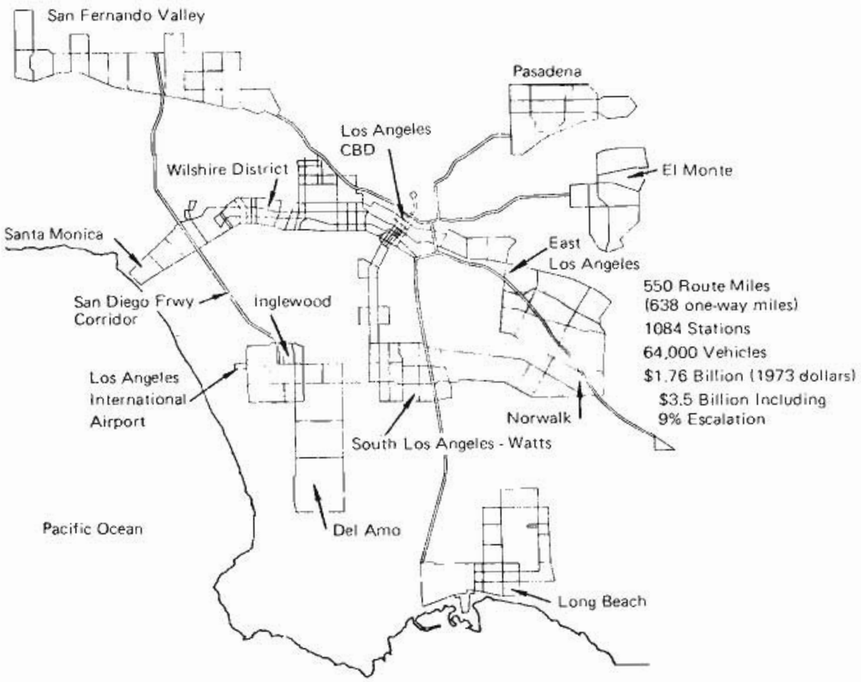

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Figure 1-2. Typical PRT Network for Los Angeles Region.

classify various types of innovation. Political systems must also be examined to consider possible links between politics and innovation. This is done in chapter 2.

A second objective is to review the history and development of urban transportation problems along with proposed alternative solutions, to clarify the existing situation. These issues are discussed in chapters 3 and 4 and help to delineate the problems the developers of personal rapid transit were trying to solve.

The third objective of the book is to examine the case of personal rapid transit and to report what happened as fully and accurately as possible. This was not an easy task, as much of the research focused on bureaucratic behavior, which is difficult to quantify with present instruments. Many decisions are made informally, perhaps even subconsciously, and often in conditions that are essentially secret. The importance of any given decision to the total outcome may not be apparent–even to those most intimately involved in the situation.

Later, when reporting on this rather vague and elusive process, people's memories may fail, or they may be distorted. Later events impinge on earlier

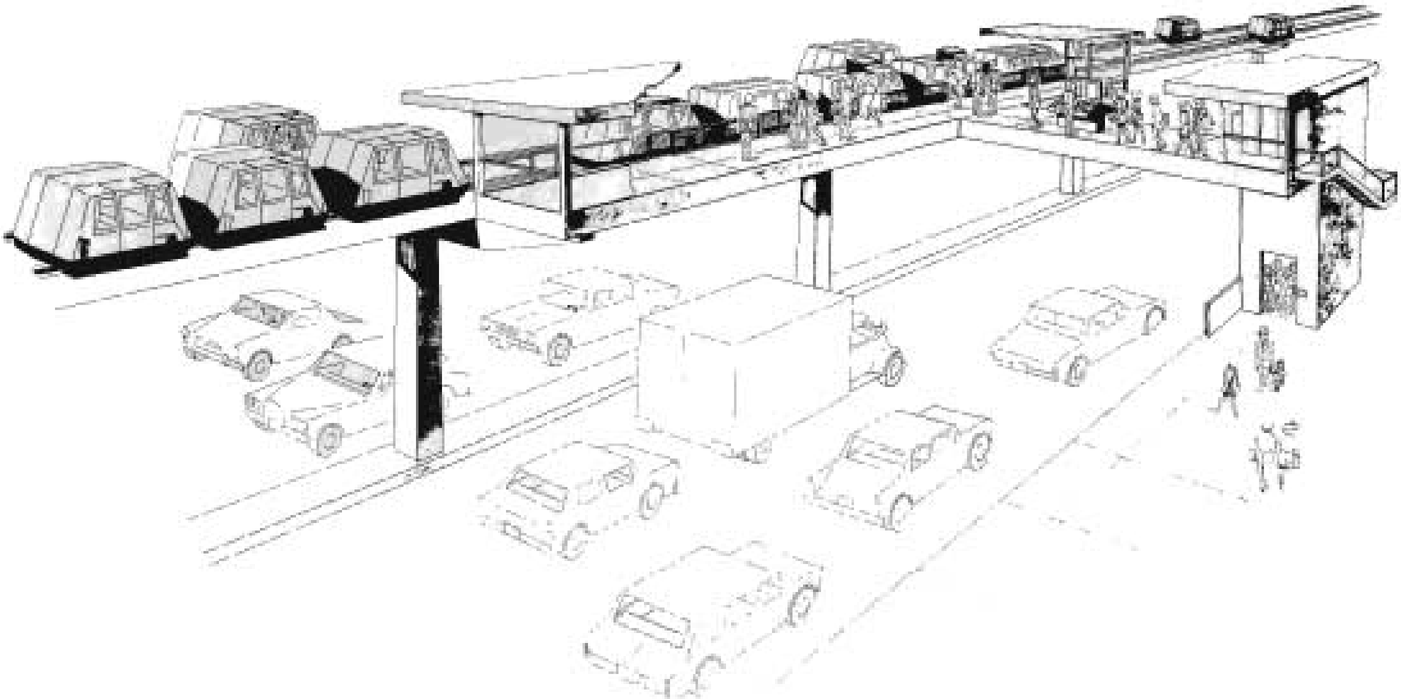

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Figure 1-3. Representative PRT Station.

events, changing their meaning. The uncertainty faced at an earlier time, the false starts, the unsuccessful steps, the illogical and nonrational elements, all may have influenced the final outcome, but they may no longer be communicable, unless there is documentation recording them.

There is a tendency to want to view one's positions as being essentially consistent, therefore earlier events are made to conform to today's situation. Unpleasant events are often forgotten, or at least the interviewer is told they are forgotten.

Yet, even while acknowledging these difficulties, every effort was made to get the facts straight. What has been captured through personal observation and interviews really did happen, but it is almost certainly not all that happened. The so-called facts reported are simplified and cannot convey the total reality as experienced by the actors at the time. It is an inherent problem in this type of research that one must rely on the perceptions and memories of the actors in the process. Some of these can be documented from congressional testimony, agency reports, published articles, and private correspondence and files.

Even with such documentation, murky areas still remain where different people remember key incidents differently. There is a Rashomon effect, wherein the perspectives, the personal ambitions, and subsequent events give rise to different facts, and different interpretations of the facts.

In these cases, one tries to get the outline of the event based on the areas of agreement. There are common threads that tie the accounts together, and differing interpretations are reported to illustrate how different actors, operating in different role-and organization-sets perceived reality. Ultimately, however, there will not be agreement on everything. Therefore some individuals who were intimately connected with the events discussed are sure to find some so-called facts to dispute.

This is inevitable in a complex situation in which all participants have only a partial view of reality. It also reflects the continuing debate regarding the issue of PRT and that careers and the success of a variety of organizations are related to the outcome. Certainly the current situation has to color the recollections of earlier events.

Despite all these caveats, however, there was a remarkable consistency on the main thrust of events. The details that may be disputed were far overshadowed by large areas of agreement. This consistency, which transcended time and place, gives the researcher more confidence in the validity of the data generated.

Chapters 5 through 7 report on the experiences with PRT at the federal level of government, and chapters 8 through 12 examine events as they occurred in four cities in the United States. Chapter 13 deals briefly with the experiences of England, France, Germany, and Japan, which contrast sharply with those in the United States. Their successes and failures offer considerable insight into the nature of the American experience and the larger meanings that attach to it.

Chapter 14 reexamines the issues raised and draws some conclusions regarding political processes and technological innovation. Some generalizations are suggested regarding the innovation process as it takes place in American governmental institutions, and the political conditions that accompany, shape, and determine its outcomes are delineated.

2 Politics, Technology, and Innovation

The significance of technology, invention, and innovation in human affairs has generated considerable controversy. The proper role—or roles—of government in dealing with technological innovation has changed as attitudes toward technology have changed. Nowhere are competing views more acutely confronted than in "technoscience" agencies—the science-and-technology-intensive agencies that link scientists and technologists to public policy. The Department of Defense, the National Aeronautics and Space Administration, and the National Science Foundation are all obvious examples.[1]

Although much less influential, with far fewer dollars to spend, the Urban Mass Transportation Administration can also be classed as a technoscience agency. All these agencies have an essential difficulty where technical judgments regarding what can be done mingle with political and value questions of what should be done. Problems of technical feasibility merge into problems of political feasibility.

It is important therefore to understand the political context in which technical and policy decisions are made. It is equally important to have clear concepts of technology and innovation to see how these may affect and be affected by government and public policy. This chapter presents a framework for political analysis and relates it to issues of urban transportation. This is followed by a discussion of technology and innovation in which patterns are suggested that link technological innovation with political processes.

Political Subsystems

In the United States today public policy is a product of interlocking networks of organizations, whose activities focus on particular problems. Such networks, termed "political subsystems," are made up of administrative agencies, legislative committees, special interest organizations, trade press, and lobbyists concerned with a particular area of program specialization.[2] Political subsystems can include a number of different governmental agencies and cross federal, state, and local levels of government.

Operationally it is useful to think of subsystem politics as involving those who spend all or most of their time dealing with a particular issue or cluster of issues such as agriculture, urban transportation, defense, energy, and so forth. Such subsystems deal, on an everyday basis, with particular issues, develop certain methods of operation, and create a balance of competing interests within their narrow confines.

Macropolitical Systems

E.S. Redford defined macropolitics as follows: "Macropolitics is produced when the community at large and the leaders of the government as a whole are brought into the discussion and determination of policy."[3] The distinguishing characteristic of macropolitics is the breadth of involvement. Depending on which level of government is of interest, the president, the governor, or the mayor will be involved. At the federal level, congressional leaders, cabinet officers, and political parties will respond to broad demands made through "public discussion, ballots, individual contacts, group representation, action by administrative agencies, demonstrations, and civil disobedience. . . ."[4] Environmental factors such as ". . . episodes (the Cuban missile crisis), a technological development, a shortage in a basic resource, a failure in or threat to the economic system, a change in belief patterns, and other like factors . . ." can command macropolitical attention.[5]

Macropolitics involves actors who have a broad range of policy responsibilities as opposed to the more narrow range of those involved in subsystem policies. Macropolitical actors become involved in subsystem issues when these issues come to public attention through a crisis, new public demands, or through appeals from those who cannot achieve their purposes because of the stable relationships within a particular subsystem.

The macropolitical system takes into account broader public interests and offers different perspectives, which may have impact on subsystem politics. Although macropolitical actors cannot pay continuous attention to all the issues that are resolved within political subsystems, they can pay attention to selected issues as the need arises. Identifying when and how such selective attention takes place is of particular significance to issues of innovation.

Domains—Consensus and Conflict

At all levels, whether macropolitical, subsystem, or individual agency, each entity has a recognized domain or policy space.[6] A domain is "a set of expectations both for members of an organization and for others with whom they interact, about what an organization will and will not do."[7] It defines the operational goals of the organization and gives some picture of what the organization is about.

The concept of domain is useful because it allows one to recognize the multiple goals, or missions, an organization may pursue simultaneously. It also includes a number of ideas that go beyond the simple idea of organizational goals. It includes the organization's definition of the situation, the nature of the problems to be solved, the methods to be used (technology), the important issues to be faced, and most importantly for this study, it helps to determine the ways in which new ideas are perceived.

The idea of domain also makes clear that there can be disagreements about its nature for any particular organization. Conflicting demands, whether generated from the environment or internally, create domain conflict. Clients may seek different services, suppliers more profitable or safer domains, congressional committees new programs, or members of the environment seek to define the domain as illegitimate.

Within the organization there may be disputes as the concept of domain moves from the general level of the organization down through subsystems, work groups, and individuals. The specific domains for each level may be disputed; there may be conflicting views over the appropriateness of particular domains; or interdepartmental rivalries and communications difficulties may develop as different individuals and subsystems attend to one or more of the overall system's multiple goals.

Domain consensus exists when most of the people inside the organization and those with whom it interacts generally agree regarding these expectations. In the case of the Urban Mass Transportation Administration (UMTA), there is general agreement that they are concerned with problems of urban public transportation, whereas the Federal Highway Administration (FHWA) is concerned with the construction and maintenance of highways throughout the country. Within this broad area of agreement, however, there can be a variety of conflicts. In the case of UMTA there has been more domain conflict than in the case of FHWA, as competing elements of the subsystem vie for UMTA's more limited funds.

Another important source of domain consensus or conflict is found in the legal authority that legitimates an organization's claims for activities, which gives the organization the right and the responsibility to carry out programs of a certain kind dealing with a broad problem area. The authority of the Congress and the president is based in the Constitution, which builds in domain conflict through the sharing of certain powers and policy space.

The domains of other public organizations at the federal level are determined in the legislation which creates them, the interpretation of that legislation as published in the Federal Register, as well as in the day-to-day operations of the organization as it gets feedback from its environment regarding what is appropriate and effective behavior. At each level of interpretation, there is a continuing possibility for domain conflict to develop. Overlapping domains, shared powers, and conflicting domains may all lead to dissensus.

Domain consensus, on the other hand, implies not only internal consensus but also environmental support. Such support is essential for the maintenance and defense of the organization's policy space. Whereas private organizations maintain support by changing to meet market demands, public organizations maintain support by protecting their domains. A domain might be compared to the private organization's share of market. Governmental authority to conduct activities is generally assumed to imply a claim on money adequate to performance of the prescribed activities, just as the private firm's share of market allows it to earn money from the sale of its product or service.

Public organizations try not to change products and services—or programs and policies—for fear of endangering existing support and having to develop new support from different environmental sources. "The result may be an organization with established operations, resistant to most change."[8]

The Power Setting

The sources of organizational support (and competition) come from other organizations within their own political subsystem and from other organizational networks. Taken together, these form the public organization's power setting—those actors who exert, or can exert, immediate influence on the organization. In the case of a U.S. federal agency, the following seem to be the main actors.

1. Controllers: those who hold formal authority to regulate the resources or activities of an agency. There are three major subtypes:

    a. Higher authorities: those holding direct responsibility for one or more aspects of the organization's resources or activities. For most federal agencies the higher authorities are the White House, the relevant appropriations and legislative committees and subcommittees of Congress, and the Office of Management and the Budget, which is technically part of the White House.
    b. Monitors: controlling bodies whose authority is limited mainly to inspecting, auditing, evaluating, or reporting on an agency's performance and expenditures. The most powerful monitor in the U.S. government is the General Accounting Office (GAO), an arm of Congress.
    c. Regulators: agencies involved in environmental protection, regional and local planning, zoning, civil rights and affirmative action, and in some cases rate regulation. They act as a constraint on organizational behavior when their rules must be taken into account.

2. Clientele groups: those who receive or benefit from the goods or services of an organization, including suppliers who stand to gain by furnishing raw materials and other resources.

3. Constituencies: individuals or groups outside an organization with an interest in but no formal power over its activities. The most common variety is the interest group.
4. Allies: individuals or organizations willing to support the agency in some specific debate, conflict, or campaign.
5. Adversaries: individuals or groups impeding the organization's ability to pursue its goals, including rivals, opponents, or enemies.[9]

Network Patterns and Relationships

When examining an agency's power setting, it is immediately apparent that it may be powerful in relationship to some organizations and weak in relation to others. The resources that essentially determine where agencies are powerful and where dependent are money and authority.

Congress is powerful in relation to UMTA because it has the authority to determine its domain and to appropriate money to maintain that domain. UMTA in turn is powerful in relation to local transit operators to the extent they must depend on UMTA for financial support. Power and dependency are, in some senses, the opposite sides of the same coin.[10] UMTA is powerful in relation to the transit agencies because it supplies a resource they need—one which is not readily available from other sources. UMTA is also dependent on these same transit operators to perform well, since UMTA has no authority to operate transit systems. Good performance from the operators plus their support for UMTA with Congress helps UMTA get additional funds and thus become more powerful.

In organizational networks, some organizations may be dominant because of their centrality in the network. They may provide services vital to all or to a large number of organizations in the network. Other organizations may be powerful because they are able to mobilize forces external to the network as a means of controlling resources within it.[11]

Thus within organizational networks, particular agencies have legitimated domains, or authority, allowing them to act and to demand resources, concurrences, clearances, and coordination from other elements in the network. They also have varying levels of money, which is a fundamental resource linking the network. Finally, organizations are linked by personal relationships, professional expertise, and information, which cannot be purchased but which may have significant effects on policies.

With these elements, organizational networks develop patterns, which help to explain organizational behavior and policy outcomes. Six patterns seem to be of particular significance:

1. Resource concentration/dispersion is the extent to which control over resource disbursements to the network resides finally in one or a few participants.
2. Power concentration/dispersion is the extent to which some participants in the environment dominate others.
3. Network autonomy/dependence is the extent to which the network is controlled by environmental forces.
4. Environmental dominance patterns can be equated with the types of participants exercising power in the environment, for example, bureaucracies or publics such as racial or clientele groups.
5. Resource abundance/scarcity.
6. Control mechanisms, incentive vs. authoritative means of control.[12]

Environmental Conditions

These network patterns can exist within a variety of environmental conditions. Many networks exist in relatively stable and unchanging environments. This is becoming less common, however, as rapid social, economic, political, and technological changes coupled with complex environmental interactions create turbulent environments that are uncertain and unpredictable.[13]

When political actors encounter either stable or turbulent environments, their perceptions of opportunity and threat may influence their behavior regarding public policy. Some environments may be perceived as being malleable—susceptible to control and change. These same environments may be perceived by others to be essentially rigid—not susceptible to control or directed change.[14]

Organizational Politics

People operate in a situation where the nature of most problems permits "fundamental disagreement among reasonable men concerning what ought to be done. Analyses yield conflicting recommendations."[15] Hundreds of issues compete for their attention everyday, and attention may be more important than the power and skill of proponents of particular actions.[16]

People in organizations have parochial priorities, perceptions, and issues. Attention is directed by the position from which questions such as "What is the issue?" and "What must be done?" are considered. The problem faced by the decision maker in the game of bureaucratic politics may be quite different from the problem focused on by the analyst.

The environment is often perceived to be highly uncertain, yet something must be done with high stakes in organizational, reputational, and personal terms. Not only are questions of larger public interest considered, but the effects on one's organization, one's own position in the organization or a profession, and the welfare of friends are also important.

Also, as G.T. Allison put it: "[m] oreover each person comes to his position with baggage in tow, including sensitivities to certain issues, commitments to various programs, and personal standing and debts with groups in the society."[17] At higher levels of organizations, people not only serve in organizational roles, they also try to shape the organization's operating goals to be more consonant with their own goals.[18]

Such goals do not have to be personal in nature, although they frequently include the idea of becoming more important and more powerful oneself—the desire to be somebody. They may also, however, have to do with increasing the organization's power in its environment or advancing a particular cause such as promoting mass transit in cities—the desire to do something.

Thus different actors, with different goals, may operate in the same organizational position in different ways. Judgments are made regarding what is politically feasible, and what ought to be done is frequently tempered by perceptions of what can be done. Political feasibility is a highly subjective judgment, and what is perceived by one person as an opportunity may be seen by another as a constraint.

In making such judgments, organizational actors are subject to criteria of rationality. They seek desired outcomes on the basis of beliefs about cause-effect relationships. They use analysis to explain and justify actions and policies. If something is done, there must be a reason for it. The distinctions among reasonable, sensible, and rational are difficult to draw in everyday language, and some decisions are justified as being made on a rational analytical basis when the analysis is tenuous at best. Nonetheless it is important to be able to justify actions and behavior on the basis of a rational decision process.

Such processes develop into routines as organizations develop a repertoire of outputs, which they can activate at any given time in response to internal or external stimuli. The repertoire is based on the domain of the organization, and it limits what the organization can do at any given time. It limits the options available when a particular problem is presented.

Different organizations within a particular subsystem perceive problems, process information, and perform a wide range of actions in their own way, which is likely to differ from other organizations ostensibly dealing with the same or similar problems. What is viewed as a problem or a crisis by one agency may be seen as an opportunity for expansion of its domain by another.

As Allison wrote: "[1] earning and change follow in large part from existing procedures."[19] Change is most likely to occur in periods of budgetary feast, when there are more resources to expand operations, during prolonged budgetary famine, which may force major retrenchment, and when there is a dramatic performance failure. Major disasters activate the macropolitical system and cause the higher authorities to demand change. People inside the organization become less resistant to change; and key members of the organization are likely to be shifted, bringing in new members committed to change.

The Urban Transportation Network

The urban transportation network is characterized by a multiplicity of organizations across all levels of government. Typically, different organizational units have responsibility for different modes of transportation. Highways, transit, airports, and other means of moving people and goods are handled by different organizations within a level of government and between levels of government. The same is true for the planning, financing, implementation, and regulatory activities of even a single mode.

The number of units involved in any particular mode or decision varies from region to region. One recent survey found as few as 11 governmental units within one of the 218 federally recognized urban transportation planning regions, whereas the largest region had over 500.[20]

Federal Agencies

From the perspective of intraurban public transportation, the two key federal agencies are the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA). (See figure 2-1.) HUD and other agencies of the Department of Transportation (DOT), such as the Federal Aviation Administration (FAA) or the Federal Railway Administration (FRA) which are not shown are more competitors for time, money, and attention rather than key actors in the urban transportation subsystem.

This subsystem is, in reality, made up of two separate but partially overlapping subsystems. Both occupy the same policy space to the extent they attempt to supply urban transportation solutions. They compete for funding (to a limited degree), and some of the same actors occupy roles that function in both subsystems. Figure 2-1 identifies most of the significant organizational actors in both the highway subsystem and the public transit subsystem, as well as indicating some of their important relationships.

The FHWA operates under a series of authorizing laws; its major purposes are to build federal highways and federal-aid highways as well as a concern for highway safety and motor carrier safety. FHWA also claims a desire to coordinate highways with other modes of transportation "to achieve the most effective balance of transportation systems and facilities under cohesive Federal transportation policies. . . ."[21] A key function is to administer the federal highway trust fund, and one of its prime objectives has been and continues to be the protection of that trust fund from encroachment by other interests—especially mass transit interests.

This continuing and assured source of funds gives the FHWA a very powerful position, since it does not have to justify its expenditures or seek funds from Congress annually. With this long-term funding base, FHWA has developed and maintained strong and long-standing relationships with the state highway departments, or departments of transportation, which have primary responsibility for highway planning and construction within their respective jurisdictions. With a personnel ceiling of 5,035 in 1976, FHWA has been able to maintain large field offices for many years, which also strengthens its relationships with state highway departments.

This highway subsystem has an enormous amount of money to spend with the federal government collecting over $7 billion for highway expenditures, while state governments collected more than $15 billion in 1975. When local governments are included, more than $28 billion were collected, and $26 billion was spent for highway purposes in 1975.[22]

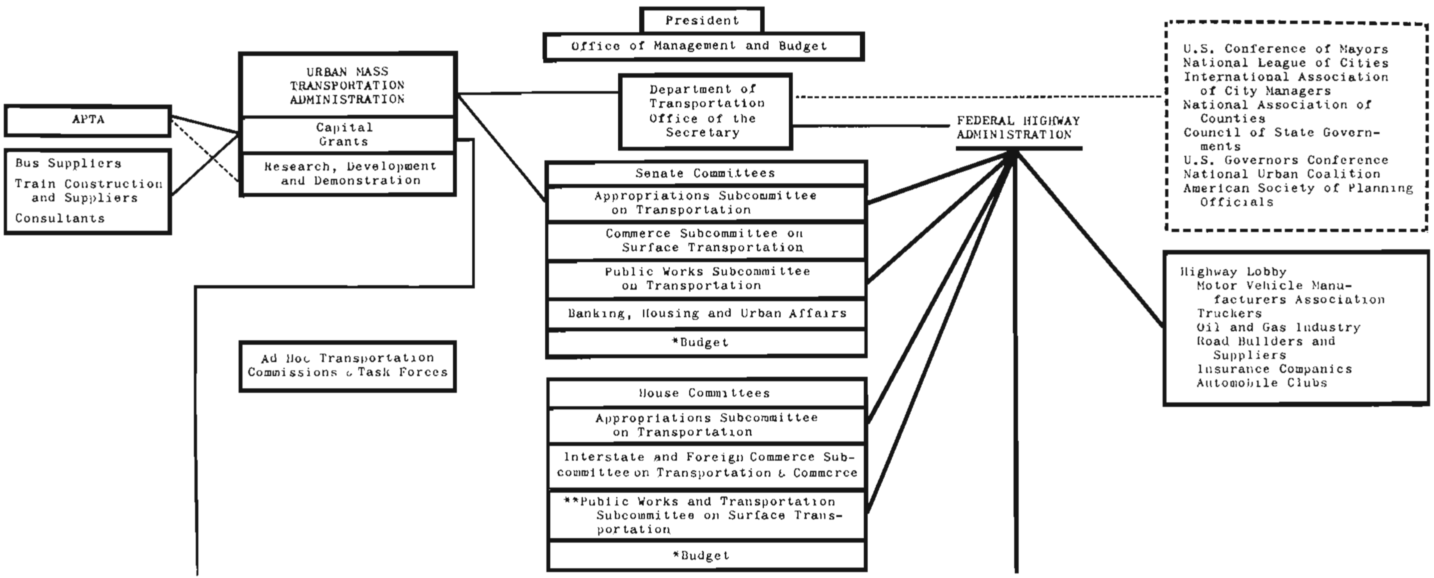
Because both the FHWA and the state agencies have independent sources of money, they operate in a relationship of mutual cooperation. Resources are dispersed as is the power within the network. The network is largely autonomous and operates with relative resource abundance (despite the recent rise in costs, which cuts the buying power of the highway trust fund). The control mechanisms tend to be based on incentives rather than on authoritative means.

Within their respective state jurisdictions, the highway departments, or DOTs, have dominated transportation planning.[23] Therefore most state plans have made highways the primary form of transportation. As of 1974, twenty-three states had changed their highway departments into DOTs,[24] but even in those states the highway division is still either strong (controlling 56-79 percent of the total expenditures) or predominant (controlling 80-100 percent of the total expenditures).[25]

Only very recently has UMTA entered the picture with its technical grants for studies of transportation other than highways, and these are done largely at the local and regional level. At the state level, most concern for urban transit centers in key legislative committees, perhaps on transportation (where this is separated from highway interest), urban affairs, or some similar committee or subcommittee. To this time, the rather weak and ineffectual transit divisions of state DOTs, where they exist, have not exerted much influence on urban transit.[26]

UMTA, on the other hand, first saw life in the Department of Housing and Urban Development (HUD) in 1964 as the Urban Transit Administration. HUD has close ties with cities, and, since the transit problem centered in the cities, UMTA began and continues to be in more regular contact with city governments and local transit operators (both public and private) than with state agencies. UMTA's linkages are much weaker than those of the FHWA, since its clients are more fragmented and its resources and personnel are smaller.

The domain of UMTA is largely set forth in its authorizing legislation—the Urban Mass Transportation Act of 1964, as amended (78 Stat. 302; 49 U.S.C.


President
Office of Management and Budget
URBAN MASS TRANSPORTATION ADMINISTRATION
Capital Grants
Research, Development and Demonstration
APTA
Bus Suppliers
Train Construction and Suppliers
Consultants
Department of Transportation Office of the Secretary
FEDERAL HIGHWAY ADMINISTRATION
U.S. Conference of Mayors
National League of Cities
International Association of City Managers
National Association of Counties
Council of State Governments
U.S. Governors Conference
National Urban Coalition
American Society of Planning Officials
Senate Committees
Appropriations Subcommittee on Transportation
Commerce Subcommittee on Surface Transportation
Public Works Subcommittee on Transportation
Banking, Housing and Urban Affairs
*Budget
Ad Hoc Transportation Commissions & Task Forces
House Committees
Appropriations Subcommittee on Transportation
Interstate and Foreign Commerce Subcommittee on Transportation & Commerce
**Public Works and Transportation Subcommittee on Surface Transportation
*Budget
Highway Lobby
Motor Vehicle Manufacturers Association
Truckers
Oil and Gas Industry
Road Builders and Suppliers
Insurance Companies
Automobile Clubs

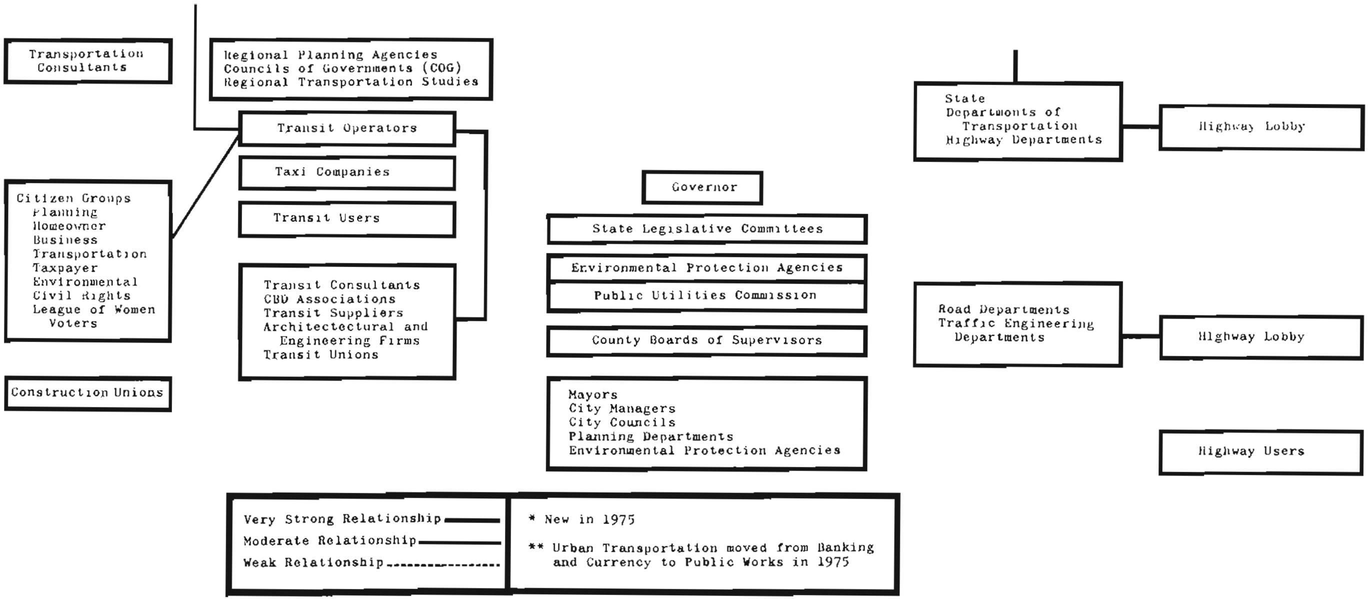


Figure 2-1. Urban Transportation Political Subsystem.

1601 et seq.) and section 3 of the President's Reorganization Plan 2 of 1968, which transferred most of the functions and programs under the 1964 act from HUD to DOT. The purposes of UMTA are:

1. To assist in the development of improved mass transportation facilities, equipment, techniques, and methods, with the cooperation of both public and private mass transportation operators.

2. To encourage the planning and establishment of areawide urban mass transportation systems needed for economical and desirable urban development, with the cooperation of both public and private mass transportation operators.

3. To provide assistance to state and local governments and their instrumentalities in financing such systems, to be public or private as determined by local needs.[27]

Within UMTA, only two key offices are shown in figure 2-1—Capital Assistance and Research and Development. They handle most of the funds distributed by UMTA, and their relationships are the most significant for the current research questions.

The Office of Research and Development has a number of tasks. Broadly stated they are to undertake research and development to improve urban transportation within the context of the UMTA program and objectives. They are specifically responsible for research and development activity regarding existing systems such as bus and rail as well as new, innovative transportation systems.[28]

The Office of Capital Assistance (formerly called Program Operations and frequently referred to as the Capital Grants Office) is responsible for urban mass transportation capital grants and loans, grants for technical studies, and grants for managerial training fellowship awards.[29] It controls by far the largest amounts of money distributed by UMTA, and it has the most frequent and continuing relations with local governments and transit operators.

Compared with the FHWA, however, the UMTA budget is quite small. Their 1974 authorization allows them to spend $11 billion over a 6-year period. When this authorization expires, a new one must be sought, and each year UMTA must justify its expenditures to the appropriations subcommittees. This, coupled with the fact they can offer benefits to only a few congressional districts, puts them in a far weaker position with respect to their controllers than the FHWA, which builds highways in every district.

UMTA clients, which are essentially local transit operators and local governments, are not in a particularly strong situation either. In the largest cities, public transit has been taken over by public authorities because private operations could no longer show a profit and were in a state of serious decline. (See chapter 3.) As public operations they still cannot break even out of operating revenue, and therefore they require significant local, state, and federal subsidies to stay in business. Only a small proportion of the public uses public transit systems, and it, for the most part, consists of those with the least power to influence public decisions—the poor, the aged, the halt, and women. They cannot offer significant strength either to their local transit operators or to UMTA in its dealings with congressional subcommittees.

The primary source of power for the local transit operations is their authority to plan, build, and operate transit systems. To the extent any individual or agency at any level of government wants to have public transit in a given city, they must operate with and through the local transit district. The weakness of these districts is their lack of resources to exercise effectively their authority.

Through their national organization, the American Public Transit Association (APTA), they do offer some support to UMTA by testifying before congressional committees and requesting more urban mass transit funds to be distributed by UMTA. Individual transit agencies also seek support for particular programs for themselves, and big-city mayors frequently ask for mass transit funding for their cities.

The essential goals of the transit operators are to survive and, if possible, to prosper. Frequently these operators seek new rail systems because such systems are expensive and therefore create many jobs. The more money that is spent, the greater the prestige and influence of the transit district. The costs of the transit system will be borne largely by the federal government, so total costs are not terribly important, as long as local matching funds (20 percent) can be raised.

The operators take the position they need more money now for existing transportation systems.[30] They would also like the federal government to increase its share of the cost of new systems to 90 percent as well as granting operating subsidies. They have been critical of much of the money UMTA has spent for research and development, especially the money spent on "exotic" systems.[31] Therefore their testimony is pointed toward more capital grants and less innovation. The only research they see a need for is that which improves existing systems—developing lower maintenance buses or a better brake lining for subway vehicles, tunneling research to reduce costs of subway construction, and so forth.

What we have is a subsystem network that operates in a situation of scarce resources, and the resources (money) available, especially for new transit systems (whether conventional or innovative), are largely centralized in UMTA. The authority to act—to plan, build, and operate public transit systems—is widely dispersed among local jurisdictions. Therefore a close and continuing relationship between UMTA and the local jurisdictions is essential. This is difficult to maintain because UMTA's total employment was 557 in 1978. Of these, less than 150 were deployed in field offices that were opened beginning in 1972.[32] The lack of resources and the lack of close relationships have led to client dissatisfaction with UMTA, especially its cumbersome procedures to apply for and obtain grants.

The controls exercised by UMTA are essentially authoritative, and there is considerable friction as various agencies and communities vie for the limited funds available. This network friction helps to magnify friction within UMTA between the Capital Assistance Office and the Office of Research and Development. The different domains of the two offices lead to different environmental relationships, which give them different problems to cope with, different perspectives on what policy should be, and different time frames in which to operate.[33]

The Capital Assistance Office must deal with immediate problems in response to the local transit operators and municipal officials. Their primary concern has been to save existing transit systems from imminent collapse, to facilitate their takeover by public authorities, and to update their present equipment.

Although they must be more concerned about the costs of particular systems because of their budget limitations, they tend to take the operators' perspectives and are suspicious of new systems. The Office of Technology Assessment has suggested that the Capital Assistance people have made it difficult, if not impossible, for new transit systems to qualify for capital grants.[34] Many of the people who work in the Capital Assistance Office are essentially administrators with backgrounds in budgeting and financial operations.

This office also maintains strong relationships with the traditional transportation consultants as well as suppliers of conventional transit. The rail lobby includes a number of firms that are also part of the highway lobby, especially suppliers of concrete, gravel, steel, tunnel builders, and so forth. The bus lobby also has strong relations with the highway lobby, since General Motors is the primary supplier of buses. In the past, the highway lobby and the rail lobby (which includes downtown business interests in most large cities) have been the center of the transit versus highway feud. In this dispute, bus transit has frequently been promoted as an alternative to trains by highway advocates. All the suppliers to UMTA are most concerned to build something now. Immediate construction means immediate contracts and jobs, both of which are strongly supported by the construction industry and unions.

The Research and Development Office has not had such close ties to the clients of UMTA—the transit operators and the traditional transportation consultants and suppliers. Until roughly 1976 they worked more closely and frequently with suppliers of new transit systems, who have been encouraged by research contracts and an occasional project. They also maintained close relationships with certain consultants, especially those with a background in space or military research.

The people who work in the Research and Development Office have more scientific or technical training, and their time frame for action is, of necessity, considerably longer than that of the people in the Capital Assistance Office. Because they lack much external support from transit operators or traditional transit suppliers, their position tends to be much weaker in relationship to the congressional subcommittees that oversee them. Their budgets are subject to much sharper scrutiny, and they appear to be a weak office in an essentially weak agency.[35]

Although these differences in domain did exist during the period of this study, their significance should not be exaggerated, since the two offices did not exist in splendid isolation and did have considerable interaction with each other and with the other actors in both domains. The research-and-development people were aware of and concerned with the problems of transit operators, and the Capital Assistance people were interested in some degree of innovation. The differences were more in degree than in absolute terms, although they do appear to have had considerable impact on the policies and programs of UMTA.

Since 1976, the Research and Development office has tried to strengthen its position with the clientele of UMTA by stressing short-term immediate benefits from research and by setting up demonstration projects in a number of cities. It has given the traditional transit clientele more influence over the research program by holding two national conferences with APTA and other transit interests to set research priorities.

The clientele, in turn, offers greater support for research and development programs with the congressional controllers. Setting up small projects in many cities also helps to broaden the base of congressional support. In 1977, the Office of Research, Development and Deployment changed its name to reflect its altered domain. It is now called the Office of Technology Development and Deployment. Research and innovation have been limited to generate political support.

Local Jurisdictions

At the local level there is a large number of governments with both contiguous and overlapping jurisdictions. In a metropolitan area, a relatively large number of these governments may have to agree before any transit development can go forward. Within these jurisdictions there are a myriad of agencies, officials, and forms. There are various public, quasi-public, and private groups that may also be involved in planning, advocacy of particular systems, promoting downtown development, and a variety of other causes that relate to urban transportation.

The highly simplified schematic in figure 2-1 calls attention to generally significant actors in the urban transportation subsystem.[36] In particular cities, as will be shown, particular citizens groups, business groups, consultants, or particular public officials are of critical importance. Further, these key individuals and organizations change over time; the relationships are not constant.

The distinction between macropolitics and subsystem politics is indicated in table 2-1, which shows the power setting of UMTA. All the controllers, except for the subcommittees, which are closely tied to the subsystem, are part of the

Table 2-1
Power Setting of the Urban Mass Transportation Administration

Controllers	
Higher Authorities	
*President	*Congress as a whole
*(White House staff)	*budget committees
*(Domestic Council)	
*Office of Management and Budget	substantive subcommittees on transportation
*Secretary of Transportation	appropriations subcommittees on transportation
Monitors	
* Office of Management and Budget	*General Accounting Office
	*Office of Technology Assessment
Regulators	
*Environmental Protection Agency	
*Federal Energy Administration	
*Civil Service Commission	
Clientele	
Suppliers	
consultants	
rail transit	
bus transit	
new transit systems	
construction industry and unions	
Users	
operators	
local governments	
*transit riders	
Constituencies	
American Public Transit Association	
*general public	
*environmental groups	
Allies	
suppliers	
operators	
some local governments	
American Public Transit Association	
Adversaries	
Federal Highway Administration	
Federal Railroad Administration	
highway lobby	
Department of Housing and Urban Development (occasionally)	

*Macropolitical system

macropolitical system. The general public and environmental groups are also shown as part of the macropolitical system, even though some environmental groups have associated themselves closely with transit interests.

The power setting of local transit districts is not shown, since this varies enormously from area to area. In general, there has been a strong alliance between advocates of rail rapid transit (usually transit suppliers and consultants plus environmental or antihighway groups) and downtown business interests.[37] To the extent that the transit district seeks to build a rail system, these are usually their strongest supporters.

The mayor and city council as a whole are usually part of the local macropolitical system as compared to the subsystem politics of transit operators and transit committees. When a mayor goes to Washington to plead for funding either from UMTA or from a congressional appropriations subcommittee, however, he is operating as part of the transportation subsystem.

A similar situation occurs with the secretary of transportation, who for most purposes can be thought of as being part of the macropolitical system. As a dispenser of certain special transit funds, he enters the transit subsystem politics from time to time, but still remains largely an outsider to that subsystem.

People and Politics

This structural outline of the organizational network of urban transportation gives only a partial view of the complex reality of the system as it exists. What we have is not so much a system as it is a series of relationships that make up a de facto system. It is loosely joined and in some cases linked only in the mind of the analyst because of one common element—some interest in or responsibility for urban transportation.

Where the system is in fact linked, whether the linkage is a tight or tenuous one, the links are through human beings operating in organizational roles with organizational values. Human beings are more than roles, however, and they also operate as whole people with personal as well as organizational values, with prejudices and friendships, knowledge and ignorance, competence and incompetence.

Rather than impersonal forces, individuals deal with other individuals. Over time they develop perspectives and relationships, which tend to serve mutually beneficial self-interests.[38] They become aware of others' positions and anticipate their likely reactions to issues and events. Although their assumptions about each other are not always accurate, they develop considerable mutual understanding and tend to work together rather effectively.

These people read many of the same journals, belong to the same professional associations, attend professional and other association meetings together, and frequently have worked together at some time (there is considerable job rotation from consultants to operating agencies to governmental agencies).

For example, William Stokes was the general manager of the Bay Area Rapid Transit District (BART) in San Francisco and went from there to become president of APTA. Frank Herringer went from administrator of UMTA to become general manager of BART. The chief engineer at BART during its construction was Dave Hammond, who became a vice-president of Daniel, Mann, Johnson and Mendenhall (DMJM), which acted as a consultant to BART. In that capacity he will now oversee the engineering and design of the Baltimore rail transit system. C. Carroll Carter once headed the Public Affairs Office of UMTA and is now the publisher of *Mass Transit,* a trade magazine. Jerome Premo headed the Capital Grants Office of UMTA and now is executive director of the Los Angeles County Transit Commission.

These examples are typical of the movement found throughout the transit industry, not just at the highest levels of organization but at all except the lowest levels. People are hired on the basis of having "good contacts at UMTA," DOT, HUD, and so forth. Formal lines of communication become clogged, and friends phone each other to find out what is happening, to press for decisions, to explain the background on a particular application.

The information thus exchanged is an amalgam of fact and rumor, valid information and half-truths, half-lies, and partial views. It is not that people deliberately lie to each other (although this may happen on occasion), the problem is that key people in the system are extremely busy. There is too much raw information available that is unorganized and in many ways unavailable for intelligent use. It is difficult, if not impossible, to sort out well-reasoned analyses from off-the-top comments and vaguely felt opinions based on the slimmest data.

Organizational politics dominates these busy individuals as they operate in a political network made up of organizations with particular domains, linked by their authority base, money, and people who occupy particular organizational positions. Government agencies are the focal point of the urban transportation subsystems as they "represent reservoirs of money, technical and trained staffs, and authority to act."[39] How they use their authority and resources in relation to technology and innovation is the focal point of this book.

Technology

Technology is a widely used and abused concept that everyone assumes they understand, despite widely different meanings attached to the term. Much of the misunderstanding regarding technology stems from the "thing" orientation commonly associated with that term.[40] The role of technology is better understood if it is viewed as a body of skills, knowledge, and procedures for making and doing useful things—as techniques for accomplishing recognized purposes.[41] The machinery, tools, or equipment that knowledge may produce are the artifacts of technology.

To limit the concept of technology to the artifacts alone is arbitrarily narrow. It may also be misleading, as in the case of the transit industry, which largely limits the idea of technology to equipment. In this way the purposes and functions of the equipment are obscured, making it more difficult to conceive of different ways to meet those purposes and functions.

The term technology comes from the Greek word *techne,* meaning art or skill. The term *technikos* meant someone who possessed a certain skill or art. Only humans can possess skills, arts, or knowledge, therefore technology is also an essential component of social systems.[42] Agriculture, industry, commerce, and social services all have technologies that are central to their operations. Technologies set certain requirements of the social systems in which they are meshed, acting as constraints on the roles taken by human beings in these systems. These constraints may be broad in scope, offering a considerable range of behaviors, or be quite narrow, with highly specific behaviors required.

The fact that many social roles take their character from the requirements of technical operations does not imply a crude technological determinism. In most situations there are a variety of means to achieve human ends, and technology remains a human choice that humans evolve, change, and modify.[43]

The social systems in which technologies exist are complexes of roles, statuses, norms, and values. The roles taken by humans in these systems do not exist in isolation but are found in role-sets—a complement of roles that hang together as a unity, any one of which is essential for the functioning of the others.[44] One cannot take the role of bus driver except in a complex that includes bus riders, maintenance crews, administrators, schedulers, and so forth. Thus single technologies are combined into complexes with other technologies, and roles are combined into role-sets. These role-sets are combined into organizations, which in turn are combined into organization-sets.[45]

To continue the analogy of the bus driver, the bus company exists in a set with other organizations—police, traffic controllers, road builders, bus manufacturers, and so forth. When new technologies emerge, whole role-sets may disappear and many organization-sets may be altered as some of their component technologies are changed or vanish. Thus a new technology may be perceived as a threat to the complex of roles, statuses, norms, values, and technologies that comprise the existing social system. The resistance so frequently noted in regard to new technologies may be partially explained in these terms.[46]

Technological Innovation

Technological innovation also generates conflicts, because individuals, organizations, and societies may be able to do something they could not do before, which enhances some values while damaging others: "Technology can never be socially neutral; it inevitably brings disadvantages and costs as well as new opportunities and benefits. It opens choices and imposes constraints."[47] In almost all cases, the political, social, and economic consequences of technological innovation tend to fall differentially on various groups. Therefore aggregate analyses of costs and benefits (especially those that stress economic costs and benefits) may give an inadequate and even inaccurate estimate of advantages and disadvantages.

The distribution of benefits may have an equalizing or a stratifying effect. Economic or political benefits may become more widely distributed or more narrowly focused, benefiting the few rather than the many. Within the producing organizations certain types of technologies appear to function more effectively with centralized authoritarian controls, whereas others require more decentralized and democratic controls.[48] Different technologies may also require greater interdependence of role-sets and organization-sets, or they may allow more autonomy. The amounts of diversity or conformity, freedom or regularity, government control or individual control may all be affected by major technological change.

Therefore it is to be expected that those who would gain one or more cherished values through the introduction of a new technology would seek its development and introduction. Those who fear the loss of cherished values would resist the change. These values may have to do with economics—profits or job status, politics—differing power relationships, or other social relationships of importance to an individual, group, or organization.

One can hypothesize that resistance to change is likely to occur when the technological innovation threatens to overturn the existing role-sets and organization-sets with their established values and statuses. New technologies may or may not be compatible with the existing roles and organizations.

Scope and Depth of Change

The degree of compatibility or incompatibility can be measured along two dimensions. Structural depth refers to the depth of penetration into the system structure.[49] Scope is the horizontal impact across structures, which can affect the whole community (areal impact) or it can have a limited impact on particular subcomponents (segmental impact).[50]

Structural depth can be divided into four levels of change:[51]

1. The level of specific actions—behavior changes occur within specific role-sets but no structural changes are required. A double-decked bus requires slightly different behavior of the bus driver, but it does not essentially change his role or the organization.
2. The level of decision rules—this requires some specific changes in the structure of role-sets by changing their normative requirements and specifi-

cations. The introduction of dial-a-ride bus service requires the bus driver to operate on demand rather than on a fixed route with a fixed schedule. This calls for a somewhat different relationship with the customer, who has more control regarding where the bus will go and when it will go there.

3. The level of decision structure—role-sets are restructured by reallocating authority among them. Actors may gain or lose power to make decisions. The consolidation of several community bus companies into a regional transit authority means local communities and local operators lose some of their influence over bus service in their area.
4. The level of goals and rationale—the technological innovation affects the very purposes for which the structure had existed. Old role-sets may become obsolete, and new role-sets requiring new skills or new people will gain power. The regional transit authority adopts a computer controlled, demand-activated transit system, which requires role-sets and skills quite different from those of the bus driver (and those who administer and plan for a bus operation).

This suggests that the greater the structural depth of penetration is, the greater will be the resistance to the technological innovation. Also, the more areal the impact is, the greater will be the resistance to the technological innovation. (See table 2-2.)

All innovations have characteristics that cause ambivalence in their creation. The risks and potential costs must be weighed against perceived benefits. The distribution of these costs, risks, and benefits must also be examined. In technologically complex societies, most innovations tend to operate segmentally;

Table 2-2
Scope and Depth of Change

	Role	*Role-Set*	*Organization*	*Organization-Set (Political Subsystem)*	*Numerous Organization-Sets*	*Society (Macro-political System)*
No change						
Behavior change						
Rule change						
Power change (restructuring)						
Values/goals change (revolutionary)						

that is, they affect some roles, role-sets, and organizations far more than they affect others, or society as a whole. Within the individual role-set or organization-set, however, the innovation may penetrate throughout the structure and thus threaten the values and statuses of the actors within the system.

For any particular segment of society, a restructuring innovation is one that penetrates to the third level of depth. At this level the need for skills changes, power and influence may be shifted, and authority is reallocated, as are economic and social rewards. Those who feel they will lose more than they gain in this situation can be expected to oppose the change or to attempt to shift the burdens of change to another segment of society.

The fourth level of change is termed revolutionary because it calls into question the very purposes for which the role or organization exists. It requires new ways of conceptualizing problems; it requires new skills; it threatens the values, the unquestioned assumptions, the theories, the methods, and the applications of existing roles and organizations. It ". . . is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications."[52]

Paradigms

In every industry or science there is an accepted model or pattern that defines reality for the experts in the field. It is a cluster of assumptions, beliefs, theories, methods, and applications, which taken together make up an interdependent network of commitments. Such a pattern of commitments–technical, social, and political–is called a paradigm.[53] It helps delineate and justify existing roles, organizations, skills, and technologies. It also supports existing market and political relationships.

When a technological innovation penetrates to the fourth level of change and becomes a revolutionary technology, it can also be termed a paradigm challenge. It challenges the old definitions of the problems and the methods for solving those problems. It offers a new means of attaining certain ends, ends which may have been deemed impossible of attainment. The new technology supplies a solution outside the existing definition of the problem.

Such a revolution need seem revolutionary only to those whose paradigms are affected. Thus, what appears to be a revolutionary change to one segment of society may involve only minor changes in other segments or society as a whole. Whenever a new paradigm is put forward, however, it is likely to be proposed by those who are very young or very new to the field: ". . . being little committed by prior practice to the traditional rules of [the field], [they] are particularly likely to see that those rules no longer define a playable game and to conceive another set that can replace them."[54]

Invention and Innovation

The first stage in the process of technological innovation is invention—". . . the act of insight by which a new and promising technical possibility is recognized and worked out (at least mentally and perhaps also physically) in its essential, most rudimentary form."[55] Although U.S. patent laws written in the nineteenth century still define invention as a "flash of insight," organizations rather than individuals are becoming more important to the invention process.[56]

Origination and application are merging as the source of ideas becomes more diffuse and imprecise, and the steps needed to take an idea from concept to production become more complex and costly. Although invention must precede innovation, they are closely interwoven. There is, in reality, no tidy separation between functions.[57]

One can think of the innovative process as involving four functions: invention, entrepreneurship, investment, development.[58] The entrepreneurial function involves the decision to go forward with the effort, organize it, and obtain financial support. Investment involves the risk of funds for the project. Development is the lengthy sequence of detailed technical activities that tests and modifies the original idea and makes it market-ready.

Many influences may induce invention and innovation—curiosity, the outpouring of genius, personal gain, the pressure of necessity, the type of competition, economic forces in general, or random chance. There is considerable evidence, however, that economic factors predominate.[59] Economic growth and market potential lead to innovative activity and technological change.

Economic demand is not the only factor, since path-breaking innovations—those that lay the foundations for new products and processes that open up new areas of technology—are less susceptible to economic forces simply because they are acts of creation whose outcome is frequently unpredictable. Nonetheless, in a study of sixty-one primary inventions made during this century, twenty-six came from research laboratories of manufacturing concerns.[60] It seems reasonable to assume that some sort of economic orientation motivated these activities.

The transit industry offers some evidence to support the idea that innovation is motivated by economic demand. That industry has been in decline since World War I. (See chapter 3.) The last major innovation in that industry was the introduction of the motor bus in London, which took place just prior to that war. During its period of growth from 1825 to 1912, numerous technological innovations were introduced, whereas during its period of decline, stagnation set in.

Systems of Appraisal

Demand may not be an immediately apparent force; often it is mediated by institutional processes of appraisal. Organizations often have to be virtually forced to adopt the ideas they generate.[61] The literature is rife with the problems of inventors who must battle to win acceptance for their ideas. A truly novel idea is usually restructuring or even revolutionary. It challenges accepted ideas, time-proven dogmas, and the existing statuses and role-sets.

Often there is the need for a product champion, not necessarily the inventor, but someone who makes a decisive contribution to the innovation by actively and enthusiastically promoting its progress through critical design states: "In forcing their ideas on a reluctant world, inventors are apparently subjected to a sociological, not an economic test."[62]

This is not in conflict with the idea that economic demand motivates invention, since the inventor's (whether an individual or organization) motives are usually economic. The problem is to persuade others of their economic viability. In this process, systems of appraisal are critical. When government is a key actor in the innovation process, the system of appraisal is based on politics and the organizational processes of government agencies.

A political subsystem is one type of system of appraisal: one conditioned by its own definition of the situation, its own technological capabilities–its paradigm. The macropolitical system is another system of appraisal, which brings another dimension to the definition of the problem and therefore to the potentials of proposed solutions.

The demand for a new technology will be identified through these systems of appraisal. Therefore gaining the attention of the appropriate system may be the key factor in the decision to launch a new technology. Revolutionary and even restructuring innovations are likely to be rejected by political subsystems that feel threatened by change.

At the turn of the century, continuous aim firing was developed for the U.S. Navy. It allowed the Navy to increase its firing accuracy by 3,000 percent in 6 years. The innovation was strongly resisted, however–not because the Navy wanted more misses than hits when firing at an enemy. The apparent reason was that this new technology made a dramatic change in the status and skill relationships in the service. It changed the whole basis for career advancement and promotion. The change finally had to be forced on the Navy subsystem by President Roosevelt of the macropolitical system.[63]

The Role of Government

Government may enter the innovation process in a number of different roles, each of which may involve somewhat different political processes of persuasion and decision.[64]

1. Government may act as a research and development agency. This occurs most frequently when government is virtually the only customer. Some examples might be efforts in defense, air traffic controls, or road building.

2. Government may also sponsor research when the private sector is unable or unwilling to do it alone. The government may offer a contract to the developer that best meets a set of specifications, or there may be a direct subsidy of the development of products because they are deemed to be in the national interest. Government may or may not be a potential customer for these products.
3. Government may act as a market catalyst by passing laws that require that certain products be used. Laws to enhance clean air, lower noise levels, or increase safety may create markets for catalytic converters, better mufflers, and seat belts in automobiles. Without such laws there might be no market for such products.
4. Government selects and supports certain research directions and may ignore others. At any given time there are usually far more ideas than can possibly be developed, and the decision to support one or another of these may effectively close off certain possibilities while enhancing others.
5. Government may also oppose and suppress some technologies for policy reasons. This may be done consciously as in the decision to stop the development of the SST for environmental and economic reasons, or it may be done inadvertently. Emphasis on a particular technology may preclude development of another technology, and the importance of this deterrence may not be immediately recognized.

The selection of any of these roles may be determined in legislation that gives life to bureaucratic agencies, or a particular role may emerge as part of the development of agency domains. In any event, the selection of the government's role in the innovation process is part of a decision-making process as is the determination to innovate, and both decisions are at least partially determined by beliefs regarding the agency's domain.

Entrepreneurship

If invention is an early part of the process of technological innovation, the entrepreneurial function involves deciding to go forward, organizing the effort, and obtaining financial support. The decision to start a major technological program is an important national policy decision, and for a bureaucratic agency it carries enormous significance. The process usually begins when individuals or groups inside or outside government perceive the desirability for a particular technology and begin to advocate the innovation to a prospective agency sponsor.

The agency usually has a variety of missions and projects, and the decision to develop a new technology competes with ongoing programs as well as other technological innovations for scarce resources of time and attention. The decision to launch or not to launch a development within the agency may be made internally, or it may be forced by outside pressures from special interests, the legislature, or competing agencies.

Such decisions may be based in part on the agency's power position—whether or not it believes it can get support from higher authorities, especially funding. There must also be the organizational capacity to receive and to use new technological ideas. An agency must not only have such capacity, but it must also be perceived by higher authorities to have such capacity for a program to be funded.

The estimated time to completion is another significant factor in government technical policy: "Bringing to completion long-term technology projects is one of the toughest problems that a democratic society faces. The political process inevitably focuses attention on short-term payoff, and long-range programs, whatever their promise, have a difficult time surviving."[65] At the federal level, long-term projects must survive changes in the presidency and in Congress, fluctuations in the national economy, variations in fiscal restraints, and changes in the requirements of the missions for which they were intended.[66] In essence, the decision to launch a technological development must be taken in a bureaucratic agency, in the Office of Management and Budget, at the presidential level (for major projects), and in Congress. This involves both entrepreneurial and investment decisions to go ahead with the development process.

The development process—taking an original concept to the stage of first utilization—is both time consuming and expensive. In essence, invention is cheap but development is expensive. The steps of the development process carry varying price tags, shown in table 2-3. Some steps are far more expensive than others, so government may take on one of or all these steps in the role of developer, sponsor, or market catalyst.

Risk

In making the decision to launch a new technology, questions of risk are often paramount.[67] In government agencies, there may be few rewards for innovators, and the penalties for failure may be severe. Risk is frequently defined in terms of what will attract media attention and therefore attract the attention of the higher authorities. In the development of public transit systems, the improper functioning of a door is likely to draw more headlines than that the system serves only a few people at very high cost. Sticky doors make good visual news for television, whereas government deficits are old hat and difficult to film.

Therefore technical risk may loom large when making the decisions to begin technological development activities. Whereas technical risk does increase as the size and complexity of the advance sought increases, it is largely within the control of the innovating organization. The key factor may be the ability to field a research team of sufficient quality to bring the project to fruition.

Table 2-3
Division of Costs of Bringing an Invention to the Market

Stage	*Average % of Total Cost Arising at Each Stage*	
	A	*B*
Applied research	9.5	5-10
Specifications	7.6	
Prototype or pilot plant	29.1	10-20
Tooling and manufacturing facilities	36.9	40-60
Manufacturing start-up	9.1	5-15
Marketing start-up	7.7	10-25

Source: E. Mansfield et al., *Research and Innovation in the Modern Corporation* (New York: W.W. Norton, 1971), p. 118. Reprinted with permission.
A. Reflects actual cost data from 14 firms, involving 38 innovations in chemicals, machinery, and electronics.
B. Estimates made by the Panel on Invention and Innovation in a report to the U.S. Department of Commerce, *Technological Innovation* (Washington, D.C.: 1967).

There are also ways of reducing risk by running parallel research efforts where there is no consensus indicating the most promising alternatives. Separate approaches to a common problem may reduce the time taken to achieve success and the overall costs. Too early a commitment to one approach can be avoided, and knowledge from the parallel efforts may contribute significantly to the success of the method finally chosen.

Because it is possible to influence the level of technical risk by the way in which projects are organized, judgments regarding the degree of risk may differ dramatically based on past records of success, the perceived level of competence of the research team, and the confidence in the managerial quality of the innovating organization.

In studies done of private sector innovation, only a very small percentage of failures were due to the "cussedness" of the technology.[68] Of course, small advances in familiar areas of technology yielded higher probabilities of completion than did more novel efforts, but the major reasons for deviation were changes in project objective or lack of suitable manpower.[69]

Private firms must also consider market risk—the likelihood that a given technological development will have commercial success. For government, the latter might better be called utilitarian risk—the determination whether or not the product will be useful. Government may be the market for the product, or it may be able to create a market through grants or legislative action, so market risk is not the essential problem. (This is not always recognized by government decision makers, but the confusion of market and utilitarian risk does not make the distinction any less significant.)

Utilitarian risk involves value judgments regarding what is useful for society as a whole and what is useful for particular segments of society—particularly those involved in the technological development. Debates regarding the utility of a project involve considerations regarding who benefits and who pays, who increases in status and power and who does not. Particular innovative ideas that are brought to an agency may actually threaten the structure of the agency—its existing role-sets, statuses, values, and relationships with its environment. Therefore in analyzing a proposed technological innovation, it is necessary to examine the depth and scope of its restructuring effects from several different perspectives, as shown in table 2-2.

These issues are the essence of political debate, but often they are sublimated into a technical debate with supposedly objective analysis substituting for political ideology. To paraphrase Clausewitz, analysis is politics carried out by other means. By discussing technical risk, the issue of utilitarian risk is avoided or at least muddied.

The emphasis on utilitarian risk is not meant to imply that the nature of the prospective market is unimportant. To the contrary, the shape of the market may require different types and levels of government involvement in the development process. Table 2-4 indicates a number of reasons why promising innovations were put on the shelf. The cases were drawn from only three fields, but they offer evidence that seems to be supported in other studies.[70]

Market problems are in the clear majority, and, significantly, the size of the market or the market's monopsonistic characteristics make up 60 percent of the cases. The federal government is a monopsonistic buyer, so government policy is clearly the significant factor in decisions to push ahead with development. In such a situation, the guarantee of a market may be the crucial factor. In defense and space exploration, the government took on the largest portion of the costs of development of needed innovations.

In the case of transit, the assumption seems to be that there is a large market available.[71] In all cases, reference is made to the overall dollar size of the market, which could amount to billions of dollars over time. What is not often

Table 2-4
Summary of Alleged Causes of Project Shelving

	Electrical	*Mechanical*	*Chemical*	*Total*
Unattractively small market	10	2	7	19
Uncertainty with monopsonistic buyers	4	6	2	12
Unattractive level of competition	4	3	4	11
Uncertainty with suppliers	2	3	1	6
Obsolescence	2	1	0	3
Total	22	15	14	51

Source: Centre for the Study of Industrial Innovation, "On the Shelf: A Survey of Industrial R and R Projects" (London: 1971). Reprinted with permission.

noted, however, is the small number of potential buyers. A single contract may be very large, but such contracts are few in number. Public transit represents an oligopsonistic market, with monopsonistic overtones as the federal government supplies most of the capital funding.

Federal officials continue to insist that transit decisions are made and should be made at the local level.[72] Nonetheless, the federal control of funding accords it a virtual veto regarding the types of systems that will be built. The rejection of local proposals from Denver and Dayton is evidence of this power. Occasionally there is a willingness to say out loud what is widely known and accepted in the transportation subsystem: "We are going to try to use the leverage of the Department's grant programs to bring about this planning and implementation."[73] As one commentator phrased it, ". . . if the Federal Government underwrote 80 percent of the cost of a cancer implant, the line for the Federal handout would extend across the country."[74]

In such a market situation, the level of federal funding required for innovative development will vary depending on the type of market guarantees it provides. If, for example, the federal government agreed to finance the first demonstrations in cities, the manufacturers might be willing to take on the costs of tooling and manufacturing facilities. In the absence of such a guaranteed market, the federal government might have to assume more of the development costs.

Summary

In essence what we have here is a political subsystem made up of transit operators, public transit manufacturers, and government agencies dealing with public transportation. Each has its own domain, and they are linked by their common concern for public transportation and their varying authority and monetary resources.

This organization-set acts as a system of appraisal—the only system of appraisal in the United States—for innovations in the area of public transit. It has its own paradigm and a particular set of technological capabilities, which make it more receptive to some ideas and less receptive, or even antagonistic, to others.

Personal rapid transit, it is suggested, was perceived by the public transportation subsystem as being a paradigm challenge—a revolutionary technological innovation—which led to its rejection. For any element of the transit subsystem to accept this innovation would offer an unacceptable level of threat to the key roles in all the organizations that make up the subsystem. Their skills and knowledge do not match the skills required to develop a PRT system.

In addition, the entire subsystem was essentially weak with limited political support and a low level of resources. What support they had depended on maintaining their domains. UMTA needed to keep the support of transit operators, who were suspicious of new technologies, and the transit operators wanted to keep the support of those who had supported existing transit plans based on the old technologies of trains and buses. The following chapters will illustrate how these theories worked out in practice.

3 The Rise and Fall of Public Transportation

Importance of Transportation

> Nearly everything Americans do, from mailing a postcard to walking on the moon, depends on transportation. Transportation is essential for the supply of food, clothing and shelter, for national defense and employment, for education and recreation, for the international exchange of goods and ideas.[1]

The importance of transportation is widely accepted, and its impact on the American economy is staggering. Total U.S. freight and passenger transportation expenditures in 1975 were $317.1 billion, roughly 20 percent of the gross national product (GNP).[2] The highway proportion alone accounted for 18 percent of the GNP.[3] A 1973 estimate indicated that half this total—10 percent of the GNP—was spent on urban transportation.[4]

Of the highway passenger transportation dollars, 96 percent is spent for the automobile.[5] Of all passenger transportation, 88 percent is highway related, whereas 78 percent of freight transportation expenditures is highway related.[6] There were approximately 106.7 million private passenger cars in the United States in 1975, which accounted for 99 percent of all automobiles in the country,[7] and 20 percent were registered in sixteen major urban areas.[8]

The Motor Vehicle Manufacturer's Association may not be exaggerating when they state, "Like two eyes united in a single vision, the needs of the nation and those of the auto industry cannot be separated or distortions are inevitable."[9] More than 14.6 million jobs are directly related to motor vehicle usage, including those employed by motor vehicles and parts manufacturers, petroleum refining, automotive sales and construction, truck drivers and other freight handling employees, and passenger transportation. Not included are suppliers of raw materials, medical personnel and undertakers, insurance employment, police traffic control employment, lawyers, and others who may gain a significant part of their employment dealing with automotive production or problems.[10]

Of all person trips, 98.6 percent are made by highway, and 78 percent of all work trips are made by private motor vehicle. Of the person miles traveled each year, 92.8 percent are made by passenger car or truck, and only 3.2 percent are made by all forms of mass transit.[11] There were 3.8 million miles of roads and streets in the United States in 1975, and 81 percent were paved.[12] Governments collected over $20 billion in taxes related to car sales and usage in 1976. Of total state tax revenues, 14.6 percent came from motor use taxes.[13]

Although these data were collected from a variety of sources over a period of 10 years (1967-1976), they give some perspective on the magnitude of the impact of the automobile. Motor vehicles provide most of our mobility, a significant share of our employment, occupy a large segment of the economy, and contribute heavily to government revenues. Thus when one considers the issue of passenger transportation in the United States, one is talking largely about the automobile and its effects, and one is dealing with an enormous economic and political complex.

By comparison, public transportation is a miniscule industry. It is an industry that has been declining both absolutely and in relationship to private transportation for many years. Today, however, there is acute awareness that there are severe problems with auto-dominated transportation, and therefore public transportation has received more public money and attention in the past 10 years than it had in the previous 50 years.[14]

Today it is commonplace to observe that we have an urban transportation problem. The nature of that problem and how it developed are not so commonly analyzed. Nonexplanatory explanations such as "the American love affair with the automobile," or "the automobile as status symbol," are not only inadequate, they are inaccurate.

Historical Overview of the Public Transit Industry[15]

To better understand today's situation, it will be necessary to examine briefly the rise and fall of the public transit industry. The historical origins of an organization or industry often help to explain its present practices. By examining the intertwining relationships over time of transit service, technology, ownership, finances, and limitations, present attitudes toward innovation and the present situation of urban transportation can be illuminated.

It should be noted at the outset, however, that urban transportation seems to have been a problem ever since humans first began to live in large cities. Congestion, pollution, and accidents have been continuing problems to the present time. It was 2,000 years ago that Julius Caesar put out an imperial edict banning chariots from the clogged streets of Rome.

Despite all the problems of urban transportation, innovation has never come about easily. Politically, the mechanisms of change involve power and interest groups. Changes in transport technology may be based on different levels of threat to different groups and the society as a whole and the relative power of different groups to deal with particular threats and opportunities. To be accepted, new technologies must present a low level of threat to the more powerful interest groups and to the community as a whole. When they do present a significant level of threat or have a high potential impact, they may be accepted if they confer considerable benefit on a powerful group.[16]

The other factor that can bring about change and can do it rapidly in opposition to powerful groups and vested interests is the failure of a system or the threat of a major failure. The best examples of this occur in the military, which is always well prepared to fight the previous war. During a new war or under the threat of war, new methods are established and adopted. The use of the airplane in World War II provides a classic example. A comparable example in the transportation industry might occur if there were a prolonged shortage of fuel, making it impossible to drive automobiles.

Technological change may also be viewed in economic and technical terms. The availability of financing for new technologies, the ability to solve major technological bottlenecks, and the economic superiority of the new systems are then seen as crucial.[17] The costs of replacing large capital investments that have become obsolete is an implicit part of any economic analysis. These two perspectives—the political and the economic—appear to be compatible, since many of the threats and opportunities have an economic basis.

The Stage Coach

The stage coach was really interurban transportation, but the arguments used to oppose it are only slightly more quaint than the arguments used to oppose later technological innovations. A variety of reasons were given for suppressing coaches in England:

> Among these were that large classes such as saddlers and spurriers, had been unfavourably affected, that inns would be deserted, that waterways would be ruined, that the coaches were too cold in winter and too hot in summer, that they would be fatal to the breed of saddle horses and the noble art of horsemanship, and that man would become effeminate . . . that they enabled gentlemen to come to London on every occasion which otherwise they would not do but upon urgent necessity . . . (and) they enable wives to come to London and spend money on clothes and the theatre thus encouraging them in idle ways.[18]

Although the stage coach clearly offered some threat to particular groups in society, it also benefited other groups and society as a whole. Both government and business have need to move mail more quickly. Thus more powerful groups had need for the coaches, and they were successfully introduced.

The Omnibus

Public urban transportation also began with a coach—the hackney—which was comparable to a horsedrawn taxi. If one could not afford to own or hire a carriage, one walked. Cities were small and compact with every effort made to reduce the amount of internal transportation required. Space was at a premium; the streets were narrow; and the larger the city, the more houses that were crowded on a street.

In 1827, Abraham Brower began the first truly public transportation in the United States in the form of an open horse-drawn vehicle that would carry twelve passengers. This omnibus, as it was named by the Frenchman who invented the idea 2 years earlier, ran up and down Broadway charging a fare of one shilling per head, regardless of distance traveled.[19]

Service. Most significantly, it should be noted that this was a group service. From its inception, public transportation has been, by definition, service to groups of people, most of whom do not know each other and who travel from different origins to different destinations. The service used public roads and traveled along fixed routes, yet because it used public roads it could change routes with relative ease, giving it considerable flexibility. These horse-drawn vehicles operated much like the modern motor bus. They averaged about 6 miles per hour with headways of 15 seconds. Motor buses do not travel much faster today in heavy city traffic, and they usually operate at lesser frequencies.

Later omnibuses seated up to eighteen passengers, and entry was through a rear door where a small boy collected the fare. Omnibus systems spread rapidly to other cities, the largest being in London, which in 1905 had 17,000 horses and 1,400 omnibuses. Some of these were similar to today's motor buses with a spiral staircase leading to an upper deck.

The introduction of this system posed no immediate threat to any powerful group in society, and there were considerable benefits to be gained in the increased mobility available to the ordinary person for the first time. The city could begin to spread a bit, making more land usable for homes and commerce.

Financing and Organizational Structure. Omnibus technology was very low in capital cost and initially very low in operating cost, since it was predominantly an industry of owner-operators.[20] It was an entrepreneurial enterprise operated for a profit with many small firms competing in the market.

Limitations and Decline. The peak of omnibus service in the United States occurred around 1855, but problems were appearing. Most serious was the congestion caused by so many vehicles on the streets of New York. Demand was far greater than could be handled by the omnibus system.[21]

The Horse Railroad

The horse car drawn on steel tracks had been used in English industries in the eighteenth century. It was first adopted for passenger service when the New

York and Harlem Railroad Company began operation in 1832.[22] Initially there were objections to the new rail system on the grounds that it was a public nuisance and would depreciate the value of property.[23]

Its raised rails interfered with other traffic and might upset carriages. It was feared the larger and heavier vehicles would run people down and kill them. The problem of the raised rail was what Kornhauser and Wilson call a technological bottleneck, and the introduction of the sunken rail solved this problem.

The rail technology offered lower operating costs by increasing productivity. Horses could pull greater weights over rails than over cobblestones, allowing increased passenger capacity. In addition, the rails offered a smoother and quicker ride, thus making the horse railway a more attractive service for the passenger. This development led to the "tracked city," again allowing greater decentralization and dispersal of populations.

Service. This was the first of the light rail systems with service comparable to modern street cars. Due to rail operation, it was considerably less flexible than the omnibus. It was both difficult and expensive to move tracks once they were in place.

Financing and Organizational Structure. The laying of the rails and the size of the vehicles made this a much more capital-intensive venture. The high capital costs as well as the social objections delayed its widespread adoption. Rather than small owner-operators, larger business organizations with major bank financing owned these new ventures, which were less competitive (since they tended to follow different routes) but still operated for a profit. The capitalists who dominated these early systems seem to have been motivated by an interest in municipal improvement and in long-term financial gain.

Limitations and Decline. The peak of horse car operations was reached between 1875 and 1885. Even before it reached its peak, however, one severe limitation became evident in the "Great Epizootic" of 1872, which killed or disabled thousands of horses. Feed prices for horses also increased, contributing to the cost advantages of two new systems.

In addition, "the horsedrawn streetcar was a passenger's inferno and a pickpocket's paradise."[24] It was extremely uncomfortable—cold in winter and hot in summer, grossly overcrowded during "rush hour" (when it moved most slowly due to congestion), and, as predicted, was dangerous to pedestrians and others who got in its way.

The Cable Car

The cable car also came out of English industry from the coal cars hauled by wire cables in English colliery railroads. Hallidie first demonstrated this system in 1873 in San Francisco, where horses could not climb the hills. Chicago then followed with one of the largest of the cable car systems:

> In pointing out the advantages of the cable railway, H. H. Windsor, Secretary of the Chicago City Railway, stated, "The value of removing from a street the voidings of two or three thousand horses is a matter not to be lightly estimated in point of health; while the constant clatter of hoofs on the pavement is supplanted by the quiet gliding of a train, scarcely audible from the sidewalk.[25]

Environmental impact of transportation systems is not a new concern. The cable railway offered distinct benefits to society as a whole and also economic benefits to the operators of the horse railways, that is, no horses to feed, care for, and replace.

Although the basic idea was invented much earlier, actual adoption of cable railways was delayed due to high capital costs and to some technological bottlenecks. First a way for covering the conduit through which the cable ran was necessary to keep it from filling with ice and snow or animal waste. Cables breaking and the lack of a grip to go around curves also delayed development.

With the building of the Chicago system and its proven superiority in winter operations (where horses frequently slipped, broke their legs, and died) and its much lower operating costs, cable systems started to be built in many cities. The objections by the owners of horse railways were overcome by buying them out and through demonstrations of economic superiority. Frequently cable systems operated in some parts of the city while horse railways continued in other parts.

Service. The service was again comparable to modern street cars, and essentially the same as that provided by the horse cars. It was faster and more reliable than horses, but the change involved was an equipment change, not a systemic change.

Financing and Organizational Structure. This system involved considerably higher capital costs than the preceding systems because of the additional cable and conduit plus the need for generating sources to power the cables. In Chicago, eleven large power plants using steam engines were strategically located throughout the system.

Cable systems offered a new type of equipment, and it was possible to patent many significant elements of this equipment. A Cable Railway Company was formed as a patent trust in 1881, and the bulk of the cable systems were built under these patents. Those that were not were frequently subject to infringement suits.

This combination of factors led to local monopoly ownership of the transit systems dominated by transit trusts. The systems were operated largely for profit, although real estate speculation also played a part in the potential earnings for transit investors.

Limitations and Decline. Essentially the limitation was economic. The electric motor proved to be cheaper to operate, and, after the peak of cable car mileage in 1893, it rapidly replaced cable operations everywhere except San Francisco.

The Electric Streetcar

The idea for electric railways seems to have been an outgrowth of the search for lucrative applications of electric power--a solution in search of a problem. Davenport operated a small model of such a system in 1835. Following that prototype, work continued for the next 30 years to overcome a variety of technological bottlenecks.

Many inventors, including Siemens in Germany and Thomas Edison in the United States, worked on the problems of power generation--solved with the dynamo--as well as the transmission problem--approached in a variety of ways by numerous inventors/entrepreneurs, such as the third rail, overhead wiring, and so forth.

Some of the early systems that were installed operated badly and had to be replaced. The ultimate success or failure may have rested with the innovator's conception of the eventual solution to the technological problem at hand. Two innovators, Van Depoele and Sprague, used different approaches in designing a trolley to pick up power from overhead wires.

Van Depoele's overruning trolley could not negotiate switches satisfactorily, and he was forced to abandon the concept. Sprague spent a great deal of time developing a reliable underrunning trolley and showed great persistence in finally solving the problem. At that time, many people said that Van Depoele proved electric trolleys were technologically infeasible. As shall be noted later, a similar attitude prevails today when one approach to solve a problem fails. It too is freqeuntly cited as so-called proof of economic or technological infeasibility.

When Sprague put the first installation in Richmond, Virginia, there were numerous problems, and the availability of continuing and reliable funding was extremely important in its success. This demonstrated success led to the rapid adoption of electric traction systems in other cities.[26]

This new system benefited powerful groups--the developing transit trusts who stood to make a greater profit from the new system--and it provided a positive benefit to society as a whole. Thus both the economic and political criteria for introducing a new system were met. Much more real estate was opened for development, and with the introduction of the interurban, outlying communities could be connected to the central city.

Service. This was and is the basic streetcar service as we know it today. It differed little, from a service perspective, from the earlier horsedrawn or cable systems on rails. It offered some improvements in reduced pollution and noise level as well as service reliability, but the basic concept of group service on a fixed rail line remained.

Financing and Organizational Structure. Capital costs plus the greater efficiency of using a single-power source led to large-scale monopoly operations. It was the power trusts that initially supplied the capital to finance the new electric railways.[27] A great deal of capital was needed not just to build the new systems but also, because of the resistance of the older horse-car railways, to adopt the new system: "Protection of a vast investment is a recurrent theme in analyses of the transit industry's resistance to innovation."[28]

> This conservatism in the industry caused speculators in the new technology to resort to buying out the horsecar owners, thereby piling capitalizations of earlier obsolescent technology on top of the newer debts from modernization—a recurrent theme.[29]

The Federal Electric Railway Commission describes the problem when it became clear that earlier investments in horse-car technology would have to be scrapped:

> Mistaken Optimism in Profits of Electricity as a Motive Power
>
> Managers of existing street railways and the public alike made the almost fatal error of thinking that the new system of motive power (electricity) contained the possibilities of a gold mine. The promoters (had) dreams of incalculable profits. The whole situation seemed one of amazing simplicity and certainty. In place of two horses, requiring the substitution of a new team every four years, and eating as much value of feed every year as their original cost, *it was necessary only to place under the old horsecar a permanent electric motor,* to build a power station, and to erect an overhead wire system consisting of wooden poles and a few wires, in order to move cars at a higher speed and carry more passengers in a more comfortable and attractive manner. . . . A veritable El Dorado had been attained. . . . (Emphasis added.)
>
> The first disillusionment of the . . . pioneers came with rapid improvements in the art. . . . Although still mechanically as efficient as when installed (the original electrical equipment had to be) replaced by . . . better equipment costing half again as much (150% of original), but . . . superior in reliability, flexibility and power . . . tracks and the cars must be replaced by entirely new units and heavier units.
>
> The introduction of the new motive power disclosed almost immediately the desirability of unifying the control of the various previously independent lines in each city. . . . *Horse* railways could be operated with as satisfactory financial results in small units as in large ones. . . .

> Each company put into effect its own stipulated rates of fare, and undertook to furnish transportation, at those rates, only upon its own lines. . . .
>
> Notwithstanding the optimism of promoters . . . , it was found that the investors in the *old and financially established horse railroad companies* (emphasis added) were reluctant to provide the capital even for the initial change from the old to the new motive power. . . .[30]

The transit trusts also developed an unsavory reputation as scandals broke involving political corruption and heavily watered stock.[31] Many of the rail systems never operated at a profit, but their holding companies did make money through the generation of power and through real estate speculation. Land value along a rail line would skyrocket, leading to several land booms and busts.[32]

All these problems led to considerable regulation of franchises and the limiting of fares charged. This governmental regulatory policy plus the inflation that accompanied World War I led to the decline of the rail systems.[33]

There were other causes as well. Management was often of poor quality.[34] Later the 1930s depression and the increase in urban decentralization damaged transit companies. The debate over all these causes still rages today and still affects public policy. Therefore, a more complete discussion of this issue follows the discussion of other public transportation innovations.

Limitations. A primary limitation for these rail lines was their inflexibility. With the introduction of the automobile, more areas of the city became accessible, and the transit lines no longer served a majority of people. This lack of flexibility proved to be vulnerable to the jitney operations, which began around 1910. There were economic disadvantages as well. Track maintenance was a great expense. One mechanical failure or an emergency such as a fire could tie up a whole line. Most of the electric railways operated on surface streets, and, as traffic increased, their travel was slowed considerably, and there were numerous and devastating accidents.[35]

Elevated and Subways

These were the systems which we now refer to as rail rapid transit or mass rapid transit. They operate as large trains on elevated lines as in New York and Chicago, or in subways—the first of which was built in London in 1863. Whereas there have been many equipment improvements since the original systems were built, the essential technology for these systems is unchanged to the present time. The BART System in San Francisco does include some twentieth century technology in the form of its computer-controlled system, but one observer has referred to this system as the most advanced nineteenth century technology in existence today.

Service. The service is again group service, very large groups, thus the term mass rapid transit. It operates on grade-separated guideways with more widely spaced stations than streetcar systems have. Therefore it can operate at higher speeds. Door-to-door speeds may be slower; however, since there are fewer stations and the distance from one's destination makes overall trip-time slower for most passengers.

Along with commuter rail, these heavy rail systems may have contributed more to urban sprawl than is commonly recognized, since a longer trip is more advantageous to the rider than a short trip. The development around New York City, Chicago, and Boston indicates it is not only the auto that encourages dispersed development. Even Los Angeles, renowned for its automobiles, was shaped to a considerable degree by the sprawl of the Pacific Electric System.[36]

Financing and Organizational Structure. A pattern similar to that of the street railways exists with the elevated and subway systems. Large organizations were needed to finance the systems, and these rapidly became monopoly operations within a given city.

Limitations. Again, they are similar to the street railways, except that there is no problem of congestion from other vehicles. In addition, the largest proportion of their ridership occurs during peak hours, roughly 20 hours per week, leaving both capital and labor unused and therefore unproductive.[37] Today this makes them even more vulnerable to the possibility of a 4-day work week. Currently, all such systems the world over are operating at a deficit (they have long since been taken over by public authorities, since private interests are no longer interested in operating a losing proposition), and they are showing declining ridership.

The Jitney

The jitney was a modified five- or six-passenger automobile operated on existing roadways charging a 5-cent fare. They were operated as common-carriers as early as 1910 in the western states and were largely ad hoc operations. Since they used the public roads, they were at first ignored by the regulatory bodies and the railroads. They were viewed essentially as motorized stage coaches.

Numerous independent operators entered this field, and they began to operate between central cities and other outlying locations. They followed semiflexible routes and would pick people up anywhere along the way and attempt to deliver them as close to their destination as possible. The term jitney came from the commonly used word, which described a nickel's worth of anything.

Service. The jitney offered a faster and more flexible service for small groups of people than that of the streetcar, and there were no standees. Jitneys could shift quickly to accommodate changing travel demands and therefore were quickly accepted by the public. Many of the jitneys would travel along streetcar lines picking up waiting passengers for a quicker and more convenient trip. Some jitney operations apparently attracted up to 50 percent of the peak-hour electric rail ridership.

Financing and Organizational Structure. The capital requirements for an individual to start operating an automobile as a jitney were relatively low. Jitneys had no municipal assessment, no required insurance, no service or route requirements, and no need to build or maintain a guideway. Therefore many independent owner/operators entered the field, many of whom wanted additional income to help pay for their vehicle. By 1917, it was estimated that 24,000 jitneys were operating in the United States, so it presumably was a reasonably profitable operation for its owners.

Limitations. Electric railways were hit hard by this competition, and they were in a powerful position to eliminate their tiny competitors. Between 1914 and 1920 restrictive legislation was passed, and the jitneys were regulated out of business. The threat to a powerful vested interest exceeded the desirability of the service to the general public.

The Motorbus

The jitney apparently led to the introduction on a large-scale of the motorbus in the United States. London had replaced its entire horse-drawn omnibus system with more than 3,000 motorbuses by 1914, but in the United States the "transit trusts" had large sums invested in street railways and were unwilling to have their investments made obsolete by the new technology. In 1920 there were only sixty motorbuses operating in the entire United States.

With the defeat of jitneys through legislation, many of the jitney operators assumed streetcar-like operations with fixed routes and schedules and, in some cases, streetcar-like vehicles. Some became feeders to the electric streetcars, and still others sold out to the street railway companies and became part of the new motorbus divisions. These motorbus divisions offered clear economic advantages, since they reduced fixed costs for tracks, the vehicles were cheaper to buy, and they only required a single operator instead of the two used in streetcars. Even though buses wore out sooner and had higher seat-mile costs, the short-term investment savings were important to financially pressed street railways.

Service. The service was still group service but again operating on roadways. The routes and schedules were essentially fixed (as required by the antijitney legislation and following the pattern of the street railways), but it was possible to change the routes offering somewhat greater flexibility than rails. Service was and is slow, however, due to numerous stops for passengers and increasing congestion on the roadways.

Financing and Organizational Structure. Because the capital cost for bus systems is much lower than for rail systems, the existing rail systems gradually converted to bus operations, and the prevailing local monopoly system of operations continued. (The monopolies are in the areas covered. Within some metropolitan areas there are several bus companies, but they rarely cover the same routes.)

Limitations. The low quality of service is a major limitation for the user. From the operator's standpoint, high labor costs are another limitation. Bus operations consistently operate in the red, and the number of transit companies has declined dramatically. In the largest cities municipal authorities have had to take over unprofitable operations, since private investors were no longer willing to operate these systems at a loss.

The Automobile

Since the automobile is, today, the dominant mode of transportation in the United States, no discussion of public transit can make any sense without recognition of its key role. Except for taxis, the automobile is considered to be a private form of transportation, since the vehicle is owned by individuals. Nonetheless, the roads it runs on are publicly maintained, and it creates a number of social problems, so it has many public aspects as well.

As an innovation, it is significant to note that the automobile was introduced as a horseless carriage. As such, it offered a low level of threat to society in general. It did offer some threat to harness makers and horse breeders, but it used the existing carriage technology and put little stress on that industry.[38]

In addition, it began in a small way as a rich man's toy and posed no visible threat to the established social order. Certainly the powerful railways, which carried the nation's goods and communications, were not immediately threatened by this initially unreliable horseless carriage. The threats that were perceived were handled with restrictive legislation such as speed limits and requiring a flagman to precede any vehicle operating above a certain speed.

There were also technological and institutional road blocks. The reliability of the vehicle had to be improved, initial costs reduced, roads improved, access to power sources developed. These bottlenecks to further development were quickly overcome, however, as the inherent desirability of the new device became clear.

For the city dweller there was relief from the pollution problems of the horse. Even with electric streetcars, there were 150,000 horses in Manhattan alone in the 1880s. With each producing 35 pounds of solid waste and 18.5 pounds of liquid per day, the pollution problems reached crisis proportions. Filth and flyborne epidemics were real threats until the auto replaced the horse as the primary means of transport.[39]

With the development of mass production, the costs of the automobile were reduced dramatically, and this plus a beginning used-car market and the possibility of jitney operations gradually enabled a majority of people to have independent mobility for the first time. Today it is fashionable to note all the problems with the automobile, but its democratizing effects—the freedom of mobility it gave to millions—is less frequently mentioned.

Service. Offering nonscheduled flexible service at any time the owner/operator wishes to travel, the automobile is extremely convenient and comfortable. One can go directly from trip origin to destination, making intermediate stops if desired and carrying packages. All riders are seated in privacy without overcrowding.

The automobile also opened up new areas for housing and commercial and industrial development. No longer were people or businesses tied to a rail line, and property away from the rails became more attractive and therefore more valuable. It also became possible to go to the beach or to the country on Sundays and holidays—places only poorly served or not served at all by work-oriented transit systems.

For the people who lived in small towns in what the census describes as "rural territory" (more than half the population prior to 1920), public transit service was virtually nonexistent. Rail lines served these towns, but not as a regional network. To visit a town only 12 miles away might require a train trip 8 hours long with several transfers.[40] Fred Allen wrote of his woes as a young vaudeville comedian traveling on a theatre circuit in eight midwestern states:

> The cities and towns of the network of the eight states could seldom be reached by any one railroad. To go from Chicago to the various theatres where he had been booked, the actor traveled on the New York Central, Chicago and Alton, Santa Fe, Wabash, Union Pacific, Big Four, Chicago and Burlington, Chicago, Milwaukee and St. Paul, and perhaps one or two other railroads. There never seemed to be a direct way the actor could go from one date to another without changing trains once or twice during the night and spending endless hours at abandoned junctions waiting for connecting trains. One trip always annoyed me. Terre Haute and Evansville, both in Indiana, were split week. The acts playing . . . in Terre Haute for the first three days went to . . . Evansville for the last three. If it had been possible to go directly from one town to the other, the trip could have been made in three hours. It took the actor eight hours . . . leaving on the midnight train. After riding for an hour, they had to get off at some small town and wait four

hours for a train to pick them up to ride the remaining two hours to Evansville.[41]

With this kind of service, it is no wonder that travelers deserted the rails as soon as they could for cars that were reliable and for highways that were not mud roads. It was the rural states that had the highest per capita usage of automobiles in 1920.[42] The city dweller, on the other hand, still had a public transit system that functioned reasonably well, and "there was no 'superior' technology to which riders or suppliers fled at first."[43]

It was post-World War I inflation coupled with the legally mandated fixed fare of 5 cents that dealt the real blow to the urban rail systems, as shown in table 3-1. The revenue rise in 1922 probably reflects the somewhat reduced mileage of that time plus some increases in fares. It is also significant to note than even in 1907 these systems were not operating at a profit as rail systems. This supports the claim that the transit companies were more interested in profits from other ventures such as real estate and electric power generation:

> Further investigation of the transit industry's complex financial history might well reveal that few, if any, operations ever made large profits from transit operation alone over sustained periods. Strict regulation and other social controls such as political intervention, requiring fares and service to be inflexible, doubtless encouraged numerous illegal or quasi-legal practices designed to produce income for those performing the entrepreneurial function—no matter what the books reported.[44]

Beginning in the 1920s, however, the clear superiority of the automobile did emerge. For those who drive, it offers excellent service in terms of convenience to the user, access to the community, freedom, and mobility. Thus the transit industry operated in its own monopolistic world—forbidding those who would compete for a share of the public transportation market, even while the public portion of the market was declining precipitously.

Table 3-1
Electric Rail Operating Costs and Net Operating Revenues

	1907	*1912*	*1917*	*1922*
Operating costs per car-mile	.156	.173	.212	.343
Net operating revenues per car-mile	.104	.122	.120	.136

Source: A.L. Kornhauser and L.B. Wilson, "Role of New Technology in Urban Transportation: An Historical Perspective," in D.A. Gary, ed., *Personal Rapid Transit III* (Minneapolis, Minn.. University of Minnesota, 1975), p. 101. Reprinted with permission.

The Decline of the Transit Industry

The decline of the transit industry is widely acknowledged, only the causes and the timing of the decline are still subjects for debate. The issue remains current, since an analysis of the reasons for the decline leads inevitably to proposals to stop or even reverse it. There are several interlocking arguments to this debate, one of which involves the demise of the street railways along with the rise of the motorbus.

The Causes of Transit Decline. Although the attractiveness of the automobile may be the most widely accepted cause of the decline of public transit, there is another fairly widespread belief that once we had good public transit in cities, which was systematically destroyed by a conspiracy involving National City Lines, General Motors, Standard Oil of California, Phillips Petroleum, Firestone Tire and Rubber, Greyhound Corporation, and others. Through the holding company, National City Lines, these organizations bought up existing street railway companies and converted them to buses to sell their products to the new bus companies.[45]

The details of the formation of National City Lines is documented in the case of *United States* v. *National City Lines, et al.*,[46] a major antitrust action with a four-volume transcript. Briefly, National City Lines was incorporated in 1936 to purchase transit systems in cities where streetcars were no longer practicable and convert them to motorbus operations. To raise capital to make such purchases, a plan was devised to procure funds from manufacturing companies whose products would be used by the operating companies.[47] Thus creating a conspiracy wherein National City Lines and General Motors were convicted of monopolizing the market.

For those who would build new rail systems today, it is attractive to assert that we once had good rail systems, which were destroyed for narrow profit motives. In Los Angeles, the nostalgia for the "Big Red Cars" continues and was the basis for a political campaign to build a new rail transit system in 1976. Unfortunately, however, the evidence does not support the conspiracy theory.

Rail transit systems began having serious financial difficulties during and just after World War I. Real estate ventures could no longer support existing systems since the land had long since been developed and the profits realized. The trend toward buses began in the twenties for economic reasons, long before National City Lines entered the picture.

Track construction and maintenance were eliminated; one mechanical failure did not shut down an entire line; buses could be rerouted if demand shifted or if a street were blocked due to construction or some other emergency. By 1919 one-third of the rail-operating companies were bankrupt.[48]

The situation of the urban transit industry became so serious that President Wilson appointed a Federal Electric Railway Commission to publicize and investigate it. The proceedings of this commission, published in three volumes, document the problems that plagued the industry during and just after World War I. Interestingly, the solutions to these problems offered by the industry were to restore corporate credit by reestablishing their monopoly, banning competition (the jitneys), and raising fares. They did not suggest improving service to the user. There was only one exception to this conservative point of view, and it went virtually unnoticed:

> . . . reorganization of the street railway companies to reduce capitalization, for improved and different service (such as more frequency of operation), and for recognition of the rights of labor to reasonable working conditions and fair wages. Otherwise, it was noted by Wilcox, public ownership would eventually come, but the public would own a mere shell of the original industry.[49]

The transit industry got what it wanted (restoration of its monopolies), but it was not enough to save the street railways. The critical factor leading to the conversion of the street railways to buses and to the further decline of the industry may have been the Public Utility Holding Company Act of 1935.[50] This Act was based on an investigation of the power and gas industry made by the Federal Trade Commission from 1927 to 1933. It was a ninety-five-volume study with a 1,000-page index, which interestingly does not carry a single reference to electric railways or urban transit. Yet these power holding companies played a key role in the provision of capital for the electrification of street railways.

In 1931, over 50 percent of the street railway companies and over 80 percent of the total revenue passengers rode bus or streetcar lines controlled by the power holding companies.[51]

> . . . almost without exception, the holding company itself could make a reasonable satisfactory statement of profits through its other classes of investments like gas, light, and power, heat and water utilities in which the labor item was of much less importance, and in which better conditions of tenure and greater flexibility of rates prevailed, than in the case of street railways.[52]

With the passage of the 1935 Act, the power companies divested themselves of the unprofitable transit operations. During the legislative hearings on the Act, the power trusts did not mention the subject of transit, and one might assume the power trusts were anxious to find an excuse for disposing of these unprofitable properties without incurring the wrath of local communities, which might jeopardize their more lucrative franchises.[53]

Significantly, in New Orleans the power company has maintained control of and subsidized the transit operation as part of its 1922 franchise. Apparently for this reason, New Orleans has maintained the lowest fares in the nation for years (it was raised to 15¢ from 10¢ in 1970) and has the second highest per-capita ridership in the United States. Total household expenditure for gas, electricity, and transit in New Orleans ranks lowest of the forty-two largest cities in the country.[54]

With the essential elimination of power trusts in the transit business, new sources of capital and support had to be found. It was here that National City Lines and the other "conspirators" entered and played a significant role in offsetting the contraction of capital for transit modernization caused by the 1935 Act. Clearly they also had a profit motive, and the chance to write off ancient, obsolete equipment still carrying high book values was an important attraction for outside capital.

In the 1950s, the National City Lines case led to another major loss of capital backing from suppliers, and this, coupled with the loss of patronage, made it unprofitable for large holding companies to remain in the transit business. Public ownership became essential to keep the transit systems operating.[55]

Thus it seems clear that economics, not conspiracy, destroyed the street railways:

> The author is convinced that the abandonment of streetcars prevented financial collapse of the industry. Almost overnight, an industry with high fixed costs of maintenance of way, generation of power, and, in some cases, engineering and construction of rolling stock, found itself buying standardized products from a limited group of manufacturers, as well as relieved of the problem of maintenance of right of way. The motor bus brought other significant savings. In many cities, two-man streetcars were replaced with one-man buses . . . (The companies) were able to close down unneeded depots, sell excess real estate . . . (etc.)[56]

In Europe a similar decline of transit systems has occurred, roughly thirty years after the decline in this country.[57] Rail systems have inherent economic and service problems that make them less attractive than other less capital-intensive systems.

Service Quality. Although the conversion from rail to bus made economic sense, some have argued that there was an accompanying decline in service, which led to the sharp decline in transit usage. Transit riders wrote letters to editors complaining about the buses—the fumes, jerky starts and stops, the lack of room, and the slow speeds in traffic. There was little or no competition among transit companies, so the best economic strategy for the operator was to offer the cheapest service the public would endure—the "endurable hardship."[58]

Transit operators tried to overcome these objections by stressing the shiny new equipment, the "modernness," the speed, and the safety of curbside stops, but there was virtually no interest in marketing in the sense of understanding consumer needs and meeting them.[59]

> The thrust of (transit) management efforts is often marked by a relatively indifferent, unrealistic, or impractical attitude toward maintaining or boosting demand. As a result, if revenues decline or profit margins shrink, the usual reaction of management is to cut costs, often by reducing service, and at the same time to raise fares to boost revenues. Needless to say, neither of these ploys encourages ridership. Indeed such policies carried on for very long almost guarantee that a transit company will eventually move only those persons unable to drive a car.[60]

One could argue that the best service that can be offered with a bus or rail system is inadequate to meet the needs of most people most of the time, but transit management has done little to make a bad situation better.

Timing of Transit Decline. The decline of the transit industry began at the time of World War I. The brief resurgence of transit ridership during World War II was an aberration due to severe gas rationing and other restrictions on driving. Nonetheless, a great deal of literature speaks of the decline of transit as beginning in 1946: "The decline of urban public transportation since the end of World War II has created real hardship for millions of people."[61]

By ignoring the decline that set in 25 years earlier, the problems of inadequate service and the changing shape of cities are submerged. It then becomes easier to argue that the problem with transit systems is their declining capital base and that the way to improve public transit is through an infusion of capital to buy new equipment.

Current Analyses of Transit Decline. Two major publications of the 1960s give focus to the debate regarding the decline of transit. J.R. Meyer, J.F. Kain, and M. Wohl argue that the decline in transit is the result of changes in geographical and demographic patterns of cities. In this situation the automobile is used as a complement to single-family housing in the suburbs, where light-density development makes the automobile the least costly method of moving people and a real necessity for those who live outside the central city. In addition rush-hour drivers from the suburbs are subsidized because the government uses average pricing rather than marginal pricing for its roads, and there is no extra charge for using the roads during congested periods.[62]

Further, the organization of urban transit systems into monopolies has caused them to be unresponsive to demand changes (as compared with jitney operations) and to have excessively high labor costs due to the development of strong unions.[63] Therefore, to improve public transit systems one should break the monopolies and allow a variety of systems to compete for the various types of trips that are taken in a metropolitan area. Jitneys, dial-a-ride buses, minibuses, and other flexible labor-intensive means of transportation are proposed by this school, which is largely made up of academic economists. Only since 1976 or 1977 has this approach received significant attention from transportation planners.

A different perspective was put forward by Lyle Fitch and Associates. They concluded that the urban transit industry declined because it was under-capitalized. Using the bulk of public transportation funds for highways through the highway trust fund has created an "unbalanced" transportation system, which makes it impossible for transit to compete with the automobile.[64]

Rush-hour travelers who had been unresponsive to price changes in transit were presumed to be highly responsive to improvements in the quality of service. Quality of service was interpreted to mean newer and more commodious buses, the substitution of rail lines for bus lines, or perhaps new systems of public transit. The prescription for this problem is to funnel more federal money into the transit industry to make it more capital-intensive.

This perspective is supported by the transit industry and is the one that has prevailed, as it led directly to the Urban Mass Transportation Act of 1964, which provided for a variety of demonstration grants and capital grants to save the rapidly declining transit industry:

> Capital grants are made for conversion of transit systems from private to public ownership, replacement of buses with new ones, purchase of ferryboats (to a limited extent), and building or re-equipment of rail transit systems. About two-thirds of the funds of the Urban Mass Transit Administration (UMTA) go into rail systems, and many of the proponents of the program, and apparently some of its former administrators, have looked upon the program as mainly designed to build rail systems parallel to freeways built by highway departments.[65]

Two significant elements regarding this debate should be noted. The catch phrase "balanced transportation" came into vogue, and is still commonly used by many transit planners. Presumably this means some balance between automotive and public transportation, but the definition is never quite clear. No one has specified what a balanced transportation system would look like, or for that matter which, if any, systems are balanced or unbalanced:

> The term "balanced transportation" is somewhat overworked, is frequently misunderstood, and needs a good definition. When we talk about balanced transportation, we are not sure whether it means balance of facilities, balance of usage, competitive balance, funding balance, or if it is some combination of all of these.[66]

The second element is the equation of service quality with new equipment providing the same type of service. Studies going back at least to Doolittle's Report in 1916 show that service quality is largely equated with total trip time. Access to stations, waiting time, the need for transfers are all seen by the public as significant factors in service quality. The completed trip has not been given proper priority in transportation planning.[6 7] This blind spot regarding the user's and potential user's definition of service quality will be noted time and again and will be significant when discussing potential system innovation.

Summary

Technology and Innovation

As can be seen, there have been only four systemic innovations in public transit operations since it first began: (1) individual coach or taxi offering personal and private service; (2) the omnibus and motorbus, which used roadways and carried small- to medium-sized groups of people (twelve to seventy passengers at one time); (3) the rail systems, operating on fixed guideways; and (4) the jitney system which offered more flexible service for very small groups of people.

Such systemic innovations are often restructuring innovations for the individuals and organizations that operate earlier systems. Such changes penetrated to the third level of depth (see table 2-2) for particular roles, role-sets, organizations and perhaps organization-sets. The skills that are needed change, power relationships change, and authority is reallocated as are economic and social rewards.

In some instances the systemic change may be revolutionary if existing goals and values are upset. The jitney was a revolutionary technology, because it challenged existing beliefs about the number of people to be carried at one time, the flexibility of routes and schedules, and the quality of service desirable for public transit. Personal Rapid Transit is also a systemic change with revolutionary implications as will be discussed in chapter 6.

Equipment changes, on the other hand, usually penetrate to the first or second level of depth. Occasionally the third level is reached for particular roles and role-sets, but existing organizations rarely find equipment changes involve restructuring of the organization as a whole. Thus equipment changes are narrower in scope and more shallow in depth of penetration than are systemic changes.

It should be noted, however, that for particular individuals in particular roles, a minor equipment change may in fact be revolutionary in character. The individual's goals and values, perhaps regarding service or craftsmanship, may be utterly changed. Therefore, it is important to note the perceptions of individuals in various organizational roles to determine their perspectives on the nature of the change. Change has differential impacts at different levels of organization and organization networks.

Within the four systems listed, there have been numerous equipment innovations. Except for the jitney, which was legislated out of business, the service characteristics for all these systems remained essentially unchanged.

Changing routes or the number of stops or the increase or decrease in headways (which affect waiting time) are service changes, which can make considerable differences in the attractiveness of transit system and its ridership. They do not, however, change the need to do some waiting, to move as groups, on a schedule, on fixed routes.

Equipment changes are frequently referred to as technological innovation, but this is a limited use of the term. A more inclusive use would refer to the service function and distinguish systemic from equipment innovations. The lack of this distinction in most of the literature on transportation is a major conceptual block to further innovation.

Service

In all cases, public transportation is group transportation. The groups may be quite small, as in the case of coaches and jitneys, or extremely large, as in the case of mass rail rapid transit. The service is also restricted to fixed routes and schedules, some on public roadways with other traffic, others on exclusive rail guideways. Antijitney laws were generally written to prevent demand-responsive nonfixed routes. Fares were made inflexible. Some operators had to have new franchise laws enacted to introduce motorbuses or to reduce the crew on streetcars from two men to one.

It should also be noted that each innovation adopted offered an improvement in service to the user. Even the motorbus, which may be seen as a minor improvement, did allow transit companies to offer services in areas that had never had rail service. It also cleared the streets of tracks, which improved traffic flow to accommodate the increasing numbers of automobiles. The enormous acceptance of the automobile with its higher level of service and convenience offers important insight into the problems of public transit.

Organization Structure and Financing

Initial transit systems were begun by owner/entrepreneurs with low capital investments. Later innovations brought a greater need for capital as well as the possibility for patent restraints on competition. Large capitalist-dominated organizations developed, which later were taken over by the power and transit trusts, which dominated the industry until the 1935 Public Utility Holding Company Act.

This was followed by local transit monopolies, often supported by loans from the suppliers of transit equipment. Frequently this support was gained by selling the transit operation to the National City Lines Holding Company. When the support of the suppliers was no longer possible due to the consent decree in the National City Lines case, the largest transit companies were taken over by local public authorities, which also operated as local monopolies.

Monopoly and Innovation

The evidence is mixed regarding the relationship between monopoly and innovation. Certainly the Bell System offers an example of a monopoly that is highly innovative. In the transit industry, however, monopoly has been associated with a lack of innovation. In part this is due to legislation and regulative practices that prevent some potential innovations, but it is also a fact that innovation in transit has been difficult from its earliest days.

One of the reasons has been the recurring theme of the industry's need to protect a large capital investment. The speculators in electric rail technology had to buy out the horse railways, thus piling new capital debt on old. The problem of dealing with obsolescent capital investments still exists. The whole history of the transit industry is one of great difficulty in handling technological reinvestment without severe economic disruptions.

Further, the monopoly position of the transit operators within one segment of the transport system coupled with the possibility of a better alternative for the majority of the population, allowed transit operators to be quite unresponsive to the needs of their passengers. The passengers were poor, old, halt, and largely female—all groups without significant power in society. These factors have combined to make possible a consistent conservatism in the industry with regards to innovative operating practices:

> Any departure from the standard or any new method of carrying passengers on a common-carrier basis is viewed only as a threat to the existing infrastructure instead of a way to offer better or more desirable service to the public and perhaps gain a larger share of the urban transportation market.[68]

As early as 1916, Harvard University did a study for the transit industry on the psychological problems of transit riding. It showed clearly that most patrons were dissatisfied with two basic aspects of conventional transit service—crowding and waiting (time loss). The response of a high transit official was (and is) to discount the opinions of the passengers instead of trying to respond to their needs.

Passengers were shown by the study to consistently overestimate waiting time and exaggerate congestion, and this proved that their "knowledge as to technical details of operation is limited and expressions of opinions . . . are varied and confused."[69] There was no consideration that the perceptions of the passengers might influence them to turn to other modes of transportation such as the automobile.

The Source of Innovation

For the most part, innovation has come from outside the transit industry. People interested in the application of electricity developed the electric rail car. The motorbus was an application of automotive technology made by automotive manufacturers.

One of the few exceptions to this pattern occurred between 1916 and 1921, when some street railway operators tried to raise their level of service by using smaller, lighter streetcars called the Birney Safety Car. It operated with one person instead of two, so the decrease in costs could be passed on to the consumer in the form of more frequent service.

After 1921, however, the operators decided that the Birney Car could not handle rush-hour crowds and that it could not cope with heavy snow. Therefore, this attempted innovation quickly lost popularity.[70] Other than this, it is hard to point to major innovations that have taken place within the transit industry.[71]

Most equipment innovation has come through the manufacturers of the equipment. These innovations are not insignificant, but they have not led to a major reexamination of what public transit ought to be or might be. With essentially only one major bus producer (there are two smaller companies but they get their parts from General Motors), and competition for business based on prices, the incentive to offer better equipment is minimal.

Conclusions

The history of the transit industry is one of increasing local monopolies with large capital investments; these monopolies were reluctant to make any changes. At the time they were large and powerful, they achieved protective legislation, which has made change even more difficult, and their view of their job is quite limited. The availability of the automobile to most of the population makes their low-quality service less likely to create demands for change.

Most transit operators see themselves as being in the bus business or the rail business, but not in the business of moving people in the most effective manner regardless of equipment used: "The transit industry [has] exhibited an attitude of fatalism and stagnation rather than one of innovation."[72]

4 Today's Problems and Alternatives

Over the centuries, the movement of people and goods in urban areas has presented a variety of difficulties and problems. As transportation technologies changed, it became possible to develop new urban forms to accommodate the explosive growth in urban areas that took place in the late nineteenth and twentieth centuries. Today, what are termed urban transportation problems are part of a much larger complex of urban problems having to do with population growth and density, industrial development, zoning and taxation policies, housing policies, geographical constraints and inducements, ethnic groupings, and personal preferences. Cause and effect relationships are often confused, leading to proposed solutions that address effects rather than causes.

Most discussions of the urban transportation problem begin and end with the automobile. This may be reasonable since the auto is clearly the dominant mode of urban transportation, but it is also misleading if it directs attention away from underlying causes of transport problems. It may also distract from another very real problem—the dearth of attractive alternatives to the automobile.

Land Use

Frequently the automobile is blamed for the problem of urban sprawl, but the move to low density living that has been permitted by the automobile began long before the auto came on the scene.[1] As people became more affluent they had more choices in housing, and track cities allowed urban expansion in roughly starshaped corridors expanding from a central industrial and commercial core.

Later the development of electric motors made land-extensive horizontal factories in outlying areas more economic than the vertically organized steam-powered factories in the central core. Telephones removed the need for hand-delivered messages between offices and also allowed people to communicate with those who lived in more distant neighborhoods. Trucks freed manufacturers from the need to be near a central rail system, and these factors plus the lower cost of land and taxes in outlying areas made greater disposal of industry attractive.[2]

Initially, suburbs were viewed as housing developments, "bedrooms" for central city workers, which were supported by governmental zoning, taxation, and housing policies. Industrial expansion quickly followed, however, and many jobs, especially industrial jobs, are now found outside the central city.[3]

In perhaps the extreme case, only 6.6 percent of all jobs in Los Angeles County are found in what passes there for a central business district.[4] Even New York City has lost 600,000 jobs since 1969, and this has been accompanied by a 24 percent drop in public transit ridership during this same period.[5]

As table 4-1 indicates, the explosive growth in urban areas has been outside central cities. Both residence and employment are becoming increasingly dispersed, modifying the demand patterns for urban transportation.[6] The automobile has met the new demand patterns and clearly made possible the type of urban growth that is visible today. It is not clear, however, that it has caused such growth, since the causes appear to include human desires, economic factors, and other technological developments as well.

The gains we have made from providing a high level of mobility for most of the population have come, however, at a cost. We have lost valuable agricultural land to development. We have run away from the internal problems of the central cities, leaving them to decay, and inhabited primarily by the poor. The value we gain in less expensive housing, we pay in more expensive traveling. We also pay social costs by denying access to the goods of our society to those who cannot drive. We pay in congestion, pollution, increased use of energy and resources. Even as we enjoy many benefits, the quality of our lives declines.

Congestion

In most transportation studies, "the problem" of urban transportation is congestion—not just any congestion, but the particular congestion found in the home-to-work commuter trip:

> The principal task of transit will be to absorb home to work travel peaks.[7]
>
> The most troublesome urban-transportation problem is meeting the peak demand of the journey to work.[8]
>
> The lack of satisfactory service by either car or transit exposes people twice daily to congestion and tension that have come to be an accepted condition of urban living.[9]
>
> . . . the primary focus is on the problem of moving passengers into and out of cities during the peak or rush hours, occurring mornings and afternoons on workdays. It is these movements that tax the capacity of existing urban transport facilities and created congestion and delays that most people associate with what has come to be known, for better or worse, as "the urban transportation problem."[10]

Table 4-1
Population by Residence: 1950 to 1976
(millions)

	Population							
	1950		*1960*		*1970*[a]		*1976*[a]	
Residence	*Total*	*Percent*	*Total*	*Percent*	*Total*	*Percent*	*Total*	*Percent*
Standard metropolitan statistical areas	94.6	62.5	119.6	66.7	137.1	68.6	142.6	67.8
Central cities	53.7	35.5	59.9	33.4	62.9	31.5	60.7	28.9
Outside central cities	40.9	27.0	59.6	33.3	74.2	37.1	81.8	38.9
Nonmetropolitan areas	56.7	37.4	59.7	33.3	62.8	31.4	67.8	32.2
Total	151.3	100	179.3	100	199.9	100	210.3	100

	Percent Increase		
	1950-1960	*1960-1970*	*1970-1976*
Standard metropolitan statistical areas	26.4	14.6	4.0
Central cities	11.4	5.0	(3.5)
Outside central cities	46.3	24.5	10.2
Nonmetropolitan areas	5.3	5.2	8.0
Total	18.5	11.4	5.3

Source: Adapted from U.S. Bureau of the Census, *Statistical Abstract of the United States, 1977* (Washington, D.C.: U.S. Government Printing Office), p. 16.

[a]Adjusted to exclude inmates of institutions and members of the armed forces living in barracks and similar types of quarters for comparability with 1976 data from Current Population Survey. Percentage increase from 1960 to 1970 is reduced 1.9 percent due to this adjustment.

> The real value of reduction in commuting time in terms of increased productivity for the community must be accepted as part of the cost equation.[11]

The difficulty with this definition of the problem is that it ignores the land-use patterns just discussed. It assumes that most people live in suburbs and work in central cities, whereas in reality only 18 percent of the working population commute along conventional paths to and from the central city.[12] Others travel in increasingly random patterns to a variety of dispersed locations. There are thousands of origin points and destinations.

Even with the steady diminution in importance of the central city, there is still a substantial population—largely poor and minority—living in or near central cities. For them, the dispersal of industrial jobs creates particular hardship. They frequently lack a car, and the transit service available is not only poor, it is going in the wrong direction. These people cannot qualify for the predominantly white-collar jobs found in the central city, and they cannot get to the industrial jobs in the suburbs.

Just to find a job is extraordinarily difficult, and many ghetto residents report bypassing work opportunities due to the lack of transportation. If one cannot get to work in a timely and consistent fashion, one cannot work. Figures for the ten worst areas in the city of Los Angeles give some idea of the potential magnitude of the problem. All are ghetto areas, primarily black or Chicano. (See table 4-2.)

One analyst suggests it would be a "comparatively simple task of arranging routes to carry central city workers to suburban jobs on reverse trips . . ."[13] but as one leaves the center, the number of potential destinations increases geometrically, making such a reversal a difficult and costly task. In addition, when such service has been provided, such as the Century bus line in Los Angeles, it was found that people rode the bus only until they had enough money to buy a car.

This is not to deny that we have congestion in our urban areas. This problem is visible and obvious in many areas, but its nature is more complex than the home-work argument allows, and it is intermingled with a number of other urban transportation problems, which get varying degrees of attention from analysts. Nonetheless, the emphasis on home-work congestion has had real consequences in terms of proposals for action, and the other problems have received less attention, as will be shown later.

Access and Mobility

The problem of the urban poor illustrates one facet of the questions regarding access and mobility. Access is a characteristic of a transportation system that

Table 4-2
Percentage of Labor Force Bypassing Work Due to Lack of Transportation

Avalon	52.8
Central	51.0
Exposition Park	40.9
Boyle Heights	38.6
Green Meadows	33.4
Industry	31.3
Lincoln Heights	21.4
Watts	18.9
Downtown	18.8
S. Vermont	16.8

Source: Los Angeles Community Analysis Bureau, *The State of the City*, vol. 3, p. IX-31, 1972.

describes its capacity for reaching all points of a community. The present road system provides access to nearly every building and attraction in our society. For those who are able to drive an automobile, there is virtually unlimited access to the goods of our society.

The ideal level of access for the automobile driver serves to hamper and even prevent access for those who are unable to drive. The width of streets and the size of parking lots limit those who must walk or move in wheelchairs. These people we refer to as having limited mobility. Thus, access and mobility are the physical and human sides of the same problem.

Beyond those who have limited mobility for physical reasons, there are those who are too poor to own an automobile. There are also those who would prefer not to drive but have no reasonable or attractive alternative. To be unable or unwilling to drive a car in most areas of the United States is to be deprived of many of the goods of society—even the normal social interaction with friends and family. Mobility is so important it has been used as a social indicator defining the quality of life.[14] Those who lack mobility are significantly deprived, although there is some dispute regarding how many people fall into this category.

Most commonly, the mobility deprived groups are described as the poor, elderly, young, mentally or physically disabled, and in a few studies, women who work at home in one-car households. The actual numbers of people in each of these categories has never been adequately determined, and therefore we have partial data of uncertain quality. One of the problems is the question of definition; another is the overlapping characteristics of these groups—the elderly poor, handicapped women, poor and young. There are, however, some data that are indicators.

For example, in 1974, 18.5 percent of all U.S. households did not own an automobile; 48.8 percent owned one car only. In poor households (those with incomes under $3,000 per year), 56.8 percent owned no car, and 37 percent had one car. Among the elderly, those where the head of the household was 65 or older, 38.1 percent had no car, and 50.2 percent had one car. Finally, in metropolitan central cities, 28.7 percent had no car as compared to only 11.7 percent with no car in the suburban rings.[15]

Licensed drivers give us another indication of automobility. There were 133,874,000 licensed drivers in the United States in 1976, approximately 62 percent of the population, or 82 percent of the population 18 and over.[16] From this we can surmise that at least 20 percent of the population that might be of an age to drive, cannot drive. Women appear to be more handicapped in this area than are men. In 1975, 45.6 percent of the licensed drivers were women, compared to their 52 percent share of the total population.[17]

Unfortunately, none of these figures give any definitive estimate of the number of people who lack convenient access to the automobile. The numbers of elderly we can identify through census data, but we do not know about their access to the automobile. The number of poor people (defined as a particular annual income) can also be determined within a reasonable degree of error.

The handicapped, however, are more difficult to count. Physical disabilities cover a variety of conditions—the arthritic, the blind, the wheelchair person, and those using prosthetic limbs or mechanical walking aids.[18] They include people who are permanently handicapped and those who are temporarily handicapped (broken legs, sprains, dislocations, and so forth). There are the multiple-handicapped and the mentally retarded. Ninety percent of the existing mental retardation in the United States is classified as mild, implying these people can learn productive skills, and also presumably travel on properly designed transit systems.

For all these handicaps, "there exists a paucity of information . . . including: (1) the magnitude of the population, (2) incidence and types of handicaps, and (3) locational variability." Handicapped people are usually poor, and the overwhelming number (80 percent) are not licensed drivers.[19]

Finally, we have the young and the women working at home in one-car households, and in all cases, there is no agreement on who should be counted as the transit deprived. There are obviously a variety of assumptions one could use to estimate the number of people without convenient access to the automobile, but most figures range from 15 percent up to 40 percent. One estimate for southern California suggested 25 percent of the population must get along without an auto much of the time.[20]

The specific numbers are less important than the fact that a substantial proportion of the U.S. population is denied adequate mobility due to lack of access to the automobile. These people are not only themselves deprived, they must also inconvenience others—primarily friends and relatives—who must take them on various trips and errands. Young executives no longer hire chauffeurs, they marry them. Much of the mobility slack in the U.S. transportation system is taken up by women who drive the transit dependent to Little League parks, schools, libraries, hospitals, doctors' and dentists' offices, grocery stores, and so forth.

For the one-car family where the commuter takes the car, this means that most of the errands must be done outside of working hours. Most facilities in large cities do stay open evenings and weekends for this reason, and at these times they are heavily crowded. A study in the Boston metropolitan area indicated that traffic peaked in some suburbs between seven and eight o'clock in the evening.[21]

Another problem for the one-car family, and the two-car family where two family members work away from home, is the lack of a backup system. Automobiles do break down, and it is necessary to service and repair them from time to time. This is difficult for those who must use their cars at all times. Poorly maintained cars wear out faster, pollute more, use more gasoline, and are less safe. They also break down more frequently, thus compounding the burden—especially for the lowest-paid workers, who are likely to have the oldest cars. There are no data on how many days of work are missed for this reason, although the number may be substantial.[22]

Finally, the automobile is becoming an increasing economic burden, which must be maintained because there is no real alternative. If economic conditions continue to follow present trends, the high capital cost plus high operating costs of the automobile will put more people in the transit dependent category.

Environmental Quality

Air pollution has been the most publicized environmental problem relating to the automobile. The data, however, are much more open to question than is commonly reported. The definitions of "smog," and the unreliable methods of measuring pollutants and estimating vehicle use make the figures highly suspect.

In Los Angeles, the "home" of automotive pollution, the Los Angeles Air Pollution Control District (APCD) once estimated that as much as 90 percent of the air pollution came from the automobile.[23] It should be noted, however, that the APCD was only responsible for pollution from stationary sources; therefore if 90 percent of the problem was from a source they did not control, they could not be blamed for poor performance.

More recent figures indicate that passenger cars in the South Coast Area (greater Los Angeles) contributed 84 percent of the carbon monoxide, 60 percent of the reactive organic gases, 63 percent of nitrogen oxides, 38 percent of suspended particulate matter, and 9 percent of the sulfur dioxide.[24] These numbers indicate that air pollution is a real problem, one that injures health, damages property, and degrades the quality of people's lives. It is expected, however, that the proportion of air pollution contributed by the automobile will be a steadily decreasing percentage.[25]

Other environmental impacts such as noise, water pollution, and solid waste disposal are also associated with the automobile. All these problems are potentially soluble, by improving automotive technology, recycling, and other environmental protection measures. The strategies chosen, however, will have to deal with the complex of issues that make up the urban transportation problem.

Safety

The present transportation system based largely on the automobile kills nearly 50,000 people each year and injures millions. Automobile accidents are one of the leading causes of death and injury for children. The costs in human suffering, medical care, property damage, and litigation are staggering. Whereas traffic safety is a complex matter involving vehicles, roadways, drivers, and various support systems, any alternative to improve transportation must take these safety issues into account.

Existing public transportation systems do have excellent safety records in regard to accidents, even though individual accidents may be highly publicized due to their severity. The safety problems in public transportation systems stem from the crime and violence prevalent in urban areas. Waiting at bus or subway stops is frequently dangerous, and gangs of criminals may enter vehicles at later stops to rob or abuse riders. Transit police, exact change bus fares, and other police surveillance have become essential to protect passengers and transit workers alike.

Energy Consumption

Since the oil boycott of 1973-1974 energy has become a very significant issue. Transportation is a primary user of the nation's energy, accounting for 60 percent of petroleum consumption.[26] Therefore, efforts to conserve energy often focus on transportation.

The automobile is often attacked as a key element in the waste of energy, but the provision of various forms of public transportation may not lead to significant energy savings.[27] Smaller, more energy efficient automobiles plus the use of alternative energy sources may make this problem less acute in the future, but the various relationships among transportation modes and energy consumption are far more complex than is commonly noted. A wide range of technical, operational and behavioral factors must be included in any assessment of energy conservation in urban transportation operations.[28]

Resource Consumption

Although rarely mentioned today, our present transportation system based on the automobile uses tremendous quantities of raw materials, as shown in table

4-3. The amounts of chromium, molybdenum, nickel, manganese, and mercury are not shown in table 4-3, but these earth resources are also being consumed at a rapid rate. Even with additional recycling, we may be approaching "the limits to growth," and smaller cars can only delay the problem, not solve it. This is not, however, accepted as a problem in all quarters. Rather than viewing this drain on resources as a problem, the automobile industry has a quite different perspective: "Any cutback in vehicle production—as occurred in 1974—has an adverse effect upon all these industries and thus upon the entire U.S. economy. In this way, a decreased demand for raw and finished materials for auto manufacturers can cause widespread unemployment."[29]

Quality of Life in Urban Areas

The quality of life in our urban areas is a matter of serious concern, since roughly 70 percent of our nation's population now resides there. The issues involve density of housing and urban sprawl, the amount of land we are willing and able to give over to asphalt and concrete for streets and parking lots. The ugliness of electrical and other wiring above our streets and noise from transportation add to the degradation of the quality of our lives.

In Europe, pedestrian zones are being created in historic downtowns and commercial areas. In Germany they not only have over 500 pedestrian zones, but they are also working for "traffic tranquilization"—the creation of residential zones free from through traffic.[30]

This movement to improve the quality of life by reducing automobile traffic may also be coupled with our rising expectations for goods and services. Although just barely discernable today, we may be approaching a time when people may wish to be relieved of the burden of driving. A system that could enhance our mobility and not require us to drive might be seen as a very positive good.[31]

Table 4-3
Automotive Consumption of U.S. Material, 1975
(percent)

Steel	19.0
Aluminum	11.8
Copper	8.3
Cotton	1.2
Malleable iron	47.1
Synthetic rubber	59.1
Zinc	33.3

Source: Compiled by Motor Vehicle Manufacturers Association of the United States, Inc., from various trade sources.

Costs

Transportation systems are expensive. The present system dominated by automobiles presents high costs to the user and to society in road construction and maintenance, insurance and medical costs resulting from accidents, police and court costs, energy, and resources, to say nothing of the human damage and suffering. To build any new system the capital costs in both dollars and resources must be carefully considered. Operating costs are also a significant factor. No system should be built that does not conserve both resources and dollars—during its construction and its operating phases.

Freight Movement

Although rarely mentioned in discussion of urban transportation problems, the movement of goods in metropolitan areas adds to many of the problems already noted. Urban transportation solutions that deal only with the movement of people are seriously deficient and may reflect the fact that different agencies of government and private industry deal with the movement of people and the movement of goods.

Institutional Problems

The most frequently mentioned institutional problem concerns the fragmentation of responsibility for urban transportation. The fragmentation involves territory—city, county, special district, and state boundaries, and it involves modal responsibilities. Different institutions are responsible for roads, buses, trains, airplanes. There is no functional integration for people who wish to transfer from one mode to another. One must also look at the weaknesses of the public transportation systems—their technological backwardness, poor management, uneconomic fare systems, the difficulties of moving in congested traffic, the slowness and effort in boarding and exiting, as well as their opponents, who support automotive systems.

We have a tendency to discuss urban affairs as a series of problems that are identified and associated with particular institutions. Public transit is the problem of the transit operator, crime is a police problem, education is a problem for the schools. There is not always a good fit, however, as problems overlap institutional policy space, and potential solutions fall outside the domain of any existing organization.

For example, the widespread institution of flextime (allowing people to set their own working hours within broad limits) could greatly reduce the number of people who must travel during traditional morning and evening rush hours.

This could not only reduce the peak hour burdens on public transit but also make better use of express highways. Organizations that have adopted flextime have found increased productivity, reduced absenteeism, and higher employee morale, but there is no institution that can promote its widespread adoption as a matter of transportation policy.

Transportation policy is, however, a significant element in local politics. In the 1880-1920 period, the big issues were the streetcar monopolies and the regulatory commissions, which were often accused of favoring them. From the 1920s to the mid-1960s politicians had the ideal public works pork barrel in the construction of roads and freeways, which almost everyone favored. Contracts could be awarded, a great deal of money was available, and the politician was in a good position to claim credit for new paving or a more convenient freeway.

In the mid-1960s this happy relationship was called into question by those who opposed highways because of their detrimental effects on the environment and urban land-use patterns. Interests polarized between those who favored more highways and those who favored transit. In big cities, downtown interests combined with the mayor, the transit authority, and environmentalists to promote transit, usually rail transit. In San Francisco, Atlanta, and Baltimore, the strong business interests that benefit most from rail transit were able to influence government officials and the electorate to support new rail systems.[32]

The protransit interests also divided in some cities as some academics and economists favored buses over rails because of their flexibility and lower capital costs. The highway interests also favored buses, since the busways would be built and controlled by highway agencies. The debate has often been acrimonious, and politicians caught in the middle find themselves in a lose-lose situation.

Highways are blocked by neighborhoods demanding environmental impact statements, whereas nonhighway solutions are anathema to the powerful highway interests. Buses are seen as old-fashioned and slow, and rail systems are viewed as expensive, dirty, socially undesirable holes in the ground that serve only the few.[33] Federal policies for public transportation have shifted frequently making it difficult to plan local systems, which require federal approval and money. The result, in many cases, has been immobility. When any decision will create vociferous opposition, the easiest course is to make no decision. Thus many urban transportation policies are effectively blocked in an institutional situation where everyone says action is necessary now but no one is in a position to act.

The decision points in the system are multiple and shifting, scattered through government structure at all levels, and through society itself as the private sector actors mobilize to support or oppose particular policies. Struggle, competition, negotiation, trade-offs, bargaining, and the alignment and realignment of actors characterize this ongoing process. Even when policies appear to be blocked, the processes continue as each set of actors tries to get its policies on the political agenda for action.

Alternative Transportation Systems

Clearly urban transportation problems are multifaceted and complex. This simplified overview does not do justice to the full scope and depth of these issues, but it does make clear that there is no single urban transportation problem and that efforts to reduce the problems to a single variable such as rush-hour congestion make the resolution of other issues more difficult.

There are many different possibilities for dealing with these problems, but often a solution to one problem exacerbates the nature of other problems. Improving access by moving people and activities closer together creates more congestion, and in the minds of many reduces the quality of life (the Manhattanization syndrome). Reducing demand for travel facilities through restrictive legislation creates real hardships for many people and is likely to be politically unacceptable without a clear and visible emergency.

Reducing the demand through technological change, such as increased use of telecommunications, is a possibility that has been predicted for the past 20 years. Although the potential clearly exists, it is not yet available for the vast majority of the population. Judging from our present state of knowledge, a complete shift from the wheel to electronics seems unlikely, although some reduction in the growth of demand seems to be taking place and more is likely to occur in the future.

Government policy has been to facilitate the physical movement of people and goods, primarily by building more highways. This often helps to reduce congestion, but it may aggravate problems of environmental quality, mobility for those without autos, land use, and so forth.

In attempting to formulate new policies, governments find themselves caught by competing demands, and different parts of the political system respond to different problems. During the peak of the energy crisis in 1974 when people were being urged not to drive, $2 billion were released to build roads to create employment. At the same time, the Environmental Protection Agency was demanding restrictions on automobile usage to improve air quality.

With these varying pressures and responses, most contemporary urban transportation plans call for a multimodel approach with greater emphasis on public transportation. There are also federally mandated strategies, Transportation Improvement Plans, and Transportation System Management for developing new policies and for improving the use of existing transportation facilities.

The difficulty with all such plans and policies is that none of the existing transportation alternatives effectively deals with the urban transportation problems enumerated. Even combinations of modes cannot deal with all the issues raised. Thus each solution has costs and benefits that are distributed unevenly, and these need to be examined from the perspectives of the user, the operator, government officials (at various levels), special interests, and society as a whole.

Private Transportation

In the United States today, urban transportation is largely private. Walking, bicycles, motorcycles, and the automobile are personal modes of transportation controlled by individuals. Although there is an occasional advocate of a return to the walking city, walking is a limited and limiting option given the scope, diversity, and complexity of contemporary urban areas. Even pedestrian malls must be reached by other transportation modes, and in a society dominated by the automobile, populations are spread out, and the spaces between attractions are large. A store which is "just across the street" may in fact be more than a quarter-mile away for the pedestrian who must cross the street at an intersection and then traverse a large parking lot to reach the destination. Although virtually all trips begin and end with walking, walkers can carry a limited number of goods, and their range of mobility is roughly a mile.

Bicycles have been primarily (except for school children) a recreational mode of travel. Bikes offer greater mobility than walking, but bicyclists must share streets with automobiles, a source of considerable danger from accidents. More bikeways could help this situation, and theft-proof parking would also help. Still, there are limitations regarding how much can be carried on a bike; there are adverse weather conditions to deal with; and one must have the physical capacity to ride a bike. Motorcycles have similar limitations although they do offer a wider range of mobility than bikes.

Because the automobile is the dominant mode of transportation in urban America, many of the problems cited earlier can be attributed to it. For users, however, the auto offers the most convenient, comfortable, and quickest way to get around urban areas. It is available 24 hours a day without waits for a schedule. It has given unprecedented freedom of mobility to the average person and allowed an enormous diversity of occupational, recreational, and living choices.

Some of the problems created by the auto could be alleviated by using smaller, less expensive, more energy-efficient, and nonpolluting cars. Staggered working hours and dispersed centers of employment could also help. For the poor it would be theoretically possible to buy large quantities of small, energy efficient, nonpolluting cars and distribute them free of charge. Over time, however, these palliatives do not confront the key issues of land use, the consumption of resources and energy, and the inequity for those who cannot drive.

For some, the problems suggest a certain irrationality in those who have a "love affair with the auto." "The motorist's apparent preference for using his car is not a fully reasoned choice: he does not realize the cost to the community or to himself."[34] Those who believe motorists are obstinate or stupid or "spoiled" suggest forcing them out of their cars through user charges for freeways at peak hours, ramp metering, or exclusive bus lanes taken from auto traffic.

Such measures create considerable hardship for many and act as irritants to the general public. They are therefore politically unpopular and difficult to institute. A variety of economic, social, and technological developments have made the automobile a necessity in contemporary urban life. Restrictions on its use may seriously degrade the quality of life unless better alternatives can be made available. Many of the attacks on the auto miss this point.[35]

The institutional support for the automobile comes from a large group of interests, sometimes called "the Road Gang."[36] These include auto manufacturers, petroleum companies, construction companies and unions, concrete and asphalt manufacturers, truckers, billboard firms, undertakers, state highway officials, and their national associations. Significantly, most legislators are also highly supportive of the highway lobby's perspective as are most of the American public--at least until a freeway threatens their own neighborhood.

This large complex of interests involves about 20 percent of the gross national product in the United States, and any change in the automotive patterns will have large ramifications throughout the economy and society. The problems suggest we cannot go on as we are, yet in another sense we cannot stop what we are doing without major disruption. It is in this exceedingly difficult situation that proposals for public transit are made.

Public Transportation

When thinking about public transit, most people think automatically of trains, or at least of something as big as a bus. Public transit can also be as small as a taxi or an elevator, or as simple as a moving sidewalk or escalator. Public transportation does not have to follow the stereotype of being group transportation. It can offer service to individuals, groups, or large masses of people, depending on the type of conveyance.

Taxis

These are the public equivalent of the private automobile, offering convenient and flexible service for those who can afford them. Even those who cannot afford them—the old, the poor, and the physically handicapped—make frequent use of taxis as their only alternative to extremely limited mobility and lack of access to the necessities of life. Taxis do not, however, contribute significantly to the solution of the other transportation problems discussed earlier.

The institutional support for taxis comes from powerful taxi companies, which are usually aligned with other highway interests. Taxi companies have played a key role in blocking certain transit proposals, which are competitive with their service. This was a factor in the cancellation of a personal rapid transit project in Las Vegas (see chapter 10) and also contributed to the demise of a dial-a-ride program in Santa Clara County.

Paratransit

There are an almost infinite variety of services that can be offered under the rubric of paratransit.[37] They operate in a middle area between personal vehicles such as taxis and large-group modes. Jitneys, private carpool vans, dial-a-ride, and subscription bus services all fall into this category. Many have argued that the combination of low capital costs and flexibilty offered by these services make them the most socially beneficial modes of public transportation available today.[38] All these systems use existing roads, which solves the access problem. The mobility of the handicapped can also be increased as these flexibly routed services can take time to accommodate their special needs.

Jitneys may create employment opportunities, since anyone who is a qualified driver can be licensed to operate a jitney service, perhaps serving people in their own neighborhoods. Carpool vans have also been used successfully, particularly to take a group of people to a particular place of employment. The Congressional Budget Office finds these to be the most energy-efficient form of transportation in urban areas.[39]

Ordinary carpooling itself is a type of paratransit. Only a small increase in the numbers of people per vehicle could substantially reduce congestion and energy consumption.[40] For users, however, carpools are not always an attractive alternative. The rigid schedules, the need for people to queue for the vehicle, the problems with the individual who is late, aggravate the continuing problems of carpoolers.[41] This may be a private form of transportation, but it is not personal. When the diamond lanes (special bus and carpool freeway lanes) were abandoned in Los Angeles, one woman carpooler remarked, "Thank goodness. No more Friday frustration." Interviewer, "Was it only Fridays which were bad?" "No. They were all bad, but Fridays were the worst."[42]

Dial-a-ride bus systems were designed to combine some of the service features of the taxi (it comes to pick you up when called and takes you close to your destination), with some of the cost features of the bus (to be obtained by sharing rides). In some cities this has been highly successful, and in others it has failed.[43] In Santa Clara County, California, the dial-a-ride program was enormously popular with the public, but a lawsuit by the taxi company, coupled with the necessity for a costly expansion of the program, caused it to be dropped.[44] In other cases, the service was more like a bus and the costs were more like a taxi, causing a discontinuance of service. This also turns out to be the most wasteful form of transportation in terms of energy usage.[45]

In a large metropolitan area such as Los Angeles, a few dial-a-ride services have been instituted in particular neighborhoods. The problem for the user has been the limited area covered by such services. Often people wish to go to attractions outside the neighborhood, and this is prevented by restrictive dial-a-ride rules plus the costs for longer trips. In one neighborhood with a population of 45,000, there were only four supermarkets and "virtually no entertainment establishments (movie theatres, bowling alleys, etc.)."[46] Since it does not appear economically feasible to supply areawide dial-a-ride services, there are clear limitations regarding its application in metropolitan areas.

For users, none of these services are as satisfactory as the automobile, and for society they do not get at the problems of land use and urban development, the use of resources and energy, the costs of roads, insurance, hospitals, police, and so forth. They do offer low capital and operating costs (except for dial-a-ride) and show promise of being better than conventional public transit even though they do not approach the service quality of the private automobile.

Institutional support for these systems comes primarily from academic economists and planners.[47] UMTA has supported some of these ventures as demonstration projects, and some city officials have sought these programs as long as there is federal money to pay for them. A few major corporations have instituted various paratransit systems for their employees. 3M Corporation in Minneapolis and Arco in Los Angeles are two notable and successful examples.

There is, however, considerable opposition to them from traditional bus and taxi companies. Jitneys are still illegal in most areas, and there is no strong movement to bring them back.

Buses

Buses come in a variety of sizes and can move large or small groups of people over essentially fixed routes on a limited time schedule. They have the flexibility to travel on any street, and when they operate at full capacity they are highly energy- and resource-efficient. Their essential problem is their low quality of service:

> Conventional buses have lower full costs (including traveler time costs) only for combinations of low time value, long routes, and higher passenger density. . . . the decline of bus transit (can be attributed to) increasing affluence and the lower resulting densities in the central cities as well as the surrounding suburbs. Consequently, public transit demand has declined, resulting in less frequent service and mounting deficits.[48]

As cities become less dense and take on a network character, there is an increasing randomness to trip patterns. It is difficult to find any group of people wanting to go from the same place to the same place at the same time. Therefore people must wait for other people along a whole preplanned route, make multiple stops, and often transfer to get to their destination. This requires a great deal of detailed knowledge regarding where to get on the bus, where to get off, and where to transfer.

Buses can provide mobility for some transit dependent people, but not those who have difficulty with steps, are in wheelchairs, or the very young who cannot understand the route structure. Buses also suffer from the general crime problems of the community where there is danger while waiting at a stop and danger from muggers and gangs who may enter the bus at any stop.

Because of these problems, buses do not attract many people from the automobile, and except on a few routes for a few hours a day, they operate at much less than full capacity.[49] Therefore they cannot contribute in a significant way to the problems of energy conservation, resource conservation, or pollution. They add to street congestion, and their noise and smells degrade the environment. They do little or nothing to shape urban development.

Finally, buses are a labor-intensive technology with high operating costs. A report from southern California gives some idea of the magnitude of the problem. To expand the bus service existing in 1974 to supplement a proposed rail system in Los Angeles, the Southern California Association of Governments estimated there would be an annual operating deficit of $180 million by 1980. By 1990 the deficit would rise to $350 to $500 million.[50] Such high costs prevent frequent service during the day and effectively preclude late night service.

It is not surprising therefore that most people view buses as a second-class form of transportation. Many people have pointed out that bus service could be handled in more flexible and service-oriented ways,[51] but even these do not avoid the problem of multiple stops, which make the service slow, and crime, which makes it dangerous.

Express buses are often proposed to solve the former problem, but the exclusive lanes on freeways act much like tunnels limiting the service to those in outlying areas who wish to go to a central location such as downtown. It is difficult to enter a tunnel in the middle, so shorter distance trips cannot use these lanes without special overpasses and construction. As cities become more polynucleated, fewer people travel downtown, and the need for such service is low.

The institutional support for bus systems comes largely from the highway lobby—partly as a response to rail transit, and partly because money spent for busways will be spent through highway departments. There is considerable support in the academic community as well, especially among economists and planners, who see buses as a low-capital investment which is highly flexible. They note that the high operating costs of buses are still considerably lower than the interest and operating expenses of capital intensive rail systems.

Rail Rapid Transit

When most people think of rapid transit, they think of rail systems—either light rail like streetcars, or heavy rail trains on separated guideways like subways or els. The proponents of these systems claim they will solve most of the transportation problems cited earlier.

Rail systems are said to create more dense urban development along rail lines and in a central business district. The idea is to counteract situations that produce cities like Los Angeles and Houston and to move toward concentrated urban patterns like New York and San Francisco. A major goal of UMTA has been "to promote transit as a positive force in influencing and supporting desired development patterns in urban areas and improving environmental conditions . . . the ultimate intent being to reduce or minimize the need for transportation facilities and the urban space demands made by them."[52]

It is not clear, however, that rail systems can cause more dense development or that they can prevent urban sprawl. In Toronto, there are indications that the development that took place along the Yonge Street subway would have occurred anyway due to the city's high rate of growth in the 1950s. The rearrangement of development that took place was accomplished as much with zoning as with transit development.[53]

Whereas some claim the billion-dollar construction boom along Market Street in San Francisco was caused by BART,[54] others believe the growth in San Francisco was due to its service-type economy and would have taken place with or without BART. In Houston, Dallas, and Denver, which rely solely on automobiles and buses, even greater expansion in high-rise central office building has occurred.[55] Nonetheless, it is still claimed that ". . . a major benefit of rapid transit is the production of high land values in the concentrated central districts possible only with this mode (high capacity fixed rail) of urban transportation."[56]

Urban sprawl may also be a product of rail transit development, since these systems best serve those who work in the central city and live in distant suburbs. These are usually the more affluent members of society who reach the train by auto. Rail systems make long distance commuting tolerable, and the land boom that has taken place around San Francisco (especially Contra Costa County) offers some evidence of this pattern.[57]

In situations of little growth, or even decline, as in many of our large central cities, it seems likely that growth in some areas will reduce demand in other areas. Whether these increases and declines offset each other is uncertain from existing information.[58] Aggregate estimates of costs and benefits frequently fail to reveal that values are being transferred rather than created.

Even where growth is assumed, a major rail network may not have a major impact on development. Washington Metro officials estimate that the number of jobs in downtown Washington, D.C. will increase from 500,000 in 1974 to 750,000 in 1990. At the same time, jobs in Washington suburbs are expected to grow from 500,000 to 1,500,000 despite the building of the $5 billion fixed-rail system.[59]

One reason for this is the low diversion rate from automobiles to trains.

BART reduced the number of cars on most heavily used lines by 5 percent.[60] In Chicago the Dan Ryan expressway train line carries less than 20,000 people per day in rush hours while the adjoining freeways carry 160,000. Experience is consistent that diversion from automobiles is equal to about one year's increase in vehicle counts.[61] Much of the diversion to rails comes from people who rode in buses or carpools before or from those who could not travel before (latent demand). This puts considerable strain on bus systems, since frequently the trains compete for their most profitable lines.[62]

This low diversion rate also affects other claims of rapid rail proponents. There is little evidence that rail systems reduce home-work congestion, one of the important values claimed for them. In addition, there is considerable evidence that rail systems increase central city congestion:[63]

> If a high-rise office building is erected in the central city in order to house economic activity that might otherwise have been located in a diffuse pattern, only some 15% of the employees can ordinarily be expected to use the rail facility to reach it. The other 85% use the streets, either in buses, in automobiles, or on foot.[64]

This pattern acts to concentrate pollutants from automobiles, making the air pollution situation much worse. Vehicles moving at low speeds and stopping fequently produce four times the pollutants than are emitted by vehicles moving freely on a freeway: "If New York had the atmospheric properties of Los Angeles, the result would be lethal."[65]

Other studies that do not consider the increasing congestion factor indicate that the introduction of a rail rapid transit system would have negligible effects on overall air pollution.[66] Part of this has to do with the low diversion of people from automobiles, and part of it has to do with the more restrictive emission controls on automobiles, which have greatly reduced their polluting qualities and are projected to reduce them even more.

For the transit dependent people—the poor, the old, the young, the handicapped—train systems offer little or nothing. Poor people in the central city need to be able to get to outlying industrial areas for jobs, not to a central business district. All the other needs for mobility (roughly 75 percent of all urban trips) cannot be easily met by train systems—the needs to go to market, to visit friends, to reach a doctor, or to get to a recreation area. These rapid rail systems are really "Mass Transit for the Few" (and the rich).[67] Of the people who use BART, 18 percent have household incomes in excess of $25,000 per year, and 48 percent have incomes in excess of $15,000 per year.[68] Over 60 percent of the BART users get to the stations by auto. On the Concord line 87 percent to 96 percent of the people use an auto to get to the system.[69] People without automobiles have considerable difficulty in gaining access to BART, which is a problem in most heavy-rail systems.[70]

To gain in speed, an attribute presumed to attract riders, stations for train systems must be placed at least a mile apart, and frequently more than a mile apart. Thus there are few points of access and egress from the system. The 71-mile BART system has only 34 stations, the larger Chicago system has 150 stations, Boston has 70.[71] Nonetheless, the much-vaunted time savings that are supposed to accrue to rail transit users disappear when total trip time is taken into account.[72] Yet it is total trip time which is most important to the consumer. Waiting time and other "out-of-vehicle activity is very onerous to individuals traveling for commute purposes."[73]

Not surprisingly, rail transit systems are not viewed with much favor by their users, and rail systems around the world are declining in ridership as more affluent people seek more convenient alternatives.[74] Rail systems also decline because of their inflexibility. As cities develop and change, the rail systems cannot be moved to accommodate the change. The growth of low-density rings around metropolitan areas as discussed earlier is part of this problem. Another factor is the growth and development of new attractions. A considerable portion of the decline in use of the New York subway system can be attributed to its lack of service to attractions that have been built in the fifty years since its completion. A new sports complex, airport, or other major traffic generator is unlikely to be served by existing rail lines.

Low energy consumption has often been cited as a primary reason for selecting rail transit systems, but this is based on the operating energy per passenger-mile, where rail systems rank best if the trains operate at full capacity. Under typical operating conditions, however, new rapid rail systems such as BART or the Washington Metro actually waste energy rather than save it.[75]

Principal reasons for this waste are the widespread use of low-occupancy private automobiles to gain access to the system, the attraction of people from more energy-efficient forms of public transportation, and the high use of energy to build the system and to operate stations. Forty-six percent of the energy which will be consumed by BART over the next 50 years was consumed before the first train was run.[76] Most recent studies suggest the best opportunity for energy savings is to improve the energy efficiency of the automobile[77]: "Rail rapid transit offers little aid to the nation's effort to save fuel."[78]

Resource consumption follows a pattern similar to energy consumption. To make a serious impact on resource consumption for transportation purposes, it would be necessary to divert a large number of people from automobiles, which are the prime consumers of earth resources. Since trains appear to have little impact on automobile ownership or use, their effect on resource consumption is negligible.

The costs to build urban rail systems are extremely high. The 71-mile BART system cost over $1.6 billion.[79] The Washington, D.C. Metro is projected to be 91 to 98 miles in length, and the cost has escalated to $5 billion (and may go up even further).[80] Table 4-4 indicates some of the costs for new transit systems and extensions of existing systems.

Table 4-4
Status of New Transit Systems and Extensions
(dollar amounts in millions)

	Miles to Be Constructed	*Total Cost*	*UMTA Share*	*Grants to Date*	*Miles Constructed or under Construction*	*Costs per Mile*
Atlanta	13.7	$1,017.0	$ 800.0	$200.0	13.7	$ 74
Baltimore	28.0	1,363.0	1,086.0	72.7	8.5	49
New York: 63d St.	3.0	692.1	482.9	81.6	2.5	231
New York: Archer	2.5	329.3	228.1	51.1	.5	132
New York: Long Island, midtown, connection	1.8[a]	228.4	182.7	46.4	.75	127
Pittsburgh	23.5	256.8	194.6	54.3	2.4	11

Source: U.S. Congress, House, Committee on Appropriations, *Department of Transportation and Related Agencies Appropriations for 1976, Hearings before a Subcommittee of the Committee on Appropriations,* 94th Congress, 1st Session (Washington, D.C.: U.S. Government Printing Office), p. 194.

[a]Amount in common structure with 63d Street line which is extent of UMTA approval to date.

Whereas capital costs are high for rail systems, proponents claim that operating costs are much lower. There is considerable evidence, however, that this is not the case.[81] The BART system ran a deficit of $58 million in 1975/1976 and $66.7 million in 1976/1977.[82] Even the New York subway system, which has largely amortized its construction costs, still had a deficit exceeding $300 million in 1975.[83]

According to the American Public Transit Association, transit deficits across the country have increased from $500 million in 1972 to approximately $1.3 billion in 1974.[84] If current trends continue, the deficits in 1980 would exceed $12 billion per year.[85] Not all these deficits are due to rail operations, but the transit systems showing the largest deficits are also the systems that are operating rail systems.[86]

Despite all these problems there is still considerable support for rail systems in many major cities in the United States and in UMTA. Much of the support comes from downtown business interests, which want increased property values and the consultants and contractors who will design and build the system.[87] Big-city mayors (who get much of their support from downtown business interests) also support these systems. A number of observers attribute this to a kind of boosterism. A city isn't really a city unless it has a rail transit system.[88]

Some people seem to have an emotional attachment to trains—a "predisposition to rail transit because of a childhood fascination."[89] "They don't have to have a reason for wanting it, they just want it."[90] There is also a desire for a visible accomplishment—something that can be pointed to with pride during the next election.

Environmentalists have been important supporters of train systems. Many of them have fought the road gang for years, and they "know" rail systems are the answer. They genuinely believe these systems will reduce energy consumption, air pollution, and congestion, as well as help the transit dependent and improve the overall quality of urban life.

A significant segment of the public apparently agrees with them, at least on the issue of air pollution. A poll taken in Los Angeles prior to a 1974 vote on a rail transit proposal indicated an overwhelming proportion of voters felt it would reduce smog.[91] This was not enough to gain a favorable vote on the proposal, however, perhaps because another poll in the same area indicated 86.8 percent of the respondents believed Los Angeles needed a new transit system, but only 4.7 percent said they definitely would ride it.[92]

Finally, there are the rapid transit districts. Their support has come primarily from the downtown business groups and the consultants and contractors who build rail systems. The transit districts appear to respond to this support by offering rail solutions time and again. A citizen's study of the Southern California Rapid Transit District concluded:

> There are presently no financial or legal incentives for the SCRTD Board or staff to select the most desirable system even after cost/benefit, environmental impact or cost/effectiveness studies are completed, or to alleviate present and projected transportation problems. Indeed selection of the most expensive and least effective transit approach (rails) can provide justification for ever larger local and Federal funding support for the District. We note that in estimating needed financial support, the SCRTD has assumed a BARTD-type rail system which is the most expensive, but not necessarily the most attractive alternative.[93]

This report, which was suppressed by the full steering committee, which supported the SCRTD rail proposal, indicates some of the incentives that can influence transit operators to seek rail systems. More money means more power, more jobs, and more income for the technostructure of the agency.

Conclusions

The existing alternatives in urban transportation do not adequately address the problems discussed earlier. The real problem may be that: ". . . urban mass transit, as a system and urban service, is far more inferior in quality and quantity than its potential users are willing to accept and the urban areas need for their satisfactory functioning."[94] The attractions of the existing alternatives lie in their external benefits, which accrue unevenly to particular interests. They are also attractive simply because they exist, and it is difficult to plan with systems that do not yet exist, especially when there is a widespread belief that something must be done now.

The existing proposals also reflect the dominance of the congestion issue, especially the home-work commuter congestion. This "has deluded some people into saying you should develop one system to handle the rush-hour traffic, such as rail systems," or express bus systems.[95] UMTA has heavily supported this perspective, as shown in table 4-5.

The problem, for most transportation planners, is that there is no visible alternative. Some admit their systems are inadequate and as a result believe the automobile will never be replaced unless people are forced out of it by a variety of incentives and disincentives:

> Review of the relative cost and service characteristics indicates that *regardless* of technological change, travel requirements and consumer choice will continue to favor the automobile.[96]

> . . . this is a scene dominated today and still to be dominated tomorrow by the automobile. The automobile provides *the* ultimate mode of intra-urban movement—door-to-door, completely flexible, completely private, and competitive in cost with the best of public transportation.[97]

With this perspective, which appears to be widely held, there is little incentive to seek innovative solutions, since apparently none of them can help the situation. Therefore, the existing proposals for transit reflect a combination of factors including the definition of the problem; the availability of systems; financial interests; mistaken notions, especially regarding air pollution and energy consumption; as well as emotional factors—the idea that we must have transit.

When confronted with the unpleasant facts that show existing transit alternatives to be inadequate, the response is usually similar to one given by a promoter of rail rapid transit for Los Angeles: "We can't do everything all at once." There was no consideration that by using so much money (in this case

Table 4-5
Comparison of UMTA Expenditures by Transit Mode

Mode	*UMTA Funding Commitments through Dec. 31, 1974*	*Number of Passengers, 1974*	*Amount of UMTA Dollars per Passenger*
Bus	$1,124,812,506	4,170,800,000	0.27
Rapid transit	1,545,374,877	1,435,100,000	1.08
Commuter rail	550,134,042	296,421,000	1.86

Source: U.S. Congress, House, Committee on Appropriations, *Department of Transportation and Related Agencies Appropriations for 1976, Hearings before a Subcommittee of the Committee on Appropriations,* 94th Congress, 1st Session (Washington, D.C.: U.S. Government Printing Office), p. 186.

upward of $10 billion) for one project it might never be possible to do anything else.

Sometimes the inadequacy is termed "unfortunate": "Unfortunately, no corresponding technology is in sight to provide enhanced transportation for the less fortunate residents of the inner city."[98] Frequently the problem is deemed to be beyond the scope of the issue being studied, and, therefore, there is no need to deal with it: "Goods movement, though equally important, is beyond our scope."[99] "Finally, it seems there is little we can say at this time about urban freight transportation technology except that it is a problem."[100]

These responses are typical of most transportation studies. Despite continuing calls for comprehensive planning and balanced transportation, which serves the need of all our people, many people, and many problems, are excluded. It may be that one cannot define as a problem something for which there is no reasonable solution. The stress on the problem of congestion between suburban home and central city work may be as much a function of the perceived solution–rail rapid transit or buses on freeways–as it is a function of its real importance as part of the urban transportation problem.

The lack of effort to solve the problems of inner-city residents who wish to get to industrial sites in the suburbs may not just be a function of the relative powerlessness of this group. It may also reflect the fact that no existing transit system, other than the automobile, can operate effectively in a situation of high dispersal.

Thus problems and solutions are closely intertwined, and it is rare when there is a complete analysis of a problem situation and then solutions are sought for the total problem. In most situations, it is assumed that the potential solutions are already known, the problems are also largely known, and what must be done is to bring the two together in as close a fit as is deemed technically, politically, and economically feasible. We "satisfice"–jump on the first solution that is satisfactory and will suffice. The parts that fall between the chairs frequently are the parts that might benefit the poor and disadvantaged. Satisficing seems to work in favor of the rich and powerful.

Essentially there is no transportation policy at all, only a series of programs of widely differing impact and often conflicting objectives. The money spent is heavily weighted toward highways, but many types of legislation other than those that deal with transportation have urban transportation impact. Perhaps this is why there is no consensus regarding what the problems are or what solutions might work.

We are, perhaps, in a situation of paradigm breakdown. This is evidenced by the increasing failure of the existing paradigms to solve the problems they themselves generate. What is breaking down is the "accepted model or pattern" that defines reality for transportation experts.

The Transit Paradigm

In the case of public urban transportation such a pattern is not so explicit as in the case with scientific theories. Nonetheless, there does appear to be a cluster of beliefs, theories, methods, and applications, which taken together make up an interdependent network of commitments, some of which are contradictory, but which appear to be widely held and acted on by most urban transportation planners and operators. Although not everyone involved in this network may consciously hold all these beliefs, the general pattern seems to be widely influential in practice.

Although the transit paradigm is discussed in more detail in chapter 6, it may be useful to outline some of its broad characteristics. Most basic perhaps is the definition of the urban transportation problem in terms of congestion during the home-work commuting trip. Lip service is frequently given to other problems such as air pollution, energy conservation, serving the poor, and so forth, but the solutions proposed do not deal with these issues.

All the solutions assume that public transportation must be group transportation and that these groups travel in corridors along fixed routes on a fixed schedule. The functions of public transportation are collection, rapid line haul transit, and distribution as shown schematically in figure 4-1. The perception is that transit systems connect geographic places rather than act as facilities to connect people. Transportation investment is seen largely as investment in physical facilities rather than in transport services, and the primary test of goodness for one geographic network of facilities over another is the criterion of least cost. What is sought is the least investment of resources, not a larger output of benefits. Even when extremely expensive subway systems are selected, these are still designed as less than ideal networks due to economic constraints.

What is missing is an obvious concern for the consumer of transport services. The principle of endurable hardship prevails. This means that service to outlying areas of a metropolitan area will be minimal with long waits for public transit, especially during nonpeak hours. Efficiency demands that larger vehicles be used, since they are cheaper to operate and maintain. The reduction in service frequency is simply another hardship that must be endured. Such hardship must also be endured by those who must work overtime occasionally or for those who work night shifts, since late night service is not only uneconomic, the threat of crime is also high.

There is also little provision for those who live near the center city and would like to travel to jobs in outlying suburbs or for those who travel between suburbs and not to a downtown area. There is virtually no provision for the vast majority of short-haul trips to the grocery, Little League games, school activities, doctors, dentists, visits to friends and relatives, and the myriad of trips that make up the bulk of automotive travel.

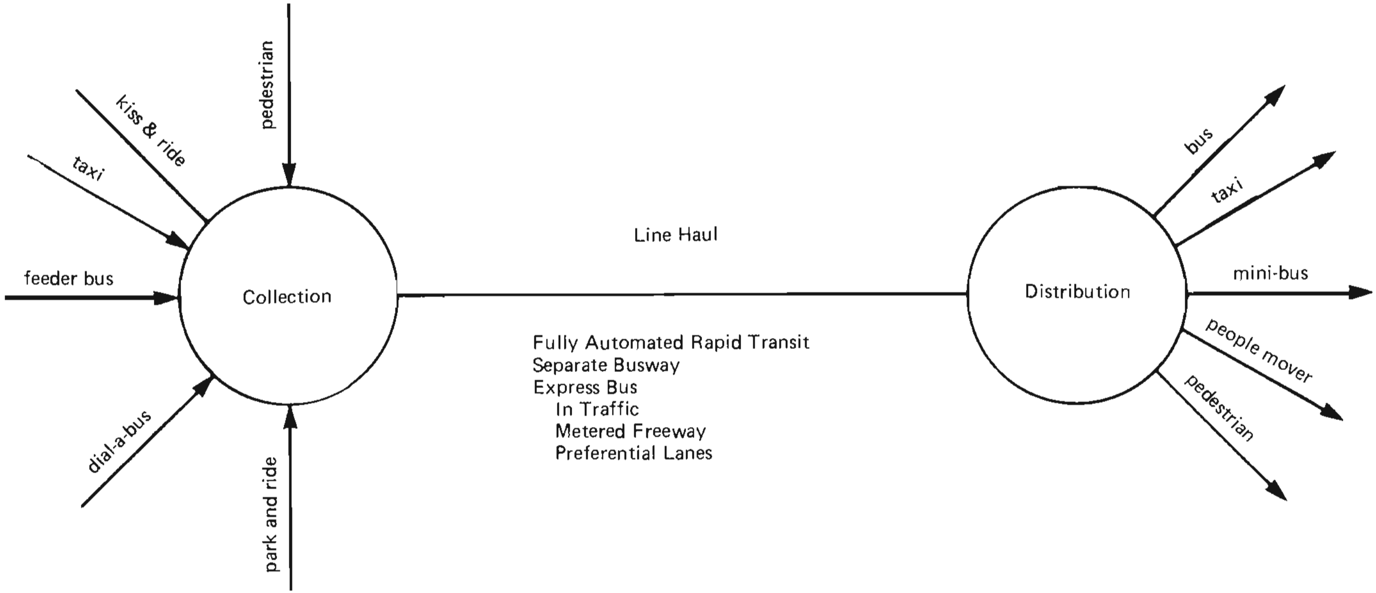


Figure 4-1. Existing Transit Paradigm.

Instead of looking at the needs of the market, it is assumed that people are spoiled by the automobile, and therefore they will have to be forced to use public transit through so-called incentives such as rationing of fuel, higher costs imposed on drivers, parking prohibitions, and so forth. Nonetheless, it is acknowledged that the automobile will remain the dominant mode of transportation into the indefinite future. Public transit is seen as a second-class service, but it is still a public "good," which must be publicly supported so that we have "balanced transportation." This implies not only public support for construction or purchase of such systems, but continuing support for operations, since public transit can "never pay for itself out of the farebox."

Other elements of the paradigm include ideas regarding patronage analyses, corridor analyses, selection of technology (defined narrowly as equipment), safety requirements, how to plan for, design, and build a transit system, and so forth. Paradigms not only define problems and alternatives; they also delineate and justify existing roles, skills, and technologies. Within the paradigm there are "proven" solutions—trains or buses in the case of the transit paradigm. Even the advanced systems that are occasionally proposed involve primarily the use of automation and/or exotic suspension systems coupled to conventional buses or trains.

A paradigm breakdown implies that the definitions of the problem are no longer adequate—they no longer describe reality as it is being experienced by many people. In the case of urban public transportation, the total complex of problems described in this chapter might define a new reality. In such a situation, existing methods and alternatives cannot deal with the new definition of the situation. The problems cannot be solved within the framework of the existing paradigm.

Therefore what is needed is a "reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications."[101] Such a change is inherently revolutionary and does not occur easily. In science, and apparently in transportation, "novelty emerges only with difficulty, manifested by resistance, against a background provided by expectation."[102]

Part II
The Federal Experience

Introduction

Despite the evidence of an apparent paradigm breakdown in public transportation, those who were dealing most directly with the problem usually proposed solutions that were essentially doing more of the same—more and better highways, or more and better transit. Automobiles, buses, streetcars, and trains were the only options seriously considered by the public agencies responsible for urban transportation.

The demands on these agencies were to act "now." The accepted time frame made it inevitable that only available alternatives could be considered; technological innovation was not a part of their domains. There was also a large investment in the status quo. Despite the obsolescence of existing capital, it is difficult and costly to replace it with new and better equipment.

There was also an intellectual investment in the status quo, as experts in urban transportation may have suffered from "trained incapacity"—when "one's abilities function as inadequacies or blind spots. Actions based upon training and skills which have been successfully applied in the past may result in inappropriate responses *under changed conditions.*"[1] Therefore change is more likely to be brought about by individuals and groups that are either very young or very new to the field. A paradigm change will not come from within the established order.[2]

Where innovation is sought within the established order, it will most often develop along existing paths.[3] Revolutionary technologies that are in essence a shift in paradigm will be avoided or suppressed if at all possible. This is true in many areas, not just transportation, as revealed in a recent study of the energy industry[4] :

> In general, corporations work on technologies best suited to their short-term interests. They do not research and develop energy technologies to solve national problems. They are mainly interested in preserving and extending the markets for their products, which are often in competition with other energy technologies.[5]

Public agencies also find it difficult to abandon the existing technologies and paradigms, not because they have to show a profit, but because they must maintain support.[6] For the transit organization which has been fighting for financial support, new buses, or a new train system, the maintenance of existing support is essential. There can be no suggestion that questions the existing paradigm for fear of alienating what little support the transit agency presently enjoys.

Notes

1. R.K. Merton, "Bureaucratic Structure and Personality," in J.A. Litterer, ed., *Organizations: Structure and Behavior,* 2d ed., vol. 1 (New York: John Wiley and Sons, 1969), p. 242.
2. T.S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).
3. J.K. Galbraith, *The New Industrial State,* rev. ed. (Boston: Houghton Mifflin Co., 1971); J.K. Galbraith, *Economics and the Public Purpose* (Boston: Houghton Mifflin Co., 1973).
4. Since presenting these ideas in some public forums, various individuals have brought me examples from a number of fields including housing, statistics, medicine, and cancer research.
5. S.W. Herman and J.S. Cannon, *Energy Futures: Industry and the New Technologies* (New York: Inform, Inc., 1976).
6. R. Randall, "Influence of Environmental Support and Policy Space on Organizational Behavior," *Administrative Science Quarterly* 18 (1973):236-247.

5 History and Development of Personal Rapid Transit

Early Ideas

For those outside the existing order (and to some within it), the paradigm breakdown was becoming more obvious. Existing transportation technologies were not solving urban transportation problems. As a result, a number of widely dispersed and intellectually diverse individuals and groups began to search for a new paradigm.

They were not consciously seeking a paradigm change but simply searching for improvements in urban transportation systems. One of the outcomes of the investigations was the development of the concept of personal rapid transit, which may have been "a natural invention made possible with the advent of the computer and automation."[1] Certainly the concept existed in many minds for many years. Several of the people interviewed claimed to have originated the idea, one stating he had first begun thinking about it after World War II. Clearly the idea of automating the automobile occurred to many people as an obvious extension of existing technologies.

As early as 1939, General Motors exhibited an automated highway, and, in the fifties and early sixties, both General Motors and RCA studied the idea of the automated highway in depth. This was a dual-mode approach in which the automobile driver would drive under manual control to an automated highway, where the vehicle would be put under the control of a computer guidance system to be whisked into the city where the driver would once again take over control to get to his destination.

Since more cars could travel at higher speeds on such automated highways, the problem of rush-hour congestion could be solved, and people would still have the convenience of their own vehicle. Such dual-mode systems are still being proposed as the ultimate solution to our transit problems, especially by those who focus on the rush-hour congestion segment of the problem.

The first such equipment was built by William Alden in 1966—the StaRRcar (Self-Transit Rail and Road Car).[2] Alden was apparently interested in automation and its industrial applications and had "a solution in search of a problem."[3] Alden did come up with a unique guidance mechanism, which could be used for ten- to twenty-passenger vehicles as well as for four-passenger vehicles. A guidance mechanism does not, however, create a transit system, and, as suggested in chapter 2, there is a tremendous amount of work and development that must be done to make an idea market-ready. In this case, there was also a need to define the market and to develop a service concept that the technology might satisfy.

The HUD Studies

Such conceptual studies were begun in the mid-sixties. In 1966, the Urban Mass Transportation Act was amended to direct the secretary of housing and urban development—HUD was the agency administering the urban transportation program at that time—to consult with the secretary of commerce and then begin to study, prepare, develop, and demonstrate new systems of urban transportation.[4] In this act, explicit encouragement was given to investigate more exotic forms of transportation.

This New Systems Research Program was fostered by Congressman Henry Reuss of Wisconsin, who felt the demonstration grants provided for in the 1961 and 1964 urban mass transportation acts did not really meet the needs of the urban transportation problem. Under 1961 mass transit legislation, there was no provision for research to be initiated at the federal level of government.

There was, however, a provision for demonstration projects, which had to be initiated at the local level and approved by the federal government, which would then supply two-thirds federal funding. The 1964 Urban Mass Transportation Act gave the federal government the power to initiate demonstrations, and the limit on the amount of federal funding that could go to locally initiated demonstrations was removed.[5]

It was only with the 1966 amendments to the Urban Mass Transportation Act that a federal research and development program was approved. It was meant to provide a longer-range approach than the previous demonstrations. None of the representatives of the urban transportation interest groups saw any need for federal leadership to encourage research of a more sophisticated nature, but Reuss apparently felt there was a broader range of solutions that needed examination.[6]

The Johnson administration was occupied with other matters and neither favored nor opposed the idea, but Reuss was able to build a coalition in both the House and the Senate and gain support for his amendment. As a result of administration indifference, HUD was not prepared to take on the New Systems Research Program. It had heard of the program only 3 months before it passed and did not have a staff capable of carrying out the activity. There were no plans ready that determined how to carry out the work.[7]

The program was given to the assistant secretary for metropolitan development, Charles Haar, who had to find a way to conduct the study: "Haar's philosophy on how to affect innovation was to acquire a good number of bright people, give each of them a problem to solve, keep them isolated from each other, and then evaluate the many forthcoming solutions."[8]

Haar decided to bring a wide range of expertise, largely from outside the transportation area, to bear on the problems. Requests for proposals were put out to industrial firms, universities, research institutes, and other potential performers. In early 1967, seventeen contracts were let, which included a number of aerospace firms. The purpose of nine of the studies was to:

> . . . outline in systematic fashion the opportunities for a comprehensive balanced program of research, development, and demonstration in urban transportation.
>
> Opportunities for research and development with future time frames can be identified in terms of utilizing present state of the art, making evolutionary improvements in existing technologies, and objectively assessing distant needs to provide incentives for the development of futuristic technological solutions.[9]

Eight additional studies were to provide greater depth in the background knowledge of demand patterns and the interrelationships of transportation with urban land use and the shape of urban life, since these were, and are, particular concerns of HUD. In many cases the final reports that emerged were very high quality—imaginative, broad in scope, moving beyond hardware orientations to the larger implications of urban transport and its institutional situation.

The research focused on three periods: the immediate future—up to 3 years; the more distant future—15 to 20 years; and the period up to the year 2000.[10] These reports were criticized by some as having relatively little value for cities faced with here-and-now problems.[11]: "It seemed foolish to study future systems when there were insufficient funds to provide a decent level of aid for existing systems."[12]

One critic suggested the New Systems project was a policy failure, since it did not meet its long-range purpose to establish a comprehensive urban transport research program. It was blocked from the policy system because assistant secretary Haar desired and anticipated exotic and visible hardware solutions to urban problems: "He was disappointed that the recommendations were only partially hardware oriented. Apparently, no technical gimmick was seen as solving the mass transportation problem."[13]

Therefore it was Haar's disillusionment that prevented the findings of the New Systems contractors from becoming part of the administration's legislative program. Of course, by mid-1968 the Johnson administration had become a "lame duck," and there was little likelihood that new programs would be proposed. There is still, however, the implication that the search had been for a technological fix.

There were so many other factors operating at the time, even if a technological fix had been proposed, it is unlikely it would have become part of a legislative program. The Viet Nam War was at its peak; there was rioting in cities and on campuses; it was a presidential election year; the Great Society programs associated with HUD were falling into disfavor; and the Urban Transportation Administration (UTA), buried in the Metropolitan Development Division, received little attention but may still have been suspect because of its association with HUD.

Advocates of mass transportation, particularly big city interests, were not concerned with new ideas: "... we must caution against the brand of 'Sunday supplement research' ..."[14] There was an insistence that what was needed was more capital funding. Transit operators were very unhappy with the low-level status of the UTA and its consequent weakness within the hierarchy of HUD, which was more concerned with overall metropolitan development than with urban transit as such.

To gain more leverage, and to get out of the Great Society problems of HUD, a coalition built up in Congress, the Bureau of the Budget, and the Department of Transportation (DOT) to move the program to DOT and make it a separate administration in organizational equality with the Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), and Federal Railway Administration (FRA). In early 1968, President Johnson announced that unless there were objections, UTA would be switched out of HUD and into DOT.[15] On July 1, 1968, the change took place and the thirty-eight employees who made up the UTA moved and became the Urban Mass Transportation Administration (UMTA) in DOT. Within this total context of problems, politics, and change, there was simply no one willing or able to take up the ideas summarized in *Tomorrow's Transportation.*[16]

One critic said *Tomorrow's Transportation* offered a lot of ideas for solving the urban transportation problem, but that they were very expensive to try out, even on a pilot basis. There was no way of knowing whether or not they would work, and what was needed was not ideas but a plan for action.

The power of ideas is not always immediately apparent, however. The package of HUD studies contained the most comprehensive analyses available on transportation problems and a number of seminal ideas on possible solutions. In reality, the old paradigms of the highway and transit planners were being challenged by a series of new paradigms. A new debate was joined regarding the adequacy of traditional transportation programs as opposed to new transit systems.

From an immediate action perspective, the timing of the report could not have been worse, but in a larger context the timing was ideal. Around the world, traffic problems were becoming worse.[17] Even the excellent public transit systems of Europe and Japan were faced with declining ridership comparable to the declines that had taken place in the United States 30 years earlier.[18]

In the United States, the space program had passed its peak employment, and there was considerable discussion of employing the skills that would take us to the moon on some of our earthly problems. A number of organizations—both private and public—were searching for new ideas to employ the high technology skills of space workers and at the same time ameliorate the problems of the cities. In essence, the HUD studies were a seed that fell in fertile soil. Major studies of some of the ideas were begun in England, France, Germany, Japan, and the United States. Other ideas were later incorporated into the research program of UMTA.[19] During my inquiry regarding the origins of personal rapid transit (PRT) proposals around the world, the seminal nature of the HUD studies was mentioned by almost every respondent.

The General Research Corporation[20] and the Stanford Research Institute[21] studies are frequently cited, and it was in the SRI report that the term personal rapid transit was first published and defined: "Small vehicles, traveling over exclusive rights-of-way, automatically routed from origin to destination over a network guideway system, primarily to service low-to-medium population density areas of a metropolis."[22]

This was an extremely different idea of public transportation, so it is not surprising that there was some confusion of definition in the summary report, both as to service area and the size of vehicles and guideway. At one point it was stated that a double-tracked PRT guideway would be 17-feet wide as an elevated structure.[23] Further on, it is suggested that the guideway would be 5-feet wide and single-tracked over "substantial portions of its length."[24]

Contrary to the summary definition quoted, another section asserts that a PRT network "would serve a metropolis, except perhaps for its lowest density outskirts with a network or grid of lines."[25]

> The guideway network covering the metropolitan area is the *essential ingredient* of the personal rapid transit system. Without a network of guideways the system could hardly avoid conventional heavy dependence on work trips and a radial orientation to existing business districts. Thus, it could not provide adequate transportation alternatives in large metropolitan areas with a wide dispersion of trip origins and destinations. No matter how sophisticated the technology, transit which operates without some sort of network service pattern almost certainly will remain a marginal service in the movement of urban populations.[26]

It should be clear that although this was a proposal for the use of new hardware, it was firmly based on a service concept. The fact that new equipment is needed to provide the new service should not obscure the service orientation, which in this case was made quite explicit.[27] Later, in some cases, the service concept was obscured in the rush to develop particular technical systems. Critics then focused on this hardware orientation and quite rightly condemned it. The advocates of personal rapid transit, however, maintained the primacy of the service to the user—asserting that transportation is a means not an end. It exists for no other reason than to serve people.

The New Systems study found over twenty proposals for PRT existing in 1967-1968, most of them little advanced beyond the concept stage. The primary development work that was needed was in the area of automatic electronic control systems. There was also a concern for safety systems: "The new systems study found that these problems were surmountable," and estimated that a prototype system could be developed, tested, and evaluated in less than ten years at a cost of about $250 million.[28]

The identification of the important service parameters and the key technological problems was of considerable use to those who went on to develop PRT systems. There were also problems as the ambiguities regarding guideway size and the service area to be covered entered into later, bitter debates. Group rapid transit (GRT) systems were developed with larger vehicles and larger guideways but were still called PRT. The possibilities for a staged development of true PRT were obscured by critics of the program, who claimed PRT advocates were reckless and irresponsible to want to build hundreds of miles of PRT networks in major metropolitan areas without proper testing.

The debate was, and is, notable for its ad hominem character with a continuing misunderstanding and misrepresentation of opponents' positions and motives. Even among the most expert, the level of misinformation and confusion is quite high, which may be due in part to the number of parallel developments that took place after the publication of the HUD studies. Different groups, individuals, and organizations began to work on these ideas, each with somewhat different purposes and directions. There will be no attempt to catalog all these events, but certain key developments in the United States and abroad will be examined to show the interactions of politics and technological innovations.

Morgantown

The development of PRT did not begin with the Morgantown demonstration, but in the United States, all the other new system developments were colored by the events that occurred there. The Morgantown demonstration was to be the first public development of a new transit system such as proposed by the HUD studies. It was called personal rapid transit, but what evolved out of the project is now what is referred to as group rapid transit.

It may also present a classic example of the ways in which technological innovation can be influenced by political processes. The project began in 1965 when officials of the University of West Virginia began looking for ways to alleviate the traffic problems of Morgantown, West Virginia. These problems were intensifying as the University added two additional campuses, each about 1.5 miles from the main campus in downtown Morgantown.[29]

In 1967 the University, through Professor Samy E.G. Elias, head of the Industrial Engineering Department, applied to HUD for a grant to study the feasibility of applying new technology to solve the city's and university's transportation problems. This grant was turned down, but it was resubmitted in 1969 to the DOT.

At that time, UMTA was in the process of reorganizing as a new administration, and new personnel were moving into key positions. John Volpe, an action-oriented ex-governor of Massachusetts, became secretary of Transportation, and Carlos Villareal, a marketing manager out of the aerospace industry, was brought in as administrator of UMTA.

Most of the top-level Villareal appointees were experienced managers, but from defense and aerospace industries, not from land transportation, urban planning, or transportation economics. In contrast, three of the original staff that transferred from HUD had a combined total of 80 years background in transportation, including highway planning, general transportation, general economics, and economic forecasting.[30]

It is significant that this new team did not have the close ties with the transit industry, and as a number of them have reported, they were risk-oriented:

> Gentlemen, we are going to be doing a lot of things. I am sure we are going to have some successes, but we are bound to have some failures. We just tell you that when these failures come, it will be because we are trying something new and different. We hope that they will be prudent selections of programs, but we want to try new things, because our greatest challenge, as Mr. Conte pointed out yesterday, is to get the motorist out of his automobile.[31]

They were seeking new ideas, and they wanted to assess the national application of PRT systems. As a later administrator of UMTA would put it, Dr. Elias walked in the door with his proposal at just the right time.[32] The University was awarded a federal grant of $153,500 to conduct a feasibility study of PRT for use in Morgantown.[33]

The University's study determined that PRT was feasible and selected the Alden Self-Transit Systems Corporation to use its system to meet their transportation needs. One of the key factors in this decision apparently (there is not complete consensus on this point) was the fact that the StaRRcar actually existed in a prototype version, whereas other systems existed essentially on paper.

In August 1970, the West Virginia Board of Regents submitted a capital grant application to UMTA for 80 percent funding of a system estimated to cost a total of $18 million. The federal government's share was to be $13.5 million. This money was to cover the design, construction, and demonstration of the Alden PRT system in Morgantown.

It was now up to UMTA and DOT to decide what to do with this application, and from this point forward there are the official and unofficial explanations of the decisions made. People were forced to publicly defend what they privately condemned, creating considerable confusion when the events are described later. The public documentation and the private interviews are in conflict in some cases.

The whole process deserves a more complete and detailed study than is possible here, but it appears to this observer that there was a convergence of interests with multiple goals, all of which appeared to be achievable with the Morgantown project. This turned out not to be true, and later problems changed the perspectives of many key actors. The University wanted to solve its traffic problems and to develop a transportation research facility.[34] They wanted to demonstrate the feasibility of a new transportation concept for the immediate needs of a mid-sized urban community or major activity center.[35]

UMTA had a research-and-development (R and D) mission written into its legislative charter, and they wanted an R and D project of national significance. Among the official reasons given for this selection were the topography of Morgantown (it is quite hilly, providing opportunities to test equipment on grades and curves), the changing climate conditions, and the captive ridership of university students. Finally, they had a community that was willing to allow a test facility.[36] UMTA was also concerned about the severe congestion on local roads not only at traditional peak hours but also many times during the day when students changed classes.

There was concern among some people within UMTA because this was clearly not a PRT system as described in *Tomorrow's Transportation.* It was not a network but a two-way corridor line 3.5-miles long with six stations. Neither was it a fully planned or developed project. The associate administrator for Research and Development did not favor the project because at that time he was trying to develop a comprehensive research proposal, not simply respond to every request that came in the door.[37]

The Secretary of Transportation, John Volpe, was enthused about the project.[38] Volpe was an action-oriented person and wanted to have some visible projects functioning quickly. There is widespread agreement on this, and among the people who worked with him, there is further agreement that he operated with the best of motives and that without him little might have been accomplished. Even though the extreme pressure for action was a significant factor in later problems with the project, every person who was interviewed went to great lengths to emphasize the fine character and high motives of Secretary Volpe. His willingness to take risks and push for action was highly praised.

With such unanimous support, one must accept these judgments, but it must also be noted that Morgantown is in the district of Harley Staggers, chairman of the House Commerce Committee, a significant part of the transportation subsystem that has a strong influence on the DOT budget. Senator Jennings Randolph of West Virginia was chairman of the Public Works Committee, another part of the transportation subsystem, and Senator Robert Byrd sat on the Senate Subcommittee on Appropriations, which had to approve DOT budgets. Within the executive branch Bryce Harlow served in the White House as assistant to the president. His brother was James Harlow, president of the

University of West Virginia. A secretary of transportation who did not pay attention to such an array of political power would have to be considered incompetent or naive, and John Volpe was clearly an astute politician.

The negotiations and discussions that occurred in arriving at the decision to go with the Morgantown project are nowhere publicly recorded, and one cannot be certain at what level the decision was made. For the associate administrator for Research and Development in UMTA, the decision came in the form of a note: "Let's go in Morgantown." It was signed "J" (meaning John Volpe).[39]

The public announcement was made in September 1970, when UMTA entered into a contract with the West Virginia Board of Regents for a demonstration project with 100 percent federal funding to be controlled by UMTA.[40] UMTA lacked control, however, of one critical factor—time. DOT officials, in making the announcement of the contract, also specified the system would be dedicated and operational by October 1972.[41]

Although publicly denied from time to time, there is widespread private agreement that the decision on timing was politically motivated. Whether the decision was made in the White House or whether DOT officials anticipated the desires of the White House is not important for this study. All evidence suggests that this was a purely political decision.[42]

It should be noted, however, that this was probably not a key political decision in the larger scheme of things, despite its critical effect on the Morgantown project. At the time the decision was made, DOT was embroiled in the beginnings of the Supersonic Transport (SST) debate (which was a major defeat for them in 1971). The question of AMTRAK and rail subsidies was also being discussed, and Volpe, along with the other two ex-governors in the Cabinet had fallen out of favor with the White House.[43] In this context, the political decisions regarding Morgantown were probably not part of a well-thought-out plan.

The demonstration project as defined by the University was to be a 3.6-mile, six-station, ninety-vehicle system. In developing this plan, UMTA was to consider local requirements to the extent possible, and the University had the option of not accepting the system if it failed to meet certain performance specifications.

The system proposed by the University had been a simple system, essentially a shuttle loop transit (SLT) system like a horizontal elevator. UMTA wanted a more ambitious project and, after visiting the developer, Alden Self-Transit Systems, decided that they needed an experienced systems management firm to take overall charge of the project.

With the extreme time constraints imposed by the higher authorities, UMTA immediately engaged the Jet Propulsion Laboratory (JPL) of Pasadena to act as a systems manager. At that time there was no clear conception of the system's requirements or an appropriate design. No detailed systems analysis had been done. JPL had no experience with transportation systems, but most aerospace people at that time assumed that such systems were much less complicated than space systems and therefore would offer no significant problems.[44]

Upon examination, however, the problems were shown to be more complex than anticipated. Off-the-shelf parts and components were found to be inadequate, and new components had to be designed and tested. UMTA had used the University's cost estimates to gain Congressional approval of the project, because they did not have the staff to compute a detailed cost estimate themselves, and the University's estimates proved to be inaccurate.[45] There is even some question as to whether these could really be called estimates, since they apparently involved little or no analysis.[46]

After an initial analysis, JPL estimated that the total project would cost $37.1 million rather than $18 million. At that point, a decision was made to cut the program back to three stations, fifteen vehicles, and 2.2 miles of track. If the system proved satisfactory, the University could then apply for 80 percent capital grant funding to complete the system. Table 5-1 summarizes the physical and cost changes as the system developed.

Aside from the rising costs, which became notorious, the changes in the concept and objectives that took place are significant. The University apparently expected to build a real PRT system based on the vehicle size chosen. PRT, however, permits a network system of guideways with many stations to handle dispersed loads. The University plan with its corridors and heavy surge loads at only a few stations was inappropriate for PRT.

The system was required to move 1,100 people in 20 minutes, and to do this it was necessary to go to larger vehicles—to become a group rather than a personal service. The name and reality simply did not coincide, and this confusion exists to the present time. Many of the criticisms of the concept of PRT are based on the Morgantown experience with GRT, and the significance of the type of service and the number of passengers per vehicle is lost.[47]

The time factor may also have had a critical effect on the decision to go with larger vehicles, since the fractional-second headways required by true PRT would have required extensive testing to prove the safety and reliability of the equipment. It would have been grossly irresponsible to operate such a system with passengers without such testing, and the October 1972 deadline precluded any long-term development work.

During the spring of 1971, the relationship between UMTA and JPL deteriorated. JPL apparently wanted more time to do a detailed systems analysis, whereas UMTA was pressuring for immediate action. The goals of UMTA and the methods of JPL were not compatible. The final break came in a contract dispute regarding the relationships of the systems manager and the subcontractors. Ordinarily such a dispute would be resolved, but the JPL people did not really perceive the political problems of UMTA, and UMTA was not willing to tolerate the "ivory tower" approach of JPL. Therefore the two organizations agreed to disagree, and Boeing Corporation was awarded the contract in August 1971.[48]

Table 5-1
Morgantown PRT Cost Experience
(millions of dollars)

	Date of Estimate							
	8/15/70	4/1/71	4/29/71	9/27/71	10/15/71	2/11/72 Orig. 1A Contract Estimate	1/1/75 Actual 1A Cost	1/1/75 1A & 1B Estimate
Estimator	Univ.	JPL	JPL	Boeing	Boeing	Boeing	Boeing	Boeing
Stations	6	6	3	3	3	3	3	3
Guideway miles	3.6	3.6	2.2	2.2	2.2	2.2	2.2	2.2
No. vehicles	90	100	15	15	10	5	5	45
Passengers per vehicle	4-6	9	15	17	21	21	21	21
Total cost	$13.5	$37.1	$23.4	$40.6	$27.4	$36.9	$40.4	$59.9
Construction	10.0	20.7	12.3	20.6	15.4	20.3	23.1	25.8
Vehicles	1.8	6.4	4.6	4.1	3.5	4.4	4.9	9.1
Command and control	1.3	6.0	4.4	8.3	5.4	6.2	7.9	13.6
Other[a]	.4	4.0	2.1	7.6	3.1	6.0	4.5	11.4

Source: U.S. Government Accounting Office, Staff Study, *The Personal Rapid Transit System, Morgantown, West Virginia,* April 1975, p. 17.

Note: PRT cost is the federal share excluding support costs; other support costs in the amount of $4.5 million constitute the remainder of the total $64.3 million of the Morgantown PRT budget and are not shown here.

[a]Other includes system engineering, project management, other miscellaneous costs.

This too may have been a political decision. After the SST was killed by Congress in early 1971, "senior administration officials" were reported to have ordered DOT/UMTA to place Boeing in charge of the Morgantown project.[49] Bernard Vierling, who had been responsible for the SST program in DOT, was moved to UMTA to head a newly formed office to run the Morgantown project.

Vierling states that although he was aware of the capabilities of Boeing, having worked with them on the SST project, that the decision to go with Boeing was based on a minicompetition between Boeing, which already had a subcontract for the vehicles, and Bendix, which had a subcontract for the control system.[50]

The evidence is not clear regarding the degree of political influence that was exercised in the choice of a contractor, but it is clear that the choice had to be made quickly. It also seemed to be necessary to select as a systems manager, an organization which already had experience with what had occurred to that time, as there were only 14 months left before the completion deadline.

With Boeing settled as prime contractor, the project moved ahead on a crash basis. There was an attempt to design, develop, and construct the system all at the same time: "This caused numerous system deficiencies and problems which required redesign work at an estimated cost of between $3 and $15 million."[51] This is called concurrent design and development, which is frequently done on defense contracts.[52] The resulting cost overruns are frequently ignored in defense but become a scandal in the domestic/social realm.[53]

When the cost overrun story broke in *Business Week* in March 1974, the headline read, "Transportation: A $13.5 Million West Virginia Experiment that may cost $125 million: The Escalating Cost of a People Mover." The criticisms this generated, plus the continuing technical problems, led the GAO to express the following concern: "GAO is concerned that the problems and criticisms of the Morgantown project's management and cost will jeopardize further research and development of PRT's by Federal and private interests."[54]

The essential problem throughout was the short time frame. This prevented an adequate system analysis with trade-off studies regarding the size of the vehicle, the numbers of passengers to be carried per vehicle, the number of seated versus the number of standing passengers, what type of steering mechanism would be needed, and so forth. The guideway design exemplifies the problems: "The schedule was dictated to us, and we designed the guideway in an unheard of five months. We designed it before the criteria were known, and even then the criteria kept constantly changing."[55] This meant that the guideway was made much stronger and consequently much heavier than necessary. This was both costly and aesthetically displeasing. Later, when vehicle design parameters were determined (and it was too late to change the guideway), it was discovered that a 6-inch difference in the width of the guideway would have allowed standard truck axles to be used on the vehicles rather than having custom axles made. Inclement weather made it necessary to have the guideway heated to melt ice, and the cost to do this after construction was very high. The construction also ran into problems from extremely bad weather in the spring of 1972, which caused expensive delays. Unmapped underground utilities were discovered and had to be moved. Construction had to take place in a busy downtown environment. As costs were added in some areas, it was necessary to cut back in others—including performance.[56]

In June 1972, the administrator of UMTA concluded that the PRT objectives were not being fully met in the existing statement of work, and as a result he decided to extend the research-and-development effort as well as to provide for a fully automated, operating transit system capable of revenue service. After that the concept of the original contract, Phase 1A, became a demonstration of system feasibility rather than a qualification of prototype operations.[57]

With all the problems, a system of sorts did operate in October 1972. It was dedicated by Secretary Volpe, Representative Staggers, and the President's daughter, Tricia Nixon Cox. The demonstration was only slightly marred by a vehicle failure. After the dedication, the problems that developed with the first five test vehicles were so great that they were almost entirely junked. A 1972 derailment of a BART train raised serious safety questions about the Morgantown control system, since the automated fail-safe mechanisms in both were similar.

As costs mounted and technical problems continued, there were more searching probes of the whole R and D effort in UMTA.[58] The Congress in general, and the House Subcommittee on Appropriations for Transportation in particular, lost confidence in the management capability of UMTA. It became more difficult to get money, and money that was planned for other projects had to be reprogrammed into the Morgantown project to cover cost overruns. Of all the money spent by UMTA for the New Systems Research from 1962 through 1975, 50 percent went to Morgantown. To make matters worse, much of this so-called R and D money was not spent for R and D purposes. The University wanted a working system and attractive stations, so money that was sorely needed for research purposes had to be diverted to make the system attractive to the customer.

There are still bitter feelings about this. There are comments about the greed of the University and the personalities of some of the principals.[59] The University, however, points out that their needs came first. UMTA presumably entered the situation because they felt their research needs could be met in a joint venture: "They said 'we'll build this for you and we'll build it right,' Elias recalls. 'We really couldn't say no.' "[60] Although this is not entirely true, for the University did apparently use its political clout to get the project in the first place, it is true that UMTA agreed to leave the University with an acceptable operating system. The operating costs were to be "reasonable and acceptable," and if the system failed to live up to the University's expectations, UMTA would "take the necessary steps to remove the facilities."

Using the threat of requesting removal of the system, the University was able to extract further concessions from UMTA for higher reliability and better performance. This caused more cost overruns, and the congressional heat kept rising.[61] Following the *Business Week* article, stories appeared in the *New York Times* (13 April 1974) and the *Wall Street Journal* (17 April 1974) followed by other essentially derogatory articles across the country.

Congressman Conte, a member of the Appropriations Subcommittee, was a strong critic of the project:

> If earlier we had the publicity that the papers now give to this boondoggle, maybe we could have stopped the project, as with the SST. But we couldn't get a line in the obituary column when we first were opposed to this kitty cart project . . . $33 million a mile to find out what you can find out in Disney World.[62]

The University was not happy either: "Because of political considerations, we are so far removed from the original system to compete with the automobile that all we have left is a test track for some hardware."[63]

Ultimately the University and UMTA arrived at an agreement regarding the existing system and a possible capital grant for some type of extension of the system. It pleased neither, but it did allow the administrator of UMTA to declare the Morgantown project a success.[64] In 1976, the journal *Mass Transit* gave tentative approval for the project saying, "Morgantown's PRT begins to prove it can be done."[65] A student from UWVa responded in a letter that the system was still not reliable enough—students occasionally missed classes due to breakdowns, and to them it was still "*p*retty *r*otten *t*ransit."[66]

Overall, it is safe to say that Morgantown has been a setback for UMTA, for new systems, and for the understanding of the potentials of new systems. All types of PRT systems are discussed in the same terms, with complaints about the orientation toward hardware and the lack of concern for service to the user. The following critique is a typical example:

> Whatever the thinking of UMTA may have been in the past several years, its actions indicate the clear assumption that hardware is the key to making transit more attractive. The strongest evidence of this bias is given in the time, effort, and money devoted to the personal rapid transit (PRT) systems.
>
> All of these systems are an engineer's delight, overflowing with electronic doo-dads; they are to be totally automated, working on the principle of the public's pushbutton selection of destination. The systems displayed or under consideration are aimed at handling relatively small passenger loads; they are not intended for mass movement of patrons in the 10,000-60,000 passengers per hour range of conventional "heavy" rapid transit. The PRT's have price tags that would choke the proverbial horse. The most costly PRT of all is being installed at Morgantown, W.Va. When completed that system will be two and one-fourth miles long and is now expected to cost about $125 million.

Supposedly it will have sufficient capacity to move 1,100 passengers in a peak 20-minute period. Even with its high price tag, one UMTA official admitted the Morgantown experiment would have only limited payoff.

"While we may learn from the Morgantown experiment regarding the costs of building, maintaining and operating an isolated, 'closed system' PRT, it won't tell us how to operate and market PRT in the open and dynamic atmosphere of an American city. Therefore, we should not lean very heavily on the Morgantown experience, except for data on the command and control system itself. The operation of PRT in a real, congested city, with its attendant 'unknown problems of vandalism and passenger security,' requires a comprehensive approach to the city itself and to indicators of the external impacts of PRT. For that reason PRT ought to be fit into a larger city plan to market the city itself as an attractive place to be." (U.S. Congress, House, 1974:350)

What is particularly bothersome about the PRT schemes is that they are generally ballyhooed as new systems when in truth they are not new systems at all, but merely new technology applied to the old system of the railway. Like the railway, the PRT's use of a fixed guideway with fixed station stops and the concomitant burden of fixed costs of such facilities that have become a problem when they are not shared by many users, as is the case with highways. Some of the "systems" have been designed to be used by a limited number of dual-mode vehicles that can circulate on regular roads and streets as well as upon the specialized guideway. One strong virtue of the PRT is the lack of need for human crew members or even single operators; cutting down on manpower is a matter to ponder seriously in light of the sharp and consistent increase in the wages of transit operating personnel.

Unfortunately, the PRT designs advanced so far don't enjoy one of the principal virtues of a more conventional railway: capacity. All of the proposed PRT systems use cars or modules of relatively low capacity. Handling peaked loads will be difficult without a large number of the vehicles, which, of course, would sharply increase the capital cost of the venture. Coupling modules together, or using modules of very large capacity, would apparently defeat the objective of developing a truly personalized rapid transit mode. So far, at least, the PRT's seem far too expensive for modest demands of patronage and too limited in capacity to meet heavy or highly peaked demand. PRT technology may be practical, but probably only under certain limited conditions. Enthusiasm waxes strong for PRT's, however, and Denver proposes making PRT's the backbone of its recently planned transit system.

The expression of faith in hardware and relative lack of interest in finding what the consumer wants is typical of undertakings dominated by engineers and other assorted technocrats. It is also typical of U.S. society; its apparent reluctance to try to come to grips with people problems in realistic terms forces it toward hardware, regardless of whether or not hardware makes sense. In short, the PRT technology, despite the funds and attention directed toward it, may only provide solutions for which there is no great and pressing problem.

> The real need, of course, is not to cease exploration in new or improved types of hardware, but to direct effort as well toward understanding the transit market and the problems and needs in transit as consumers see them. The key to making mass transportation attractive and useful to increasing numbers of people is quite likely not to have much to do with hardware. Indeed UMTA itself admits that key factors in developing more transit ridership are really a coupling of factors that are nothing more or less than what one would expect of a well-managed, systematic, marketing oriented, businesslike transit organization factors are:
>
> 1. Fast, frequent service.
> 2. Convenience of routes and schedules.
> 3. Adequate route and service information.
> 4. Ease of transfer intra- or inter-modal.
> 5. Clean vehicles and stations.
> 6. Courteous personnel dealing with the public.
>
> Unfortunately, UMTA has done little to promote or research activities related to these factors in recent years.[67]

As the statements indicate, there is considerable misunderstanding regarding what PRT is, and what its potential might be. Quite naturally, the author takes UMTA at its word, that Morgantown is personal rapid transit, even though it is neither personal nor rapid. As he points out, this system is not new, nor does it offer much in the way of improved service characteristics for the user.

He errs in the exaggerated statement of costs—the $125 million is for a 3.4-mile system, not the 2.2-mile system. He also errs in the assumption that all PRT systems must be hardware rather than service oriented. He states that improving service does not have much to do with hardware, but with existing hardware it seems to be impossible to supply the service characteristics he demands.

The problem at Morgantown, coupled with the numerous critiques such as Smerk's, gave transit operators ample evidence for their beliefs that new systems are unreliable toys. The Morgantown experience confirmed all their existing prejudices, making the new systems more difficult to accept. Morgantown was to be the "proof of the pudding" of personal rapid transit, and when it failed all new systems were tarnished as well.[68]

Congress demanded an investigation by the General Accounting Office, and the Senate requested a study of the whole automated transit area by the Office of Technology Assessment. The result has been greatly reduced funding for UMTA R and D. (It is frequently stressed today the UMTA is a "mission" agency—one which is to get action now, not to do extensive research.)

A number of potentially worthwhile projects have been delayed, or possibly stopped permanently, and the whole area of automated guideway transit (AGT) has been seriously tainted. People who have taken over in UMTA have been more cautious. There is little inclination to take even prudent risks, and the transit operators and manufacturers have gained greater influence over R and D projects, making for more conservative and less innovative projects.

Transpo '72

It was not only Morgantown that caused problems for UMTA. The U.S. International Transportation Exposition at Dulles Airport was held for nine days in May and June of 1972. The purpose of the exposition was to provide this nation's transportation and allied industries an opportunity to display exportable products in a marketing sales-oriented environment.[69]

Initially the plan had been for the DOT to build a tracked air cushion vehicle (TACV) train from downtown Washington to Dulles Airport as a demonstration project. Secretary Volpe had ridden such a train in France and wanted a similar project for the United States.[70] This idea was killed by Congress in 1971: "The committee (Sub-committee on Appropriations) see virtually no practical application for a TACV in an urban mass transportation system."[71]

Officials at DOT still felt that some sort of urban transportation system should be displayed at the Exposition, so $6 million was allocated to UMTA for the project. Within UMTA, the decision was made to have a competition and select four systems for display at Transpo. Each would receive $1.5 million to defray their costs. Their problem again was the lack of time. Only 10 months remained before the exposition was to open, so the primary criterion in the competition was for a manufacturer to have a product far enough along in the design process to be able to display it within the time limits.

The corporations also had to be willing to put up any additional money needed beyond the $1.5 million supplied by the government. The incentive for the corporations included an agreement that UMTA would do follow-up testing of the systems with respect to safety, comfort, acceleration and deceleration profiles, power consumption, maintenance costs and time, passenger reactions, and so forth. There were also to be trade-off comparisons among the four diverse technological configurations.[72]

Following these tests, deployment sites were to be selected with representative urban configurations, potential patronage, rights-of-way availability, environmental impact, public acceptance, construction costs, and the capability of the recipients to complete the demonstration project. When one of the technologies was shown to be compatible with one of the sites, it was proposed that pilot systems be deployed in urban areas starting in December 1972.[73]

The corporate competitors had every reason to believe that there would be further government investment in their systems to help gain immediate urban deployment. This was not, however, forthcoming. Congress chose not to fund further development until after the tests of the systems were in, and by that time a series of events including the escalation of costs at Morgantown intervened to delay additional government funding.

One of the factors causing delay was the quality of the systems themselves: "The systems were designed, fabricated, and integrated during the remarkably short interval of 10 months."[74] As a result, the orientation was to have functioning hardware, not to have a fully developed system design. There was considerable controversy regarding what urban needs these vehicles might fill.

One critic called these hardware displays a "collection of half-baked ideas." Another person who was involved in the effort noted, "They were stuck together with spit and glue." There was not enough time to do a really good job and to make the systems as attractive or technically sound as possible. Several local public officials who attended Transpo gave similar responses: "The systems at Transpo were not impressive."[75]

Although at the time all the systems were referred to as personal rapid transit, two of the systems were of the GRT type and two were essentially PRT. (The Transportation Technology, Inc. (TTI) system had a personal six-passenger vehicle and a group ten-passenger vehicle.) Some of the key characteristics of each of these systems are shown in table 5-2.

Each system at Transpo included two vehicles, one complete station, and a limited guideway configuration designed to fit into an area 700 by 150 feet.[76] During the exposition over 80,000 passengers were safely carried and were asked to evaluate the systems.

The public's reaction was apparently more favorable than the reaction of

Table 5-2
AGT Systems at Transpo '72

System	*Vehicle Capacity Seated*	*Capacity Standing*	*Total Capacity*	*Vehicle Length (feet)*	*Vehicle Empty Weight (pounds)*	*Suspension*
Bendix-Dashaveyor	12	20	32	23.0	18,000	Supported dual rail–rubber tires
Ford	12	12	24	26.0	15,000	Supported dual rail–rubber tires
Rohr-Monocab	6	0	6	9.7	4,100	Suspended monorail–rubber tires
Transportation Technology, Inc.	6/10[a]	0	6/10	15.5	6,500	Supported dual rail–air cushions

Source: D. MacKinnon, "Personal Rapid Transit Systems at Transpo '72," in J.E. Anderson and S.H. Romig, eds., *Personal Rapid Transit II* (Minneapolis, Minn.: University of Minnesota Press, 1973), pp. 38, 39. Reprinted with permission.

[a]Both six-seat and ten-seat vehicles were displayed at Transpo.

public officials. They seemed to like automated systems, although there were some reservations about the visual impacts of the guideways.[77] Because of the differences in the display of the systems, it was difficult to compare the various guideways for visual impact. They were all in an open area, which makes a different impact from a city street. The width of the street and the height of the guideway make considerable difference. More importantly, only the Rohr guideway was elevated, and although it was the slimmest and potentially the least intrusive of all the guideways, it received the worst ratings.[78]

The other three guideways were much larger and would also be elevated in most urban situations. At Transpo, however, they were placed at eye level, and therefore their structural impacts could not be readily assessed. The operating reports were inconclusive as well due to the speed of construction, and the expectation of immediate development and sales failed to materialize.

The Bendix-Dashaveyor was originally designed as an ore-carrying vehicle for open-pit copper mines. It was converted into a passenger-carrying vehicle, but its performance characteristics did not match a real urban need, and there were no sales. The company retired from the business of supplying AGT systems but is still a supplier of control systems.[79]

Ford improved on the system it displayed at Transpo and made two sales—one to Bradley International Airport (which was later cancelled) and the other to the Fairlane Town Center, a shopping complex near Dearborn, Michigan. The Fairlane system was completed, and then Ford also retired from the market.

To many observers the Rohr Monocab was closer to being a real system (rather than a piece of equipment) than the other displays. Rohr did win a competition to build a privately funded PRT system in Las Vegas, but for a complex of reasons discussed in chapter 10, the project was cancelled. Rohr was essentially an aerospace firm that entered the transportation business to diversify its product line. It became financially overextended, taking severe losses on the rail cars supplied to BART, the Washington Metro, and other projects. In the fall of 1975, a new chief executive was brought in and announced that the corporation in the future would concentrate on its aerospace business. Transit operations would be severely curtailed although the company would continue to compete in the high performance personal rapid transit (HPPRT) program.

Transportation Technology, Inc. became the Transportation Technology Division of Otis Elevator Company. They made no sales as a result of Transpo, although they are presently one of three competitors for the HPPRT program.

Although all the technologies at Morgantown and at Transpo were automated and used sophisticated computer controls, none involved a real paradigm change. A critic was essentially correct when he said, "they are not new systems at all, but merely new technology applied to the old system of the railway."[80] The orientation was toward hardware not to systems analysis, which might lead to new service concepts.

During this period—1969 through 1972—serious paradigm challenges were being made, however. Several institutions operating independently developed the concept of true personal rapid transit and attempted to get UMTA to sponsor necessary development work to make it market-ready. To this time (Summer 1978), they have been unsuccessful, and the record of their activity will be set forth in detail in chapters 6 and 7. The HPPRT program mentioned will also be discussed, since it may have arisen as a compromise between the two paradigms.

Summary and Conclusions

This chronicle of events from the HUD studies through Morgantown and Transpo '72 illustrates some of the ways in which politics intervenes in the technological innovation process. Although in one sense these are unique historical events, there are also some larger patterns, which connect the political processes with the processes of innovation.

In chapter 2, the distinction was drawn between the macropolitical system and functional political subsystems. The macropolitical system included the executive and legislative leaders of government as a whole, who have a broad range of interests and more general concerns for the community at large. The political subsystem included a particular executive agency, the congressional subcommittees that dealt with it on a continuing basis, and the special interests, which benefit from agency activities.

It was suggested that both the macropolitical system and political subsystems act as systems of appraisal regarding the need for innovation and the adequacies of proposed innovations. Each operates in a different environment with different roles, pressures, and powers. Particular situations and particular innovations offer differing threats and opportunities to various actors within each of these systems.

As discussed in this chapter, there were essentially two types of macropolitical intervention that influenced the course of technological innovation in the area of public transit. The first involved events in the larger community that called particular attention to the transit subsystem and the need for change.

Several such events occurred in the mid-1960s as concern developed over the quality of life in urban areas and as part of the War on Poverty and the general concern for cities and the urban poor. Air pollution was becoming a more public issue, and there was concern regarding the role of the automobile in generating such pollution. If there was one critical event, it was, perhaps, the 1965 Watts riot, followed by the McCone Commission Report, which indicated that a primary cause of the riot was joblessness. This, in turn, was due to a large extent to the lack of adequate transportation.

Thus real events were generating pressure for change, and Congressman Reuss (a member of the transit subsystem through the controlling House

Banking and Currency Committee) was perhaps helped by this pressure in his efforts to get the HUD studies started. The 1964 Urban Mass Transportation Act allowed the federal government to initiate research projects, but the 1966 legislation required such action.

Once research and development is established as part of the agency domain, people must be hired to do the actual work–to direct and take part in the technical innovative processes. The appointment of the political controllers of such processes is another function of the macropolitical system. The assistant secretary for metropolitan development in HUD, the administrator of UMTA, and the associate administrator of research and development in UMTA, were all presidential appointments. (Even when these are actually made by people other than the president, they are still acting as his agents and as a part of the macropolitical system.)

The background and "baggage" these people bring to their positions can have considerable influence on innovative processes. The fact that Charles Haar chose contractors from outside the traditional transit industry for the HUD studies meant that different ideas and different approaches that would go beyond traditional transit solutions became more probable. (It should also be noted that his concern for the overall agency domain of urban development was another significant factor in defining the problems to be considered by the outside contractors.)

Later, in the Nixon administration, people were selected for positions in UMTA from outside the traditional transit industry because there was a concern to move UMTA in more innovative directions. Certainly the people who were appointed describe themselves as being risk-oriented and concerned with innovation.[81] The definition of their domain was considerably more circumscribed than the domain of HUD, however, and this may have contributed to the hardware orientation of the UMTA program, which was noted earlier.

Thus it is through the macropolitical system that attention may be drawn to the need for change and innovation, appointments are made to carry out the innovation, and domains are legitimated that may influence the character of the innovation. There is some evidence that the impetus for new directions comes from the macropolitical system not from political subsystems, although at this point it is far from conclusive, and there is contrary evidence as well. Certainly it appears that pressure to innovate is likely to come from elected officials and certain top political appointees rather than from within the bureaucracy.[82]

Once attention is directed to the need for innovation, the organizational domain is established, and the people are appointed to direct the innovation processes, the attention of the macropolitical system will move on to other concerns. By definition, the macropolitical system is concerned with a broad range of issues, and few problems can hold its attention for more than a brief period of time. As a force for change, it operates in an ad hoc manner. Individual actors, especially politically appointed executives, tend to have a short tenure of office. Therefore, much of the continuing interest in change and innovation must be left to the political subsystem.

In some senses this turns innovation over to the more institutionalized and permanent forces for the status quo. Unless otherwise directed by the macro-political system, innovations that are developed within the political subsystem are likely to support the existing domains and power relationships among actors in the subsystem. In the case of UMTA, it is clearly easier to support research into improved bus and train systems than into alternative systems that threaten the roles, statuses, and powers of key actors in the transit subsystem.

The relative power of the forces for change and the forces for the status quo will vary as a function of time, however. The appointment of new people at the beginning of a new administration is a considerable force for change. New people coming in wish to make their mark—to show new initiatives—and this may offer greater opportunities for technological and other types of innovation. The HUD studies had almost no operational impact in the last months of the Johnson administration, whereas new approaches were being sought at the beginning of the Nixon administration.

As a new administration takes office, the commitment to existing programs is minimal, which can both help and hurt innovative projects. The help comes from the new people with new ideas who want to start new programs. The problems occur when an innovative project requires more than 4 years to complete. It may be difficult to sustain such a program even when the same president serves two consecutive terms. With the turnover among politically appointed executives, the proponents of a particular program may leave resulting in premature termination of worthwhile projects.

In 1969, there were few ongoing R and D programs in UMTA that had been initiated by the federal government. The bulk of the programs were locally initiated demonstration projects. The Office of Research had only eleven employees,[83] and a budget of $18.5 million.[84] Hemmes reports that he was anxious to "structure a good innovative program." This meant research—taking a concept and putting it on paper; development—moving from paper to a prototype; demonstration—from prototype to an actual situation with an experimental design; and production—where the experimental design would be eligible for capital grants.[85]

With these purposes in mind, and the opportunities that presented themselves in the form of the HUD studies and the impetus of a new administration, it is significant to examine why more dramatic innovation did not take place, why a paradigm challenge did not occur. The important factors seem to be: the relationship of UMTA to its environment, especially the other actors in the transit subsystem; the action mentality that dominated certain key actors; the force of the existing transit paradigm as it operated on key actors in the subsystem; and the attempt to centralize research decisions at the federal level of government.

Although there are a number of studies that document the close relationships within particular political subsystems,[86] such closeness is more likely to occur in older agencies, where there are mutual rewards to both the agency and subcommittee members in satisfying the needs of their clients and constituencies.[87] Where the mutual rewards are small, there may be a greater tendency toward conflict, especially between the executive agency and the congressional subcommittees that control its areas of authority and resources.

In the case of UMTA, a relatively new agency within a relatively new department, close and mutually supportive congressional relationships had not yet been developed comparable to those enjoyed by the Agricultural Stabilization and Conservation Service with its program subcommittees[88] or the FHWA with the Public Works subcommittees. Therefore, even though most policy decisions are made within the subsystem, there was not a close cooperative relationship between UMTA and its controlling committees.

The substantive committees have authorized the domain of UMTA and a particular level of spending over a period of several years, but public transit is only a small part of their multiple interests. The amounts of money involved are much smaller than for other areas (the FAA and FHWA for example), and therefore these committees appear to be less attentive to the transit subsystem as a whole. More attention is paid by the appropriations subcommittees with their annual review of the budget. Most important, due to the amount of time and attention its members devote to the issues, is the House Subcommittee on Appropriations for the Department of Transportation and Related Agencies. This committee has had relatively stable membership over the years, and its members have developed considerable expertise in the field of public transportation.

They tend to accept the existing transit paradigm, and they closely question expenditures for research and development.[89] They operate within a congressional subculture that is oriented to "cutting the fat" from the budgets submitted to them by executive agencies,[90] and research and development activities lead directly to new programs, which may cause greater expenditures. Therefore their inclination, both from the perspective of the transit paradigm and the subculture of the appropriations committee, is to cut research expenditures rather than to encourage them.

The hearings also indicate they wish to see results from previous expenditures before they authorize new expenditures. Research and development, which require several years to bring to fruition, are more difficult to sustain when budget cuts are demanded. This brings pressure for action now—visible concrete projects that can be displayed to constituents to show what the elected official is doing for them: "Our system puts a premium on *action,* on doing something whether right or wrong, seeking simply to avoid the obvious and apparent negative effects."[91] This seems to be an important psychological motivation of congressmen. Pressure for action is most immediately translated to executive agencies as they seek appropriations for particular programs. When there is an essentially weak agency, such as UMTA, with a weak program, such as research and development, it is perhaps inevitable that short-term projects displace long-term projects.

In this particular case, Secretary Volpe was also motivated by the desire for quick dramatic action.[92] Carlos Villareal reflected the desire for new beginnings and for action in his testimony before Congress: "Now, we are quite anxious, gentlemen, in reorienting this [research, development, and demonstration] program to show quick term visibility, and in the short term to improve existing systems."[93]

The name of the Office of Research was changed to the Office of Program Demonstrations for a brief period to reflect this action orientation. Beyond that, elections set clear deadlines within which the action should take place. In the case of Morgantown, unrealistic construction deadlines set by such political considerations caused problems that have endangered the whole concept of automated transit.[94]

Whereas clearly some individuals are more action-oriented than others (action defined as the building of visible projects), it is also clear that our elective system of government puts pressures on the elected officials to achieve visible results. Even a cursory examination of the news media indicates the approval shown for visible projects. Such pressures are translated into pressures on appointed and bureaucratic officials. Congressional appropriations hearings are filled with comments to the effect, "What did you do with the money we gave you last year?"

Perhaps equally as important in this action mentality is the knowledge that studies and research are often a substitute for action—a means of delaying certain actions while resources can be gathered for other courses of action. Much study and analysis is devoted to rationalizing certain policies, rather than to truly examining alternatives to determine superior approaches. Therefore if you have the votes, vote—get the action started. If you don't have the votes, delay—often this means doing another study or more research. Action and research are viewed as antithetical rather than complementary processes.

In this situation with a weak program within a weak agency in a network where overall resources were scarce, research projects may be seen as a type of pork barrel to satisfy key congressional leaders and to build overall agency support. To be effective in this approach, the "research" had to be, in fact, action—the building of a visible project. The Morgantown project seems to have filled this need, and initially it seemed to fit a congruence of interests, which made it possible for it to get quick approval. By demanding immediate action, that is, construction and operation within 2 years, the pressure was to get something built, not to examine the possibilities for innovation.

The time pressures also meant that the existing transit paradigm would be the only one considered. The corridor design, the peak loads, the limited number of origins and destinations, all led inexorably to a conventional solution with new automated equipment. Even people who are new to a field such as public transit have some ideas regarding what it is about, and these ideas will be largely stereotypes of the existing paradigm. Under extreme time pressure, they are likely to revert to such stereotypes, even though they might be more open to alternatives given different circumstances.

Their need to gain congressional support led to their rushing projects into construction, skipping research and development in favor of quick demonstrations. They could, at the same time, preserve their self-image of being risk-taking innovators, because the existing transit interests, especially transit operators, viewed automation as an extremely radical step. The criticism of the transit interests confirmed their innovativeness whereas the actual projects remained within the existing transit paradigm.

Rather than taking charge of the federal research-and-development effort in transit, the officials within UMTA found themselves subjected to political pressures that directed the course of innovation. The desire to take charge did not diminish, however, and, where it was possible to centralize control of research and development within UMTA, this was done.

This desire to control their own research program meant that after Morgantown few locally initiated research, development, or demonstration projects were approved.[95] The Morgantown project actually marked a transition from locally initiated projects as it combined aspects of both policies. It was locally initiated but then completely taken over by the federal government. This centralization was supposed to supply a greater coherence to the overall research program and make possible more dramatic and all-encompassing breakthroughs. The locally initiated projects lacked boldness, were not easily used to generalize to other larger situations, and provided little direction to transit managers of UMTA.[96]

Centralizing, however, made it more difficult for UMTA to keep in touch with the real needs of urban communities. It also meant that the pool of talent that would be seeking innovation would be more limited. Nonetheless, the HUD studies might have offered a basis for elaborating a highly innovative and integrated program of research and development—precisely what Villareal and Hemmes reported as their desire.[97]

Hemmes also states that his research program was largely based on the work of Bill Merritt.[98] By implication this could mean the HUD studies, since Merritt was the technical editor of *Tomorrow's Transportation.* There is some evidence, however, that people within DOT were not interested in promoting the work of HUD, which was viewed as a competitor for time, attention, money, and policy space. The HUD studies were NIH (Not Invented Here), and although the evidence is not conclusive, the HUD studies do not appear to have had a significant impact on the UMTA research program even though the term PRT was adapted from them.

The centralizing of Research and Development in the federal government had other effects, which will be discussed in the following chapters, but the decision to centralize was involved in a larger debate regarding the proper role of UMTA in the innovation processes and transit research. In the case of NASA, defense, or road projects, the government is the primary consumer of the products of research, therefore much of the research is done by government, or by contractors who are directed by the government agencies that support the research. Public transit is also a service that is largely provided by government, and therefore research and development should presumably be supported in a similar manner.

The history of the transit industry, however, placed the burden of research on the transit supply industry. With a declining market and the common industry practice of purchasing the equipment of the lowest bidder that met certain mechanical specifications, there was no way to get even modest improvements in equipment, let alone new systems developed.

There has been considerable ambivalence within UMTA and in the congressional appropriations subcommittees regarding the proper role of UMTA in this situation. There is still talk that innovation must come essentially from the transit supply industry. There is also concern that innovative systems developed by UMTA will find no market among transit operators. This idea conveniently ignores the fact that UMTA through its capital grants program creates the market for all transit systems. Some transit suppliers argue that it is the policies of the Capital Grants office that delay the adoption of innovative systems, although the conservatism of most transit operators is acknowledged.[99]

Whatever the case, the proper domain of the Research and Development Office has lacked a continuing consensus. For several years, the definition of mission allowed them to operate in areas that were not supported by the transit industry. Higher political authorities both in the Congress and in the executive branch apparently recognized the need for innovation and allowed and encouraged them to pursue a somewhat more innovative course.

These same forces may also have prevented a real challenge to the existing transit paradigm by forcing the innovators to operate within an extremely short time frame, which prevented the extended analysis and development necessary for a revolutionary innovation. The selection of particular projects, especially those designed at the local level, also assured that the existing paradigm would remain in place.

By definition, a paradigm challenge is unlikely to fit in with existing transit plans that are based on the old paradigm. The small Morgantown system with its limited number of origins and destinations and its heavy surge loads demanded some type of group system to operate along corridors. It was still essentially a product of the old paradigm, an automated bus.

Despite this, it did not gain the support of most of the transit industry, which was suspicious of automation in general. This was not immediately important as that industry exercised most of its influence in the Capital Grants office, which distributed the bulk of the UMTA funds. Later the transit industry would gain much support from the higher authorities for its position that UMTA research and development was excessively oriented to the future and not adequately concerned with existing transit problems.[100]

This was facilitated by the difficulties encountered at Morgantown, which gave critics an exposed target to attack. The real problem, however, may have been the lack of recognition of the role a political subsystem can play as a system of appraisal. There was little information gathered before deciding to go with the Morgantown and Transpo '72 projects, and there was little or no calculation of risks.

Even though the people who were within UMTA at the time describe themselves as being willing to take risks, it is not clear how they defined the idea of risk. After the fact, many have said that both Morgantown and Transpo '72 offered great technical risks. The so-called technical problems that developed seem to support this point of view, but many of these problems were not technical at all. They resulted from an unrealistic time frame not the inherent difficulty of the technology.

A political subsystem, however, operates in an environment that is heavily influenced by lawyers. Most members of Congress and many high-level political appointees are lawyers by training. They tend to define risk as not following precedent. By this definition, all innovation involves risk and may be to some degree suspect. This inevitable and necessary level of risk can be controlled, however, with good planning and good people. Although the elements of good planning are relatively well known and discussed further on, the need for good people is often assumed but left unanalyzed. Any technical innovation requires certain skills, some of which are commonly found in the population, while others are relatively scarce.

The more complex and difficult the project, the greater is the personnel risk—the risk that one cannot field a team adequate to the task at hand.[101] This particular risk seems not to have been considered in the projects discussed in this chapter, where it was assumed the tasks required no extraordinary skills difficult to find.

There was some concern for market risk—the idea that an innovation must have consumer approval if it is to be accepted. This was met in Morgantown by the local institutional demands for the system and the captive ridership offered by the students. This narrow definition of the market meant that the larger utilitarian risk was ignored. One of the primary justifications for the Morgantown project was its presumed applicability to other urban areas. It was not, and is not, clear that the system designed for Morgantown has utility for other urban areas with their multiple origins and destinations, high crime danger, noncaptive riders, and narrow streets where the wide guideway would be an aesthetic blight.

There was also a time risk—the time frame was much too short as events later proved. Many people in UMTA, including Bob Hemmes, were acutely aware of this problem.[102] When things are not done on time, further risks of unfavorable media attention become more probable, and such adverse attention leads to the risk of upsetting congressional support. It also risks forcing the issue to macropolitical attention in a most unfavorable way.

Not meeting planned deadlines causes some criticism, but it is nothing compared to the criticism generated when a project goes over budget. This is always a danger in innovative projects—perhaps one of the greatest dangers if past histories of innovation offer any lessons to the present.[103] These costs are most likely to sky-rocket, however, when simultaneous design and construction take place.

It is cheaper to tear up paper than to knock down cement, and design problems that are not caught in the early applied research and specifications stage, will be far more costly in the prototype and tooling stages (as shown in table 2-2). By sequencing the innovation process, costs can be contained, especially at the most expensive phase of manufacturing tooling and setting up manufacturing facilities. Up through the prototype stage, there is some risk of cost overruns in even the best planned innovation, but these will be small compared to overall project costs. When the early stages are largely omitted, the costs at the later stages are likely to rise dramatically as occurred at Morgantown.

In the case of Morgantown, however, UMTA accepted the University figures regarding costs because they did not have enough personnel to evaluate the cost data themselves. These University figures became the basis for congressional approval of the program.[104] When these proved to be erroneous, in part because of the changes made in the program by UMTA, cost overruns became inevitable.

The events at Morgantown suggest there was little calculation regarding the risks which were taken. It is not even clear that the people involved understood which risks they were taking at the time. Later events apparently have caused a further distortion as the technical and cost risks have been over-emphasized, while the utility, personnel, and time risks have been minimized.

As a system of appraisal, the transit subsystem, operated poorly, if at all. Within UMTA, it is not clear that the people saw themselves as functioning as a system of appraisal. They were reacting to a variety of political pressures from higher authorities in the executive and legislative branches, and they seemed to be much more concerned to satisfy these higher authorities in the short term than to truly analyze the projects these authorities were promoting. Later when things began to unravel, UMTA was blamed for incompetence, poor management, and worse, while the higher authorities held themselves blameless.

If one attempts to analyze these processes in terms of a rational, unitary decision maker with clear goals and objectives and alternatives from which to choose, one becomes mired in the lack of such goals and the inconsistencies regarding available alternatives. The reasons for the actions which took place can best be understood in the context of a bureaucratic politics model where there is a mixed competitive-cooperative game.

In such a game there can be fundamental disagreement regarding what is to be done, and the outcomes depend heavily on the power and skills of the opponents. In this case, the power rested with key congressional leaders who were able to get a particular project because certain executive branch leaders believed they could improve their positions in the game by accommodating the congressional leaders.

If such leaders demand action now, innovations that require time and considerable research and development will be neglected in favor of demonstration projects, which can show visible results quickly. Whereas such demonstrations may have innovative aspects, they are unlikely to challenge existing paradigms or power relationships. Instead the existing paradigms, statuses, and power relationships will be reinforced as those who benefit by the existing relationships will control the innovative processes. It is only to be expected that they will tend to direct those processes in ways supportive of existing subsystem purposes rather than moving toward more radical or revolutionary change.

Although there was some evidence from events in the macropolitical system that more fundamental change was needed, the issue of public transit was not a vital one to either executive or legislative leaders. Almost all federal transportation money was going into highways and aviation, and there was some uncertainty as to whether any activity was worthwhile in the area of public transit.

In such a situation, the pressures for change were at best ad hoc and sporadic. The questions regarding what is to be done could be limited to getting a project for a particular district, gaining support of congressional controllers, and having a showpiece ready for the 1972 election. More fundamental questions regarding the need for public transit, characteristics of good public transit, and how to develop such transit could be, and were, ignored.

6 The Challenge of Personal Rapid Transit

In chapter 5 it was shown that considerable innovative activity took place through the intervention of government, but it functioned within the existing paradigms of public transit. People were still to travel in groups along linear corridors. There was some shift with the development of personal-size vehicles and the idea of operating on demand during some periods of the day. There was not, however, a total system evaluation coupled with equipment development such as that proposed in the Department of Housing and Urban Development (HUD) studies.

Such a development process was taking place during the time period covered by the Morgantown and Transpo experiences, but not under government auspices. The Aerospace Corporation, a not-for-profit systems management firm, which worked primarily for the Air Force, decided to diversify its operations into the civilian area. The corporation was interested in technical problems that they were equipped to work with and that could have a significant impact on society.

Dr. Jack Irving was asked to look into several areas, and came to the conclusion that urban transportation was a serious problem in terms of long-range energy consumption, air pollution, the paving over of huge land areas, congestion, the quality of urban life, and so forth. It was an area that has significant impact on all our lives, and as he examined a variety of problems, he heard of a new idea that intrigued him.

During 1966, HUD and the Office of Science and Technology sponsored a conference under the auspices of the National Academy of Sciences to examine means by which technology could be used to help solve problems of the city. It was at this conference that Dr. Irving first heard of the idea of personal rapid transit.

This was followed by discussions with some people from General Motors who had worked with these ideas and could identify some of the challenges in the area. The publication of the HUD studies, especially the work of General Research Corporation and Stanford Research Institute, clarified the issues, and, in June 1968, Irving approached the Aerospace board of trustees to get funding for an investigation of urban transportation problems.

The board agreed that this was a fruitful area for exploration and provided the necessary money to form a small team to analyze urban transportation problems. They began with some vague ideas regarding the desirable service characteristics of the automobile, which they later confirmed with more systematic analyses of mobility needs and travel patterns in cities. Following Kuhn's hypothesis (discussed in chapter 2) they were newcomers to the field of transportation, which may in part explain why they came up with a revolutionary innovation.

Their concern, however, was not for revolutionary innovation but for moving people and goods more effectively and comfortably in cities. They took the perspective of the user, noting the clear desire for a short total trip time. They seriously examined the success of the automobile to find out precisely why it was so popular. Public transportation was also examined to see why it was failing the market test.

The user perspective was supplemented with a larger societal perspective, which concerned itself with the quality of the urban environment, energy consumption, pollution generation, congestion, safety, social equity, aesthetic desirability, and so forth. Whereas the automobile offers excellent service to the user, the social costs to the community are high. The Aerospace purpose was to develop a mode of transportation that would optimize values for both the users and society as a whole.

From initial ideas that were later supported by analysis, a concept of personal rapid transit evolved, similar to the concept from the HUD studies, but with some clearer ideas on how the service concept could be accomplished. It is significant to note that many different transit concepts were examined, and some of the ideas that have been put forward as popular solutions were rejected.[1]

Alternative Systems

Various forms of group transit of the simple shuttle or loop variety (SLT) or the more complex GRT systems with their off-line stations were analyzed and rejected. The SLT systems have been developed by manufacturers and put into operation at several airports and amusement parks. They do not, however, meet the needs of large dispersed urban areas.

With many origins and many destinations, it is highly unlikely that a large group of people will want to travel from the same origin to the same destination at the same time. This is why all group services require people to gather and wait for the system, to have intervening stops, and to travel on schedules. This time for waiting, intervening stops, and transfers is what most people find disagreeable in public transit. It increases total trip time and requires some means to get to the system.

There are also severe technical problems with the group transit when there is an attempt to give it some of the random service features of personal rapid transit (PRT). In such a system, the station computer cannot know until 15 to 30 seconds in advance at which of the four to six berths the vehicle should be assigned to load and unload:

> A four-berth station will be roughly 80 to 120 feet long. Since passengers do not know at which berth their vehicles will stop, they must wait near the middle of the platform, watch a series of signs for indication of a vehicle headed to their respective stations, then walk quickly from twenty to fifty feet to the vehicle.[2]

This would require alert and quick passengers during off-peak hours, but during crowded conditions, the situation appears to offer insurmountable difficulties. For anyone who must walk slowly or move in a wheelchair, the situation is impossible.

In Denver it was found that GRT systems would require 60- to 90-second stops for passenger loading and unloading as compared to 34-second stops for the average on-line train or bus system. Their conclusion was that the intermediate group systems offered no advantage over conventional train or express bus systems with on-line stations.[3]

From a purely technical point of view, GRT systems are easier to develop because it is not necessary to operate the systems at close headways, and a technically functioning system can be built relatively quickly without extensive testing. It is much more difficult, however, to integrate such hardware into anything but the most simple urban service, such as connecting a few (2-8) stations at a university or in a downtown area.

To expand the service to several hundred stations involves tremendous difficulties that no one has yet been able to solve. Therefore such systems are usually proposed to run along corridors like conventional trains or buses. A number of reasons are given for doing this, but buses on exclusive lanes would provide essentially the same service, and it is unclear if purported savings in labor costs make the development of GRT systems worthwhile.[4]

GRT systems are also an aesthetic blight. They need to be heavy and wide to support heavy vehicles.[5] Most of the group systems that have been developed are comparable to automated buses. The vehicles weigh up to 25,000 pounds and require single guideways from 8 to 11 feet wide. Two such guideways side by side cause significant visual obstruction, which may be unacceptable to citizens.[6]

Another significant problem is the vulnerability of group systems to crime. Crime is most likely to take place while people are waiting at a stop, so the larger the station and the longer the wait between vehicles, the greater the likelihood of crime. Unattended vehicles may also offer a temptation to crime as individuals and gangs invade a vehicle at intervening stops.[7] With all these difficulties, group rapid transit did not appear to be a promising approach, despite its less complex technical problems.

Dual-mode systems, which have been termed the "ultimate" answer to our transit problems, were also examined and rejected. In such systems, vehicles operate as normal automobiles or buses for part of a trip, then travel on an automated guideway for part of the trip. A typical example would be commuters who travel from home to guideway under manual control, travel the long commute trip under automatic control, then leave the guideway to drive to their place of work under manual control. The idea is to relieve commuter congestion and to save money, since far fewer guideways would be needed than would be required for a fully automated system.

There are a number of problems with such systems, but several major problems were decisive in rejecting this approach.[8] The first stemmed from the definition of the transportation problem itself. As in the example shown, dual-mode concepts deal most effectively with commuter trips along heavily used corridors. This, it was felt, was not the only nor the primary transportation problem of urban areas. (See chapter 4.) There was also a technical problem of queuing, particularly at exits, which threatened to back up the whole system creating congestion in a manner similar to that on existing freeways.

A vehicle that is capable of traveling on highways as well as in an automated mode must essentially double the power systems, control systems, and so forth, creating a much heavier, more complex, and more costly vehicle. The size and weight mean that the guideway must be correspondingly larger and heavier. The cost of the vehicle could very well make it a system for the rich, not for the poor who are most in need of transit. It would also be more difficult to serve those who cannot or choose not to drive. In a complex technical system, good maintenance is essential if there are to be reliable and smooth operations. Relying on individuals to maintain such vehicles would open the system to serious risks of breakdown due to faulty vehicles.

The conclusions were that dual-mode would not solve many of the transportation problems confronting urban areas today and that with the size of the guideways and the station areas, "we would be creating blight, not benefit."[9] The system that was designed by Aerospace could support a type of dual-mode by using pallents to carry road vehicles, but until there are some operational systems, it is difficult to determine if such an option would be useful or attractive.

PRT—Service and Technology

The system that did emerge evolved through a series of analyses to determine the desirability of various service and technological configurations. What is significant in this approach is the interweaving of service and technical characteristics to form an integrated system. The idea of service came first, then the technical requirements to supply that service were determined.

The decision to have personal vehicles was made on the basis of improved service characteristics—fast service, random patterns of origins and destinations, reduction of crime hazard, and so forth. If the vehicles were to be small, with only one or two occupants in most cases, it then becomes necessary to run many more vehicles closer together to get adequate capacity.

If the vehicles run close together, it is necessary to have the stations off the main line so there is no delay for loading and unloading. This requires frequent and rapid switching. Designing a switching mechanism outside the service context is not useful, since its characteristics must be determined by the operations it is required to perform. In this particular case, the switches have to be able to operate at half-second intervals. Therefore, some of the clumsy and time-consuming mechanisms developed for group systems proved to be inadequate for a personal transit system. By designing the hardware without a service concept in mind, the mechanical devices may determine the service rather than vice-versa.

In practice, the development of service and technology becomes an iterative process as compromises and adjustments are made. A new technological capability may enable one to improve on service, whereas a technical block may prevent ideal service. Certain blocks, however, become problems to be solved so that service can be made adequate.

Conceptualizing Change

A number of different values come into play in the design of the guideway. Much of the initial work on automated systems has been conceptualized as automating a bus or an automobile, just as the initial attempts to build the automobile were conceptualized as a horseless carriage. Such a conceptualization looks toward a wheeled vehicle in a configuration such as that shown in figure 6-1.

In this configuration, the guideway must be wider than the vehicle—at least 5 feet or more in width. This is not only an aesthetic problem, it creates a whole series of additional problems. It is difficult to have rapid switching of a four-wheeled vehicle. It becomes necessary to heat the guideway to melt ice and snow, and the cost of materials for such a large structure rises.

The monorail configuration shown in figure 6-2 has the advantage of requiring a much slimmer and more aesthetically acceptable guideway. This may be one of the reasons for the continuing public interest in monorail developments. For the technician, however, the monorail presents severe problems in switching whether at long or short intervals. Except for a simple configuration, such as that found at Disneyland, the monorail is not viewed as a practical alternative.

Figure 6-3 illustrates the design developed by Aerospace Corporation to meet the needs for a small, aesthetically unobtrusive guideway, while meeting the needs for quick switching and precise control. The guideway could not, however, be developed independently of command and control systems. Figure 6-4 is a photo of the vehicle and its undercarriage, which fits into the guideway. It shows the active part of the DC linear-pulsed motor, which provides both the

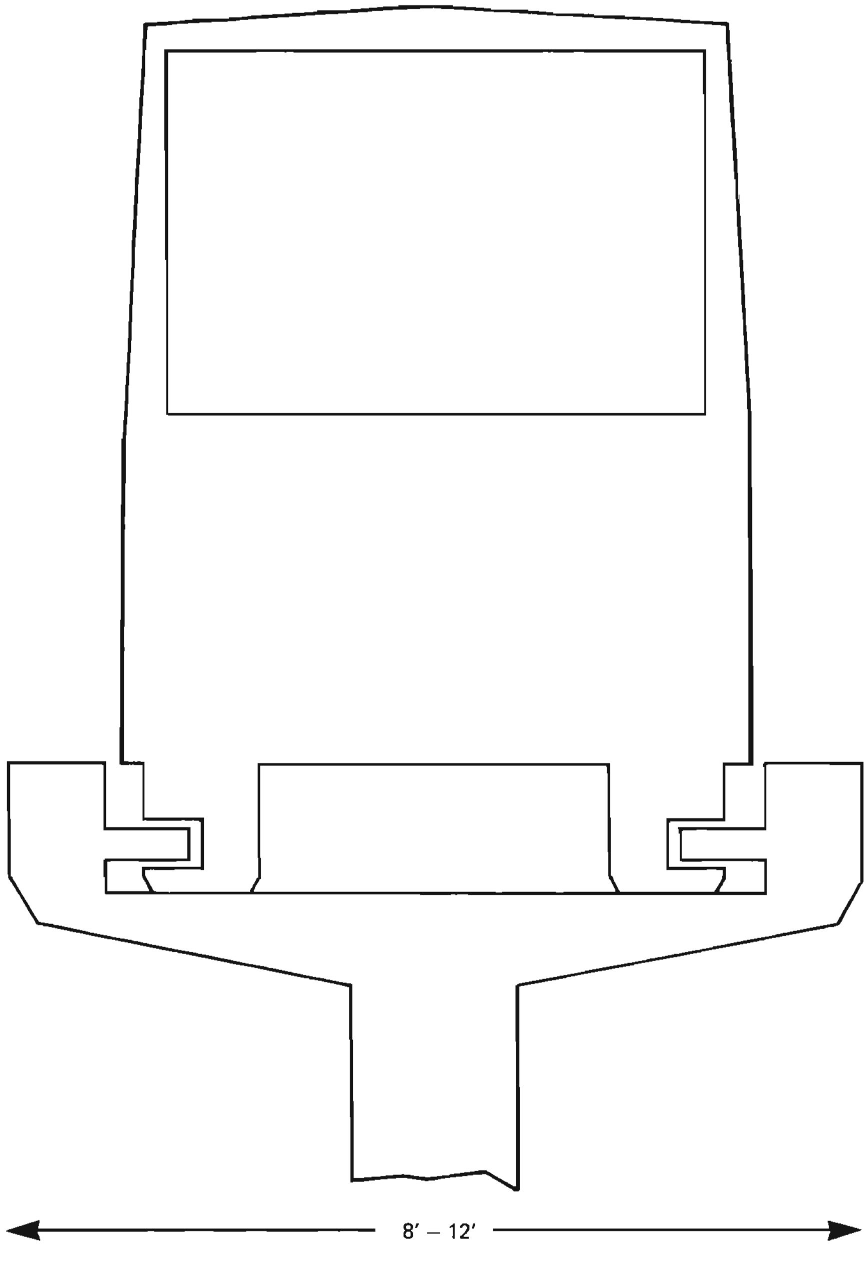


Figure 6-1. Generic Automated Guideway Transit Vehicle.

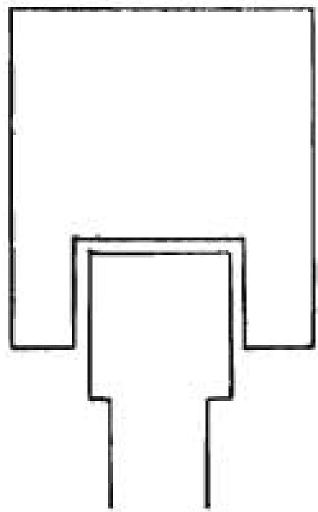


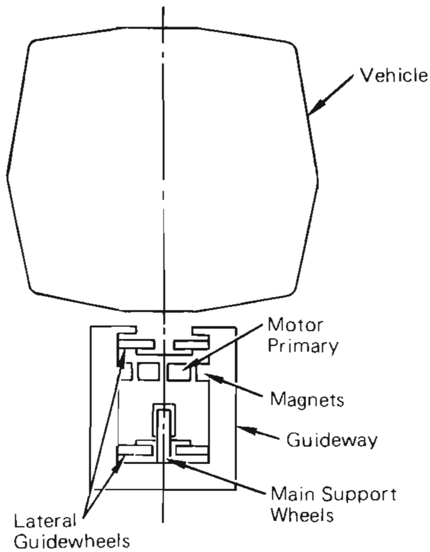
Figure 6-2. Monorail Guideway Configuration.

motive and the braking power for the vehicle. It works in conjunction with permanent magnets, which are placed inside the guideway as shown in figure 6-5. Also shown are two devices that are designed to clear the guideway and keep the magnets clean.

The open space between cross beams allows snow and rain to fall through the guideway, preventing accumulation. It also makes possible a lighter structure requiring fewer materials, which can be constructed in a factory and assembled on site. Factory construction means less disruption on the assembly site, so that streets need be blocked for only a few days, not several months or years, as with heavier construction.

Switching is accomplished by electromagnets placed at each intersection as shown in figure 6-6. When the electromagnet on the top is turned on, the vehicle will turn; when the one on the bottom is turned on, the vehicle will go straight. This allows for virtually instantaneous switching so that vehicles traveling at 0.5-second headways can be manipulated with one going straight and the next turning. Not shown in the illustration is a mechanical device that will keep the vehicle on track in case of electrical failure. Figure 6-7 gives a more complete view of the vehicle in the guideway.

These technical details are explored to illustrate the interactions of technical elements with social and economic values. The service concept and the hardware development are totally integrated—one cannot exist without the other, and a change in one requires a change in the others.



Aerospace Corporation. Reprinted with permission.

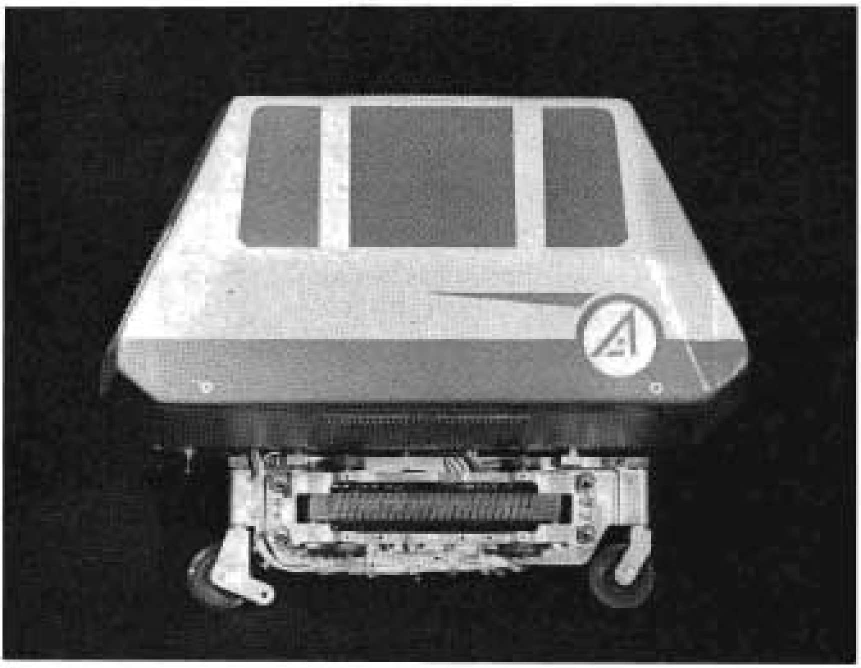
Figure 6-3. Aerospace Corporation PRT Guideway Configuration.

The design of the guideway network illustrates this point. Most transit systems operate in two-way corridors—train lines side by side, buses on opposite sides of the street. With PRT it was determined that a one-way network would allow greater areawide coverage, create less visual intrusion, and allow for much simpler intersections. Compare the differences in the two-way and one-way intersections shown in figure 6-8.

The one-way network allows a person to enter the system at any station, and the vehicle will be automatically routed to the most efficient path to his destination. Therefore the direction of traffic flow is unimportant. It also allows for greater dispersal of stations increasing their accessibility for more people. All these factors appear to offer positive service advantages.

It is interesting to note, however, that these advantages do not exist for a two-way system, and that true PRT operates less efficiently in the traditional corridor pattern. The proponents of PRT see this as a benefit and suggest that rather than gathering people to travel through a single corridor, a more dispersed pattern is likely to take people closer to their real destinations.

The opponents of PRT argue that such systems will not handle the surge loads that are found in many urban corridors. Figure 6-9 illustrates how a PRT network might be designed to serve the Wilshire corridor in Los Angeles. With several lines carrying 6,000 to 8.000 people per hour, the carrying capacity matches that of a heavy rail system.



Aerospace Corporation. Reprinted with permission.

Figure 6-4. Aerospace Corporation PRT Vehicle.

Station placement is another critical issue that is intertwined with social, political, and technical problems. Good station placement allows greater access to the system, whereas poor station placement could make the system economically unfeasible. Studies of bus systems indicate that people are willing to walk no more than 1/4 miles to reach a transit system. Therefore one would like to design a PRT system to meet this requirement. A number of studies have indicated that this would require guideways to be placed at .25-mile intervals.[18] This requirement comes from the placement of stations at the intersections of guideways, just as buses stop at street corners, to facilitate transfers. (See part A of figure 6-10.) With PRT there are no transfers, so stations may be placed midway between intersections. (See part B of figure 6-10.) Assuming one must walk a grid pattern of city streets to get to a station, the latter approach allows 1/2-mile spacing of guideways while retaining the 1/4-mile maximum walk for the rider.

Actual station placement would depend on a number of social and political factors—the need to cover some neighborhoods but not others, the type of activity center, the population density, the clout of particular local officials. The technical issue of the required distance between guideways can cloud this debate and lead to political conclusions that are erroneous. It might be politically

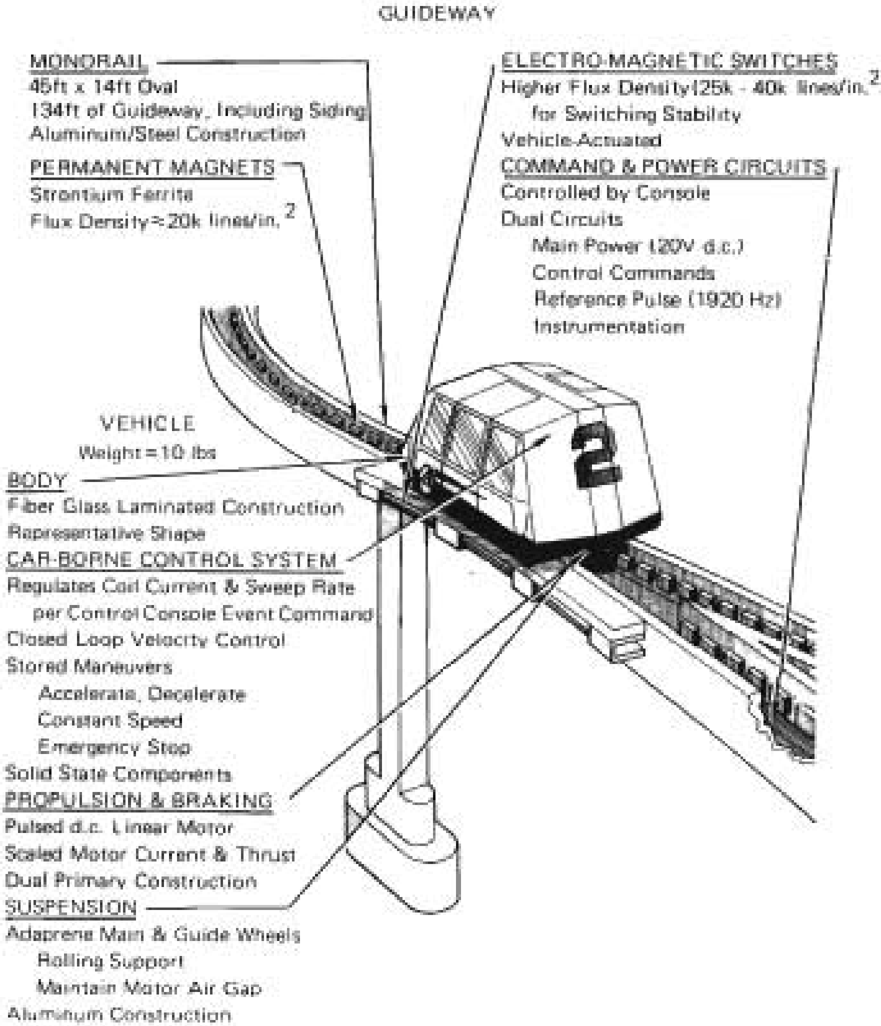


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Figure 6-7. PRT Model Description.

This opens up the system for children, who cannot ride on existing systems. Small children could travel alone if an adult got them started and another adult met them at their destination. Older children could travel on their own, opening up new possibilities for mobility for both central city and suburban children. This would also take the pressure off women, who must now act as family chauffeurs.

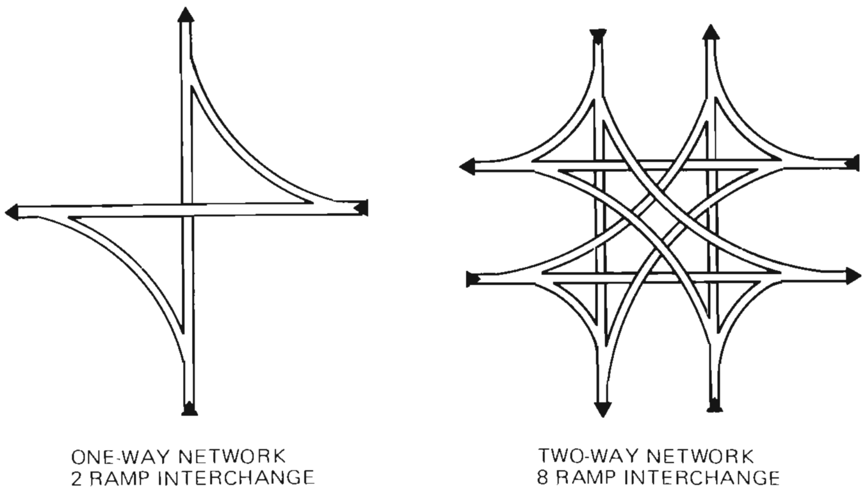

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Figure 6-8. Intersections: One-Way and Two-Way.

Cultural attractions, schools, and recreation areas could be made more accessible for more children. The cultural deprivation of central city children has been widely reported, but there may also be some cultural deprivation among middle-class children isolated in suburbs.[15] Special magnet schools for science, music, art, or trade skills would become feasible, and integration of existing facilities might be eased.

According to proponents, PRT is a safe system for children, since it is much less likely to have accidents than any current transportation alternative.[16] It is also less vulnerable to crime. Its small stations make it less attractive for criminals, and during off-peak hours the vehicles wait for the passenger. There is no waiting in the station, making the period of vulnerability very short.[17]

There is also no reason for loitering in such stations, so closed-circuit television could be used to spot potential criminals in high-crime areas. Once in a vehicle, the passenger is in a private car that no one can enter, and is therefore safe from criminal activity. Should someone force their way into a vehicle as a passenger enters it, an emergency button can be pressed that takes the vehicle immediately to an emergency stop with health and police services. Such a button should be a major deterrent to crime and therefore would be used primarily for health emergencies.

Mobility is enhanced for the entire community because a PRT system is not restricted to particular corridors. Operating on a network basis, people can cross traditional transit corridors or travel from one outlying area to another. For the

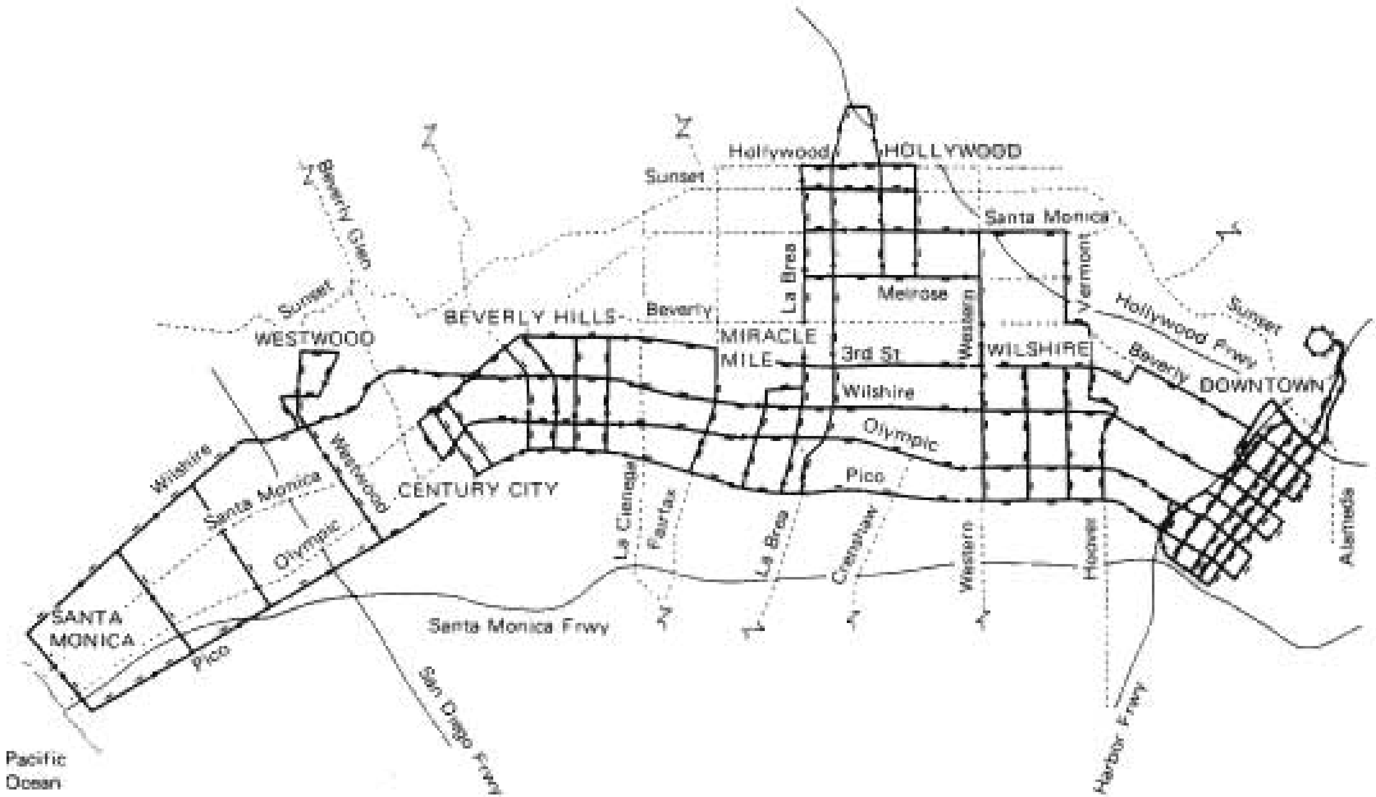

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Figure 6-9. Hypothetical Network for Wilshire Boulevard in Los Angeles.

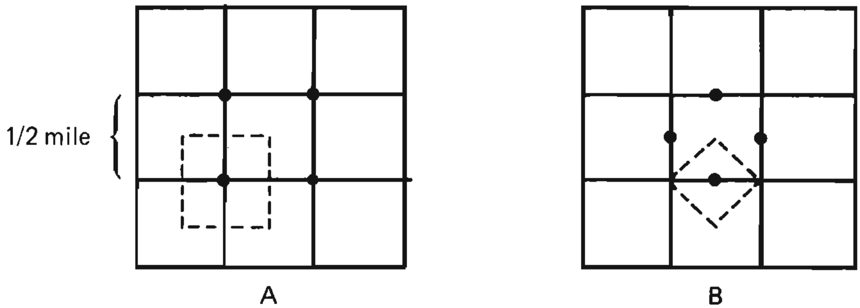


Figure 6-10. Station Placements on Sample PRT Networks.

poverty-stricken transit dependent of the central cities such a network offers the possibility of traveling out of the ghetto to industrial jobs.

It also offers the best opportunity for balanced development of the whole community. Concentrated development such as that found in Manhattan is not gracious living for most people. Although concentrated development along rail corridors may make some people rich, it does not appear to serve the best interests of the whole community, nor does it fit today's level of technical and economic development.[18]

PRT appears to have the most potential for offering superior service to moderately dense urban areas–6,000 to 12,000 people per square mile.[19] The extremely dense configurations found in Manhattan are not necessary for PRT to operate successfully. It does, in fact, operate best at moderate to low densities including the dispersed situation found in Los Angeles–roughly 6,000 people per square mile. Proponents of PRT believe it will enable us to avoid the extremes of urban concentration or sprawl–allowing and encouraging a mid-level of density, which is apparently more attractive to more people. Many major metropolitan areas are predicting polynucleated cities with average densities of 6,000 to 12,000 people per square mile. These can best be served by a network configuration that connects the multiple centers and can distribute people within them.

Because the system uses fixed guideways, it could influence the growth and density patterns of a metropolitan area. By building the network closer together with more stations, more dense growth could be encouraged in some areas, whereas a more sparse network could discourage growth.

A PRT system is modular in character–parts of it can be built separately and later joined to a larger network. This would allow local groups to plan for neighborhood development and actually control their own segment of the transit system within the broad limitations of total network requirements. Smaller governmental jurisdictions could be brought into the planning, development, and financing processes. The broader coverage offered by PRT might help to reduce jurisdictional disputes.

PRT systems are designed to operate over existing roadways so virtually no

Table 6-1
Composite Weightings of General Criteria

Criteria	*Composite Weight*
Convenience	1.022
Travel time	0.945
Reliability	0.927
Safety and security	0.900
Metropolitan form and design	0.831
Comfort	0.827
Travel cost	0.808
Human physiology	0.727
Psychological	0.719
Sociopolitical	0.584
Right-of-way	0.574
Flexibility	0.273

Source: W. Keller, "A Method for Development of a Mass Transit Evaluation Model Based on Social System Values," 1973. Reprinted with permission.

additional land need be taken to construct the system. This greatly reduces capital costs, which the Aerospace Corporation estimates would be $4,150,000 per mile in 1975 dollars. This figure includes guideway, an average of two stations per mile, one hundred vehicles per mile, and all control and maintenance facilities, assuming 100 miles are built at one time. For a smaller purchase, the cost per mile would be higher; for a larger purchase, the cost drops approximately 10 percent per hundred miles of guideway. The estimate for rail systems in 1975 dollars is $50,000,000 per mile, although recent experience indicates that that estimate may be low. (See table 4-5.)

A PRT system can be built in a relatively short period of time given the desire to build it and enough money. For example, after the footings were in place, the Germans found they could erect two columns plus a 120-foot span connecting them in about three hours. This means that guideways the length of whole city blocks could be built in a matter of days, not years. This reduces the costs to the community from the disruption of construction and also the costs of inflation, which increase as construction time is extended.

Operating costs have been calculated in some detail, and at the 1975 price of electricity in Los Angeles all costs could be covered by a fare of 5.3¢ per occupied vehicle mile. This means that an average Los Angeles trip of 10.8 miles[20] would cost approximately 60¢, assuming a million passenger-miles per day. If we assume two million passenger-miles per day, the costs go down slightly. Thus, with passenger travel alone, PRT systems show promise of being able to operate without taxpayer subsidies.[21]

PRT systems can also be designed with spurs to industrial and commercial establishments to facilitate the movement of light freight during off-peak hours. Retail establishments with central warehouses, the postal system, shopping centers, and others might find it advantageous to pay for the construction of guideways into their facilities to move freight or bring people to their location. The charges for freight operations could be used to reduce passenger charges. The first operating PRT system in Japan was planned for port operations near Tokyo. Some of the Japanese believe freight operations could pay for passenger operations, if that were the government policy.

These favorable cost factors make it feasible to operate a PRT system 24 hours a day, 7 days a week, allowing people to choose their own schedules rather than being bound to a timetable. This does not waste resources, because PRT is demand activated. It only operates when someone wants to use it.

This allows greater energy savings than can be attained with buses or trains, which must run with partial loads during off-peak hours, if they run at all. A total system in use (with present designs) would consume roughly 55 percent of the energy that is used for the same amount of automobile travel.[22] The use of electricity makes it easier to use nonpetroleum, nonpolluting sources of energy such as solar or geothermal power.

To the extent such nonpolluting sources of energy are used, to that degree will the system be nonpolluting. In the Aerospace version, PRT is also virtually noiseless because it does not use friction for propulsion or braking. In construction, PRT will use much less energy because the guideways and vehicles are light weight and consume far fewer materials than do conventional rail systems.

It is believed PRT will be attractive to automobile users because it is rather like having a chauffered car—traveling in seated privacy, nonstop, where and when the passenger desires, without driving, and with no maintenance or parking problems. Even its critics concede the attractiveness of the system, although they may argue that it is not necessary to have such an attractive system given the rising costs of the automobile, which may force people to use public transit.[23]

Conservative estimates indicate that with a fully developed PRT system (one which covers 80 percent of an urban area), 25 percent of all vehicle miles travelled in the area would be on PRT. The Germans have estimated that for one small city of 100,000 their PRT system, *Cabinentaxi*, would require 138 kilometers of guideway and 182 stations to place 95 percent of the built-up area within 350 meters of a station. With this system all the public short-haul trips and 70 percent of the individual trips could be made on PRT. Six thousand PRT

Table 6-2
Master Chart of Decision-Maker Criteria

*Travel Time**	*Travel Cost**	*Convenience*	*Comfort*	*Safety and Security*	*Reliability*	*Human Physiology***
Walking	Parking	Schedule	Ride Quality	Personal Safety	Schedule	Air Pollution
		Rush-hour frequency	Acceleration/deceleration	Deaths	% on-time operation	
Waiting	Riding	Off-hour frequency	Jerk	Major injuries		Noise pollution
			Vibration	Minor injuries	Delays Enroute	
Riding		Station	Linear motion		Major	Vibration of buildings
		Distance to destination		Personal security	Minor	
		Distance between stations	Vehicle Seating	Robberies		Accidents to nonusers
		Platform elevation	Seat type	Assaults		
		Station location	Seat direction	Insults		
		Ticket procedure	Crampedness			
				Anxiety		
		Vehicle	Vehicle Environment	Whereabouts		
		Access/egress	Noise	Connections		
		Provision for parcels	Air conditioning			
		Transfers	Lighting			
		Travel group size				
		Control	Privacy			
			Seat direction			
		Parking	Car capacity			
		Availability				
		Access/egress congestion	Aesthetics			
		Distance to station	Age of car			
			Cleanliness			
			View			
			Station Comfort			
			Waiting time			
			Aesthetics			
			Crowding			

Right-of-Way Associated	*Economic*	*Metropolitan Form and Design*	*Sociological-Political*	*Psychological*	*Growth Flexibility*
Partitioning community	Cost	Land Use Distribution	Individual Life Style	Social Acceptance	Line expansion
	Construction	Parking to offices	Increased use public facil.	Acceptance by inc. group	
Displacements	Operation	Parking to parks	Increased use cultural facil.	Appearance	Speed increase
	Travel cost reduction	Parking to cultural			
Construction inconvenience		Streets to malls	Community Involvement	Pleasantness	Capacity increase
	Business income		Increased public interest		
Property values		Integration/Fit	Increased public visits	Safety and Security	
	Personal income	Station location		Guideway elevation	
		Station/guideway elev.	Political Feasibility	Vehicle appearance	
	Total jobs in area	Station/guideway appear.		Window size	
			Increased Tax Base		
	Jobs on system	Population Distribution			
		Change in residency	Integration Effects		
		Traffic Congestion Relief			
		Design Flexibility			
		Removable/permanent			
		Aesthetics			
		Style			
		Design			

Source: W. Keller, "A Method for Development of a Mass Transit Evaluation Model Based on Social System Values," 1973.
*With regard to the value of time and money.
**External effects of system.

vehicles could do the work of forty thousand automobiles.[24] This type of dramatic reduction in automobile usage, if it actually occurs, would greatly reduce vehicle congestion, air pollution from automobiles, energy consumption, and the drain on resources that comes from the construction of automobiles.

Computer operations should prevent congestion within the PRT system. During peak hours, however, people may have to wait before they can get a free vehicle. Street congestion would, of course be reduced to the extent that automobile users find the system attractive and use it rather than drive. The 25 percent modal split can be compared to the 2 percent modal split achieved by BART in San Francisco[25] and the 1 percent modal split predicted for a train system in Los Angeles.[26]

PRT is least attractive in handling surge loads, such as emptying a stadium after a sports event, but none of our present transporation systems handle that problem very well. PRT should at least equal, and perhaps exceed, the capacity of the automobile, comparing the wait for PRT to the wait to get out of the stadium parking lot.

To examine rush-hour congestion, the Aerospace Corporation did some preliminary studies of the downtown Los Angeles central business district (CBD). Using fifty-eight stations varying in size from three berths up to twenty berths, they estimated that a PRT system could move 50,000 people per hour in or out of the CBD. With a two-hour rush period, this is slightly more than half the 1975 CBD working population of 180,000.[27]

The overall aesthetics and design of an urban area could potentially be enhanced by PRT development. A guideway roughly 30 inches by 30 inches does not intrude greatly in an aerial configuration. It could certainly be designed to be aesthetically pleasing, perhaps even with hanging flower pots. It could also support street lighting and some of the city's wiring, removing much of the existing clutter from city streets.

On weekends, the terrible crush of people leaving the city on Fridays and returning on Sundays might be alleviated as the PRT network expanded to serve nearby recreational areas. The environmental studies done for the Cabtrack project in England indicate that PRT is less intrusive than roads in some park and recreation settings.[28]

Because it is attractive to users, it offers the realistic possibility of making some areas auto-free zones without hardship to area merchants or to automobile drivers. Whether or not it could replace the automobile will be determined by many factors that are speculative and beyond the scope of this study. It could, however, give increased mobility and access to those who cannot or choose not to drive. It would also remove the pressure for families to have two or more automobiles. The amount of change this implies for an economy and society based so heavily on the automobile deserves more extensive analysis than is possible here. Although considerable testing and demonstration work will have to be done to prove these assertions, the proponents make their case that for the user and for society as a whole, PRT offers the potential of high-quality service and an overall improvement in the quality of urban life. By defining the urban transportation problem broadly, they attempt to avoid the social, economic, and environmental externalities that have either been ignored or dealt with inadequately by existing transportation systems.

In so doing, they thought they were operating within a widely shared framework of understanding and beliefs regarding the nature of urban transportation problems. Their approach certainly matched the rhetoric of the times, which emphasized the crisis in urban transportation—the need to reduce automobile traffic by 10 percent or 30 percent or 80 percent to meet pollution standards and deal with the energy crisis; the severe problems of the poor and physically restricted; the need for sound and sensitive use of land; and so forth.

The Paradigm Challenge

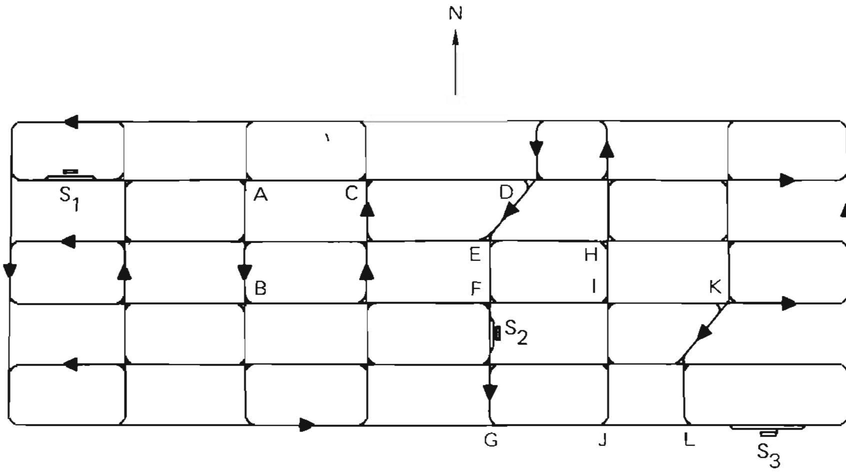
The reality for the political subsystem with responsibility for dealing with urban transportation problems was considerably different from the rhetoric, however. There the problems were more narrowly focused. The highway interests viewed the problems in terms of highway, and perhaps, some busway solutions. The transit interests focused on problems that could be solved with trains or buses. Any definition of the problem that made these "proven" solutions appear to be inadequate was immediately suspect. To go even further and suggest there was a better solution than the ones that had been put forward was not only suspect, but implied those who had been dealing with the problem were incompetent.

Further, the concept of PRT challenged the very essence of the transportation subsystem: ". . . it is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications."[29] In the case of PRT, the new fundamentals include the idea that public transit can be a personal, individualized service rather than group service.

The degree of change this implies for the transit planner is difficult for an outsider to comprehend. The whole approach to transit planning must be changed. Corridor analysis is no longer appropriate. Two-way lines give way to one-way lines. Small and large *networks* must be analyzed. Fixed routes and schedules give way to a random dispersal of trips operating at random times chosen by users.

Compare figure 6-11 with figure 4-1 to see the difference between the old paradigm and the new. In figure 4-1, it is assumed that people live in one place (usually the suburbs) where they must be collected to travel along a corridor to a central location (usually a CBD) where they will be distributed to their jobs. The new paradigm assumes a multiplicity of origins and destinations throughout a complex network.

A passenger can enter the system at any time at any station and travel



Aerospace Corporation. Reprinted with permission.

Figure 6-11. Schematic of PRT Network with Multiple Origins and Destinations.

nonstop to any other station. Central city residents can travel to industrial suburbs or crosstown, and people on the edge of the city could travel to other areas on the edge as well as in traditional radial lines to the central city. Figure 6-12 gives an example of such a network for Los Angeles, which can be compared to a rail proposal to cover the same general area (figure 6-13). Figure 6-14 is a PRT proposal for Minneapolis/St. Paul.

A system that can attract a significant proportion of automobile drivers will also be subject to certain iterative effects that have not been noted with existing transit systems due to their small diversion rates. Such iterations work as follows: As a number of people leave their autos to use the transit systems, the streets and freeways become less congested, therefore making them more attractive for automobile travel. Some people may then shift back to the auto until the streets are again crowded.

With present techniques it is very difficult to determine at what level of traffic an equilibrium will be reached between auto travel and the public transit system. Such an analysis will be necessary, however, to provide timely and convenient service on a PRT network without congestion, delays, or excessive movement of empty vehicles. The people who are developing PRT are working on this problem, but it is a radically new type of analysis for traditional transit planners.

Traditional transit planners also discount the possibility of moving freight on a system designed primarily for passengers. They point to earlier transit developments, including the London subway, which were promoted as potential

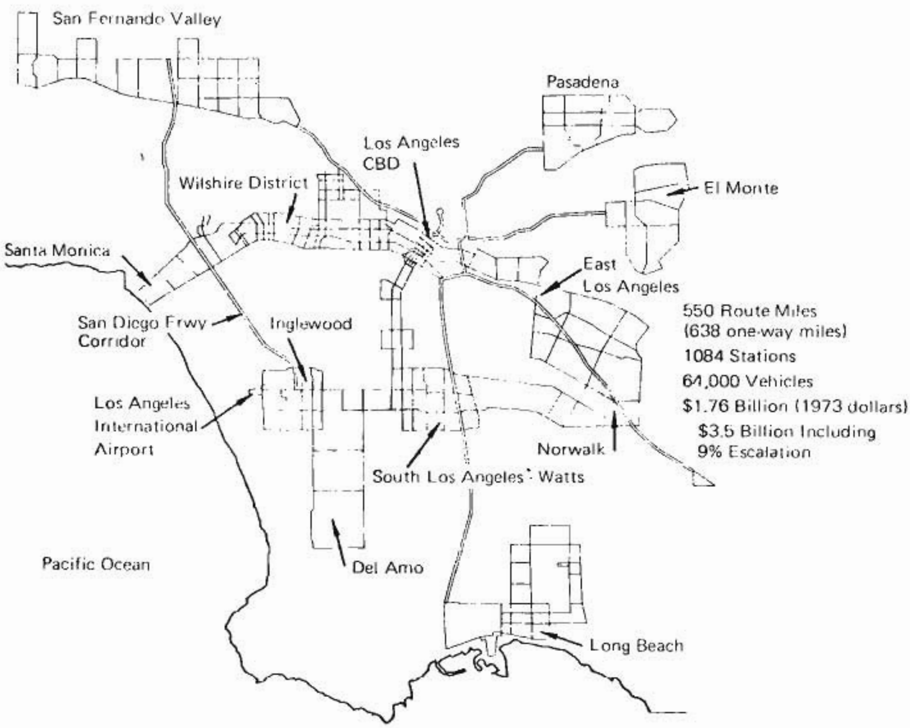


Figure 6-12. Hypothetical PRT Network for Los Angeles.

freight operations but never came to fruition. It is therefore assumed that freight and passenger operations could not be integrated in a PRT network. The possibility of separate spurs and stations for freight is disregarded even though PRT technology allows for completely different service characteristics.

These new service characteristics require a much greater orientation to market demands than is commonly found in existing transit districts.[30] Many types of travel needs of a variety of people will have to be analyzed to supply optimal service. PRT offers the potential to become a first-class service that can attract many customers with proper design. No longer can transit be viewed as a second-rate operation that people must be "forced" to use. The public cannot be blamed for being "unreasonable" or "spoiled" when they do not choose to use public transportation. This shifts a major responsibility onto the transit planners for designing an attractive and useful system—a responsibility they do not have at the present time.

As noted earlier, there is also the possibility that a PRT system will be able to pay for itself out of user charges. This suggestion violates an article of faith widely held in the transit industry for years, that is, that public transit systems cannot pay for themselves out of the farebox. Even the highway system, which uses private vehicles and is theoretically paid for by user taxes, especially the gas tax, generates externalities that are paid for by society as a whole.

When a PRT system is put into operation, it too may operate at a general cost to society, but existing analyses done in several countries using 1975 costs and dollars indicate that PRT systems can at least break even using passenger charges alone.[31] With freight operations they can show a profit. The ultimate profit or loss will depend on a number of factors—the quality of the management, the size of the total system, public policy regarding charges to users or subsidizing certain users, the amount of ridership, and so forth. Nonetheless, even the suggestion of a potential breakeven or profit-making operation has apparently caused many in the transit industry to discount the seriousness of PRT proposals.

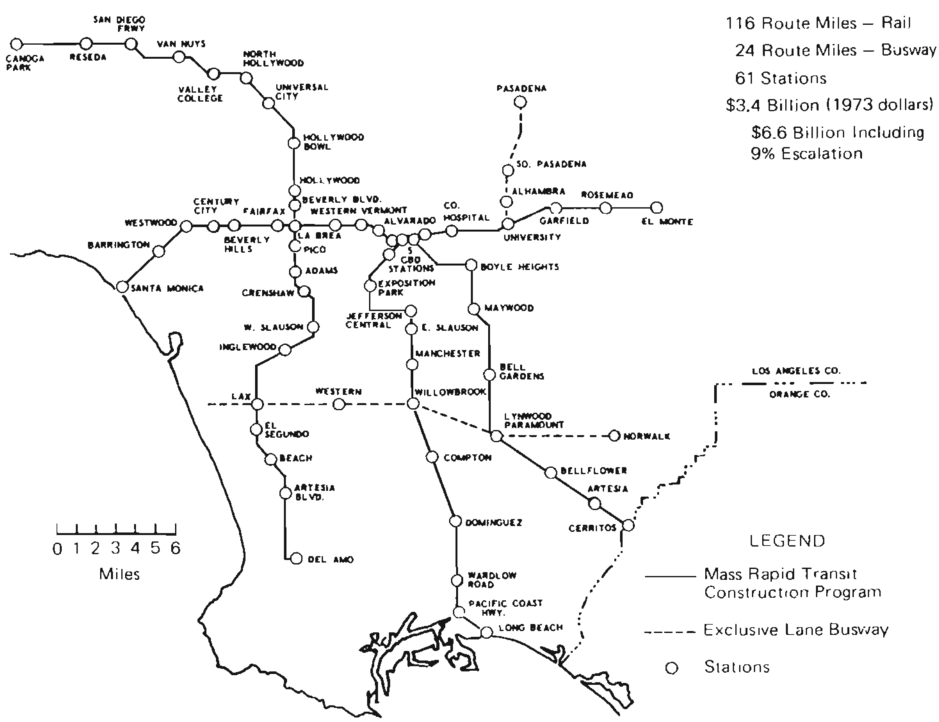
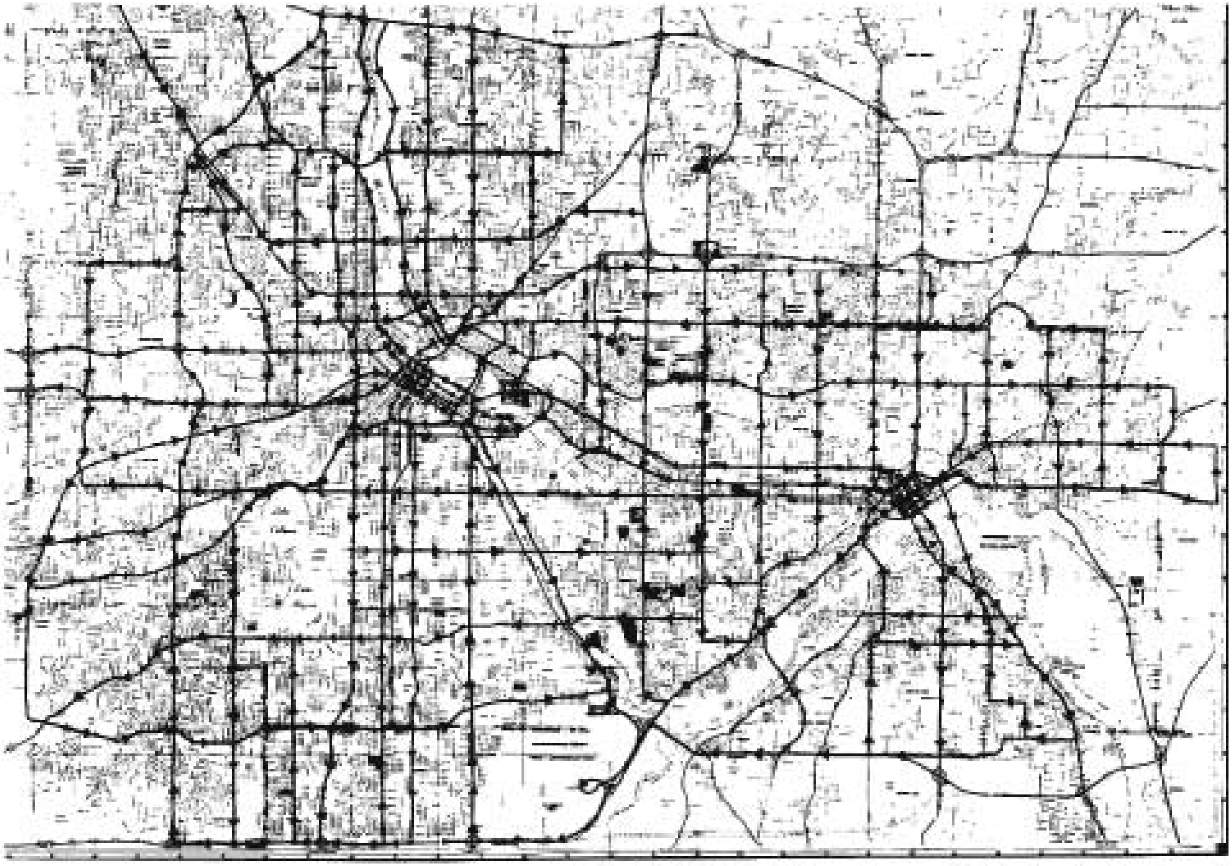


Figure 6-13. Consultants' 1973 Recommendations to the Southern California Rapid Transit District.



J.E. Anderson et al., "PRT Planning in the Twin Cities and Duluth," 1973. In J.E. Anderson and S.H. Romig, eds., *Personal Rapid Transit II* (Minneapolis, Minn.: University of Minnesota, 1974), p. 192.

Figure 6-14. Hypothetical PRT Network for Twin Cities.

There is also the question of efficiency. Transportation specialists have stressed the greater efficiency of large steel wheel, steel rail systems.[32] Because larger vehicles carry more people, and large train systems can carry up to 40,000 people per hour, they are assumed to be more efficient. Such systems can only be efficient, however, if they operate at, or near, capacity most of the time: "It is not sufficient . . . that a public transit system *can* carry 40,000 people an hour much more cheaply than a private automobile system can; it is also necessary to establish that enough demand exists to sustain a large-volume operation."[33] Still the existing efficiency criterion stresses large vehicles and questions the efficiency of small-vehicle systems.

Based on experience with earlier train systems, especially the elevated trains, conventional transit planning assumes the travel path between stations is a blighting element in the city. Therefore there is an effort to place the guideway in areas people do not wish to go to keep blight to a minimum. With a PRT system, the off-line stations can be placed almost continuously along the guideway path if there is sufficient demand, thus the value of all abutting property may increase rather than decrease.[34]

Finally, in the case of the Aerospace PRT system, the guideway has much in common with the monorail. (See figures 6-2 and 6-3.) The switching problems of monorails which have caused transit engineers to reject them, seem to have been carried over to the inverted monorail of PRT. The fact that switching is not only possible but also highly efficient with an inverted monorail does not seem to satisfy critics of a monorail-type system.

There are other technical issues as well. Professional conservatism demands that engineers and designers follow the canons of "prudent design."[35] Often this involves no more than doing that which has been done before. There is a real concern for liability in a new system design if it does not follow the rules of earlier systems.

One example of this type of thinking involves a traditional safety rule for trains and streetcars that must be changed in the case of PRT systems. Sometimes referred to as the concept of k, this rule of thumb asserts that should one vehicle stop instantaneously—"hit a brick wall"—the following vehicles must be able to stop without hitting the first vehicle, that is, k must be greater than 1.

This requires a certain minimum distance between vehicles depending on factors of speed, reaction time, the amount of jerk, the type of surface, and other technical considerations.[36] By keeping such spacing it is assumed vehicles will not collide. Therefore trains and buses are designed as if a crash will never occur. When inevitably there is an accident, the loss of life and the injuries are very serious. K protects the designers, since the causes of the collision are not subject to the designer's control. It does not, however, necessarily protect the passengers from faulty equipment or human error.

As noted earlier, PRT vehicles must travel at very close headways to carry the capacity required during peak travel periods. Therefore in the event of an instantaneous stop, at least one vehicle may collide with the first vehicle. Passengers in both vehicles are protected from this contingency by reinforced frames, padded interiors, and hydraulic bumpers to cushion the impact. In cases of extreme emergency, airbags can also be deployed to prevent passenger injury or death.

Although they can deal with the "brickwall" stop, proponents of PRT question whether it is an appropriate criterion for a system where it would be virtually impossible to have any obstruction on the guideway that would cause an instantaneous stop. Even a large tree branch, should it fall on the guideway, would have some give to it, thus greatly reducing the probability of an instantaneous stop. With just a small amount of skid, following vehicles coud be stopped without further collision. In the case of a vehicle losing power, the speed differential between it and the following vehicle would be very slight, allowing the following vehicle to make soft contact with the front vehicle and to push it to an emergency siding.

Ultimately all these systems would have to be proven safe in a test situation, but detailed analyses, scale-model testing, and some actual full-scale tests in other countries indicate that PRT systems will be much safer than any existing system. Nonetheless, the idea of planning for collisions is deemed a radical (and dangerous) practice by many. "The necessary automatic control system . . . is not going to be available in the foreseeable future without seriously degrading our safety philosophy for operation public systems."[37]

This safety philosophy is the one described as the concept of *k*: "If the brick-wall-stopping criteria are abandoned . . . This does not seem worth the institutional risk involved in breaking with tradition."[38] Yet it is just such a break with tradition that PRT demands; the concept of *k* is one of the paradigm methods and applications that must be reconstructed to work within the new paradigm.

Such a paradigm shift is comparable to Kuhn's idea of revolutionary science. For people who are trained for and experienced in the existing transit paradigm, the changes are revolutionary, since they penetrate to the fourth level of goals and values (as shown in table 2-2). The immediacy of the impact and the depth of penetration differ among various roles, role-sets, organizations, and organization-sets.

Within a public transit organization, existing operations—supplying bus or train service—would remain essentially unchanged for a number of years. During the testing stage of roughly five years, and during the construction and operation of the first small circulation systems, buses and trains would operate as they do now.

As PRT systems are put into operation, some bus service would be rerouted to act as feeders to the new systems and to give better service to areas without PRT. Only after many years of staged growth would the interconnections of the entire system take place, thus reducing the demand for other transit services.[39]

For transit planners, however, change would occur immediately. The admittedly crude planning tools used for corridor analysis would be inadequate and inappropriate for the detailed systems analysis needed for PRT design. Skills in tunnel building or operating trains would become obsolete, or at least less significant. More importantly for the individuals involved, the new skills required by a new paradigm imply that new people will take their roles. If there are to be no studies, plans, and development of train systems, there is no need for the people with the skills to do this. Some of the skills might be transferrable, but the uncertainty regarding what can be transferred and what cannot is very great. Certainly the computer-modeling skills will require new people, so the level of threat for individuals can be quite high.

At the level of the transit organization, a PRT system may or may not involve a revolutionary change. To the extent the transit organization defines its task as moving people, the PRT system does not threaten that goal. If, however, the goal is defined as building a train system or running a bus company (as is frequently the case), then PRT involves a revolutionary change.

It will almost certainly involve a restructuring change under any circumstances. Some people will become more powerful within the organization, and others will lose power. Many top-level people in the large metropolitan transit districts were brought in because of their expertise in gaining support for and building train systems. Thus it is not only certain planners and engineers who are threatened, but the top of the organizational hierarchy as well.

Another type of restructuring change might come about if local jurisdictions and neighborhoods claimed the right to plan their particular module of a PRT network. No longer would they be dependent on central decision making in the transit district to meet their transportation needs. This is an unsettling idea for many in the transit industry. Transit interests tend to follow the logic of the planner that "suggests a comprehensive approach to the problems of the city. The application of this logic to transportation would result in programs instrumental in achieving the broad objectives of the metropolitan community."[40]

This approach is often treated with approval because it presumably takes in a broader spectrum of interests than the narrower perspectives of the highway technician. Whereas some acknowledge that there is a lack of agreement on broad community objectives, they still insist such objectives must be the basis for any transit planning.[41] Certainly a broader perspective on community interests can be taken, but in the case of most transit planning, the special interests of downtown business groups and certain land developers are promoted at the expense of the wider community.[42]

Rapid rail systems that are proposed for many large urban areas not only serve these special interests particularly well, they also encourage comprehensive planning and dense urban development, which has been favored by much of the urban-planning profession for a number of years. This commonality of value perspectives is reinforced by the weak power position of public transit operations.

They must rely on others for financial subsidies to maintain their organization, and their primary support usually comes from central business district interests along with the central city mayor who is also beholden (usually) to these same interests. If local government plans and the CBD interests call for a rapid rail system, the transit authorities are unlikely to suggest something new and unproven that might jeopardize their support.

Most metropolitan plans have been predicated on some type of train transit for many years. Smaller surrounding communities make their plans based on a potential station in their midst. These interlocking plans require substantial time to develop and even more time to gain agreement. Once agreement is reached, no one wants to change that which was so difficult to achieve. Certainly the transit district is in no position to upset all these relationships, since it needs the support of community leaders and the planners.

Thus at the level of the organization-set, PRT offers the potential for power changes and perhaps for value changes as well. Not all the organizations of the set will be equally affected, and some may benefit more from changes than others. If the first small PRT network were built in a central business district, these powerful interests might find the changes advantageous rather than threatening in the short run. As the network expanded over time, the increased mobility and access for the whole community would probably offer a continuing advantage for all even if a preponderant concentration of wealth in one area did not occur.

Other organization sets that might potentially be adversely affected by a dramatic change in the methods of urban transit—the automobile industry, insurance industry, petroleum industry, roadbuilding industry—are not likely to notice much change in the short range of ten to twenty years. Even over the longer term, the changes are not likely to move past the restructuring level. The goals and values of the highway interests are essentially consumer oriented as are the goals and values of the PRT designs: "Highway planning . . . has a fundamental tenet that construction should follow existing or anticipated traffic demands. It is consumer-oriented."[43] This is referred to disparagingly as the logic of the technician, which "is manifested in a consumer-oriented, free enterprise approach. According to the technician, transportation facilities, paid for by the user, are provided to meet existing or predictable requirements."[44] The problem with this approach has been in the narrowness of interpretation of consumer values. Mobility for drivers has been a greater concern than protection of neighborhoods and concern for overall community development.

Personal rapid transit was designed to enhance the larger community development as well as to provide excellent access and mobility for the total population. This matches the values of the highway interests remarkably well and may, in part, explain why highway interests occasionally react more favorably to the idea of PRT than they do to other transit proposals.

They may also see PRT as a means of defeating other transit proposals as the transit interests claim, but the underlying value structure seems to be significant. It is difficult to quantify these factors, and they surely differ from organization to organization and from person to person within various organizations. Certainly the size and power of the highway/automotive interests make it possible for them to absorb any new system such as PRT. The automobile industry could supply vehicles, and construction techniques used in building freeways and bridges would easily transfer to the construction of guideways.

These industries are already facing considerable pressure to change. Money for new highway construction is being cut back. Cars will soon have to be smaller and consume less energy. Therefore PRT, which is not a paradigm challenge for the most powerful elements of this industry, may appear more compatible than other transit approaches.

For smaller, less powerful segments of highway/automobile complex, there may be local and, over a long period of time, national dislocations should PRT systems come into widespread use. Service stations and garages, local truckers moving intracity freight, taxi companies, asphalt and concrete manufacturers could all find a reduced demand for their services. Some roles, role-sets, and organizations might disappear entirely. Other roles, role-sets, and organizations would come into existence, but it is uncertain how many roles, at various levels of skill, would be created, how many destroyed, and how well those who lose their positions could find new ones in the new industry.

These problems will have to be faced over time, but PRT systems will begin in a small way, just as the automobile began in a small way. Its restructuring potential will evolve slowly, which should allow sufficient time to deal with particular dislocations as they occur. These will not necessarily be easy to deal with, but the pressures for change will make it necessary to deal with them with or without the existence of PRT.

For the user of public transit, the immediate change would be only at the first level–a behavior change. For the automobile driver who might shift from the automobile to PRT, only the first two levels of change would be required. To the extent that PRT networks could offer similar access and mobility as the automobile, the smaller would be the changes for the users. The changes that do occur are likely to be seen as positive rather than negative.

For society as a whole, PRT conforms to existing values of continuously available mobility. It is a democratizing technology which offers greater equality of mobility for the poor and other transit dependents. It opens up opportunities for those who cannot or will not drive. Expanded employment opportunities offer the potential for more equitable distribution of incomes. Even for those who drive, it is difficult to find or accept jobs which are more than a limited distance from home. An extensive PRT network might make longer distance travel both practical and attractive; expanding job opportunities for the individual and the labor pool for the employer.

The long-term impact on land values would also be dispersed throughout the community rather than concentrated in a few central areas. It would therefore have a distributing effect upon wealth as well as upon opportunities. Over a very long period of time this might be seen as a restructuring process, a restructuring change for society as a whole. Still the expanded opportunities at the bottom of the social and economic scale are not in any immediate way threatening to those at the higher levels. Such an expansion of opportunity may, in fact, serve to prevent serious dislocations, which could result from extremes of economic inequality.

At the fourth level, these distributive, democratizing values are widely agreed on in the common rhetoric of American culture. It is acknowledged they are not always the operational values that are practiced, but they do permeate the society. Any proposal that supports such values is likely to be more acceptable than one which opposes them.

Summary

Table 6-3 summarizes the depth of penetration of the changes that may occur for particular roles, organizations, and society as a whole. The degree of change may be great or small, and it may occur immediately or at some time in the future. The greater the depth of penetration and the more immediate the potential change, the greater is the likelihood of resistance to the proposed change.

As table 6-3 makes clear, the first impact of PRT on the society will be felt by particular roles and organizations within the transportation subsystem. These changes apparently penetrate to the level of goals, values, domains, and therefore are likely to be perceived as revolutionary in character. The estimates and examples of change are judgmental rather than precisely measured, but they do reflect the perceptions of a number of the people interviewed. Whereas they did not discuss change in terms of revolution, penetration, or immediacy of impact, the real issues they posed could be categorized in such terms.

The timing of change and the depth of change can reasonably be debated, but the general thrust of the paterns shown has been judged by a number of respondents to be essentially accurate. Agreement at the level of roles and role-sets was more widespread than the agreement about organizations or organization-sets. This is to be expected because organizations are made up of roles and role-sets, which are differentially affected as shown. Still, certain organizational characteristics such as domains and support groups can change, making the organizational focus reasonable.

For example, in the case of UMTA, a PRT test program would be completely compatible with the domain and goals of the Advanced Systems Division of the Research and Development Office. For the organization as a whole, however, such a program might jeopardize support from transit manufacturers, who are developing less advanced systems, and certainly would upset relationships with transit operators. Since these are the primary support groups

Table 6-3
Depth and Immediacy of Change for Selected Roles, Role-Sets, Organizations, and Organization-Sets

	Transit Mgmt.	*Transit Planners*	*Bus Driver*	*Transit Operator*	*Auto Mfgr.*	*Highway Dept.*	*City Govt.*	*UMTA*	*Present Transit User*	*Auto Driver*	*Truck Driver*	*Society as a Whole*
Behavior change	1	1	3	1	3	3	2	1	2	3	3	4
Rule change	1	1	3	1	3	3	2	1	4	3	3	5
Power change	1	1	4	1	4	4	4	1	4	5	4	5
Values/ goals change	1	1	4	1	5	5	5	1	5	5	4	5

Note: Scale runs from 1 to 5; 1 represents immediate change (within 1-5 years), and 5 represents change in distant future, if ever.

for what is essentially a small and weak organization, PRT offers a rather immediate threat to the organization.

The case is thus put forward that PRT is a paradigm challenge to the established transit subsystem, which includes UMTA, transit planners, operators, and manufacturers. There is a disjunction among the needs and desires of transit users and society as a whole as compared to the needs and desires of suppliers and operators of transit systems.

This disjunction makes it difficult to build the traditional transit systems because of their costs and lack of attractiveness to the user. It also makes it difficult to move toward new systems, which are resisted by existing transit interests. It is the latter case that is of particular interest as a problem of politics and technological innovation which will be examined in the following chapters. It can also be compared to the politics of innovation discussed in chapter 2.

7 Paradigm Challenge and the Political System

While there were a number of proposals for automated transit systems made by manufacturers and university groups, the most fully developed and articulated paradigm challenge in the United States came from the Aerospace Corporation. The university groups focused more on a systemic analysis without detailed hardware designs to make their systems work, and the manufacturers stressed hardware without systemic analysis to relate service needs and equipment.

Although such a generalization does not do justice to the variations among manufacturers and their approaches, it does draw attention to their common marketing orientation in which they had to satisfy their customers to make sales. Their customers were not the transit user but the transit operator, airport authority, amusement park owner, or, in some cases, the Urban Mass Transportation Administration (UMTA). Therefore the systemic analysis of needs was made by the customer and the needs were defined by some conception of what was technologically possible. The existing transit paradigm dominated the definition of needs, and this led to the development of group rather than personal systems.

These systems were easier to sell, not only because they fit the existing transit paradigm, but also because they were most suitable for airports and amusement parks, which needed systems to move large numbers of people with common origins and destinations over relatively short distances. The simple decision-making structure of such organizations made quick sales more likely, and therefore meeting these needs showed greater promise of an early return on research and development investments. It would be unreasonable to expect a manufacturer who is dependent on sales and profits to seriously challenge the existing orthodoxy of potential customers. Even the idea of automation was viewed with suspicion by transit operators, as the controversy over the Westinghouse Skybus project in Pittsburgh illustrates.

The primary point of contention there was the issue of safety. It was argued that an automated system without an operator in the vehicle would open the community to unacceptable risks.[1] The attitude toward computer operations was most succinctly expressed by a major transit operator: "Computers are only good for making out bills."[2]

The Aerospace Corporation, on the other hand, had no need or possibility of making direct sales. Their primary concern was to develop a good urban transportation system from the perspective of the user and the total community. This is not to suggest that their motives were more pure or unbiased than the manufacturers, simply that they had different domains and goals. Internal research-and-development money in not-for-profit firms is usually spent with the idea of generating a market—in this case a market for the systems management services of the corporation. Aerospace Corporation did not, however, face the same pressure for quick sales to clearly defined customers and therefore could operate differently from manufacturers.

The difference in time frame and pressures made it possible for them to begin with a detailed systems analysis of service needs, including those articulated within the existing paradigm, and they attempted to design a system that would meet all these needs. The development of particular hardware came out of the systems analysis in the iterative manner described in chapter 6.

They did not realize they were creating a paradigm challenge and still do not perceive the degree of change their proposal requires for traditional transit planners.[3] They believed their system offered a superior opportunity rather than a threat to existing transit interests. They wanted to work within the existing organizational structure, not in opposition to it. Their corporate rules and funding limited them to research and development projects and to systems management roles. As a not-for-profit "think tank" they could work only for governments, and they could not compete for contracts. Therefore to take their ideas to a full development stage, they had to gain government support.

UMTA was clearly the central locus for transit research and development. The Aerospace proposal appeared to match their stated organizational objectives for research and development, so it is significant to note what happened to the proposal and to compare its reception with that of the University of West Virginia proposal discussed in chapter 5.

The Urban Mass Transportation Administration

After working out a full system design and the solution to certain technical problems such as the switching and control systems, Aerospace Corporation took their proposal to Washington to determine if UMTA would be interested in funding further development. In mid-1969, Dr. Irving went to see an old friend who was an assistant secretary of Transportation, but a holdover from the Johnson administration. He suggested Irving see Bill Merritt, who was acting associate administrator for research and development at UMTA.

Merritt had been the technical editor of *Tomorrow's Transportation,* and Irving thought he seemed quite delighted that someone had used his work. He also appeared to be interested in the system devised. Later Merrit would say he thought the Aerospace system was too much too soon, that the technology was not available to make it work.[4]

Whatever his attitude in 1969, Merritt was soon after made the assistant to the newly appointed associate administrator for research and development, Dr. Robert Hemmes. The Aerospace people found it impossible to see either

Hemmes or Carlos Villareal, the newly appointed administrator of UMTA. They were apparently busy trying to set up their own programs and did not have time for the many inventors who were approaching them with "the answer" to urban transportation problems. After 1970 almost no externally generated projects were funded by UMTA.[5]

The Aerospace people did manage to give a presentation to some of the UMTA staff people, but it did not go well. One of the senior technical people insisted the system was unsafe because the space between the vehicles was too short. The traditional brick-wall stop was cited. At that time the Johns Hopkins Applied Physics Laboratory (APL) was doing some analyses of various automated systems for UMTA, and their work indicated that k must be greater than 1 to have a safe system. APL was not, at that time, deeply involved in the transportation field. They were essentially a Navy facility working on a variety of technical projects.

They became involved with UMTA almost by accident, when UMTA was seeking some facilities for testing out an inventor's idea for a gravity train.[6] This resulted in further contracts to examine the technical characteristics of other new systems. Over time APL developed considerable expertise in transportation, but their analysis of k may have been more limited than some of their later work. Certainly it was analyzed with systems that operated under different principles and conditions from those proposed by Aerospace.

Nonetheless, once the issue of k was raised, it was difficult to get any further attention from the UMTA staff. They said they did not have time to read the Aerospace analysis. One staff member did like the ideas, and tried to set up an appointment for the Aerospace people with Hemmes. At the last minute Hemmes tried to cancel this meeting but the staff member prevailed on him to show up.

Hemmes does not recall this particular meeting, but Irving recalls it as a terrible, "traumatic" meeting.[7] Hemmes apparently misinterpreted their desire to act as a system manager to develop the PRT concept and seemed to think they wanted to take over UMTA research and development. He also referred to questions raised by the House Committee on Armed Services regarding the fiscal and management practices of Aerospace Corporation. These had to do with differences regarding appropriate behavior for not-for-profit private but publicly funded corporations, and both the Corporation and the Congress came to agreement on these issues in 1965. They had little or nothing to do with the PRT proposal.

Hemmes did not attack the competency of the corporation but was generally negative. When the concept of PRT was mentioned, he immediately associated it with *Tomorrow's Transportation,* and this too appeared to cause a negative reaction. He said he did not wish to be bothered with details, that he had hundreds of proposals and he had no time to read their report.

Although Hemmes does not remember this particular meeting, he does recall the difficulty he had getting a well-planned, properly staged research program going. He "wanted to structure a good innovative program," and "ancillary things" kept interfering.[8] He did not want to be involved in Morgantown, for example, but that was forced by higher authorities.

His memory is of hundreds of inventors with the "perfect" solution for urban transportation, most of whom had limited notions and undeveloped ideas for equipment. This might explain his attitude toward another such system. This would have been reinforced by the staff people, who felt the Aerospace proposals were preposterous on their face. Both Hemmes and Villareal thought of themselves as managers and were apparently less interested in technical details. This may have led them to resist sitting in on technical presentations. Also, there were tremendous demands being made on these men—to do, to act, to see many people.

It is not surprising they found it difficult to see the Aerospace people, and neither Hemmes nor Villareal recall these incidents.[9] Villareal, in his first testimony to Congress, indicated he wanted action now,[10] and even if he had heard the Aerospace proposal, which called for a test track to be built followed by staged development, that might have appeared to be another study, not action.

Dr. Samy E.G. Elias and the University of West Virginia, on the other hand, were seeking a capital grant, which presumptively indicated they were ready to build an existing system. This may have made their proposal appear more action-oriented. They also had powerful support within the transportation subsystem. Through their congressional forces and perhaps the White House influence of Bryce Harlowe, they gained the attention of the secretary of transportation whose support was critical for their success.

The Aerospace people felt their contacts in Washington were not proving fruitful. The corporation had excellent contacts within the Air Force and Department of Defense, but this did not help in the transportation area. Since it was obvious few people believed it was possible to build a system such as that proposed, Dr. Irving and his team returned to California and persuaded the Aerospace Board of Trustees to fund a 1/10 scale test tract to prove the system would work.

This was done in fiscal year 1971—roughly July 1970 through June 1971. During the same period, Aerospace also submitted proposals to UMTA to do other transportation research in the area of light rail and bus development. As noted earlier, Aerospace cannot normally compete for projects, since by its charter it must operate on a sole-source basis. These were exceptional proposals, which specified the competitors could not produce hardware in the field for a period of 6 years, and this was exactly what Aerospace was supposed to do—manage a project but not produce hardware.

There were some other contracts that came up locally, however, and because of potential conflicts with other competitors, Aerospace was forced to withdrw from the competition. Dr. Irving wrote a long letter seeking some sole-source work, and apparently Dr. Hemmes eventually received the letter and was impressed by it. He and Dr. Irving spoke on the phone and had a very cordial conversation, discussing the test track and the total systems analysis.

The decision to build urban systems for Transpo '72 had been made, and Irving suggested that this might be an appropriate system for Transpo. He reports that Hemmes liked the idea and agreed to talk to the administrator of UMTA and the person in charge of Transpo. Irving was later told informally that the purpose of Transpo was to sell existing systems to help the balance of payments situation. They did not want to show anything too futuristic because it would hurt the sales of current systems.

This version of the events of Transpo is vehemently denied by several people who were involved with the exposition for UMTA. They claim an open competition was held and that if Aerospace Corporation competed, they simply did not meet the criteria for selection.[11] Whatever the case, the Transpo exhibits were essentially hardware, not fully developed systems, but they were available for sale. The more highly developed Aerospace system was available but could not be sold directly without further testing and contracting with manufacturers.

Although the Transpo idea did not work out, Hemmes did arrange for Irving and his team to meet with the head of the New Systems Research Group, Charles Broxmeyer. Hemmes himself said he did not like meetings and was too busy to attend. Sending unsolicited proposals was doing him no favor as he already had a huge pile of them.[12] The meeting with Broxmeyer apparently went very well. Irving thought he was impressed with the ideas although he too had no time to evaluate them. He wanted the Transportation Systems Center (TSC) to look at them, and set up some meetings for Aerospace at the TSC office in Boston.

This time the meetings did not go so well. Despite the success of the scale-model test track and the development scenario that was laid out, some of the TSC people were still negative. The essential problem for them seemed to be that regardless of what makes technical sense, some things can be done and others cannot. One cannot buck "the system." The cities won't appreciate a better system, and therefore it will not be adopted.

As happens repeatedly in the development of new technologies, the technical people make political judgments regarding what is acceptable. This may be inevitable, even necessary, but it is important that their political judgments, for which they have no special training or experience, not be equated with their technical judgments, where they do have special expertise.

Hemmes recalls this period as one where Aerospace presented some interesting ideas but ideas that were not fully developed. His reaction, as he remembers it, was that there was no development plan, no staging of research, and that he and Broxmeyer wanted Aerospace to finish the job they had started.[13]

Hemmes's overall research program called for building three generations of PRT systems. The first was to be shuttles and loops (really the group SLT systems as defined by the Office of Technology Assessment). The second generation was to be GRT, and the third generation high capacity or pure PRT.

This description of the research-and-development program proposed by the associate administrator may be a later reconstruction rather than an accurate description of what occurred at the time. Under-secretary of Transportation James Beggs recalls having to force UMTA to consider the idea of loops and shuttles.[14] Also, the idea of a truly personal system predated ideas of group systems.

The short time frame and the limited service requirements of the Morgantown system caused the move from personal to group vehicles. Later this approach would be justified on the basis that "you have to crawl before you can walk."[15] The group systems were then said to be part of the development process, which would lead to more advanced personal systems.

The validity of this argument is open to question, since the extremely different service and technical characteristics of group systems as opposed to personal systems do not necessarily support the developmental reasoning. In many ways personal systems are simpler than group systems, and solving the technical and social problems of one will not lead directly to the solutions for the other.

The group systems do fit the existing transit paradigm as noted earlier and therefore may be easier to sell to operators and local governments, but this is a political not a technical problem. Hemmes also noted another political (and partially technical) problem regarding the probability that some vehicles would collide from time to time. This was politically anathema, even though the vehicles were designed to minimize the impact and prevent injury to occupants. With the problems that were already being experienced by Morgantown, Hemmes did not feel UMTA was ready to pursue such a sophisticated system.

It was during this same period that the American Society of Civil and Mechanical Engineers held a meeting in Seattle, where Dr. Irving first met Professor J. Edward Anderson of the University of Minnesota. Anderson's group at Minnesota had also been wrestling with the urban transportation problem and had arrived at conclusions similar to those of Aerospace.

Anderson and Irving were drawn together as supporters of a similar concept, and later Anderson would gain the reputation of being the leading supporter of PRT in the nation—the product champion. He worked actively for its adoption in Minneapolis-St. Paul, and he testified on several occasions before congressional committees in support of more federal funding for PRT research.

The association of Aerospace Corporation with Anderson in the minds of some people may have hurt the Corporation in its dealings with UMTA. His personality as well as that of Dr. Irving apparently irritated many people, and a number of opponents of PRT cite Anderson and Irving as prime reasons for their opposition.[16] Hemmes said that as Associate Administrator of Research and Development for UMTA he felt as if he were under constant attack by Anderson. He felt Anderson subjected him and his programs to "reckless, ubiquitous, nasty criticism" which made his (Hemmes's) dealings with Congress much more difficult.[17]

Later in 1971 the First International Conference on Personal Rapid Transit was held under the auspices of the University of Minnesota with Anderson acting as chairman. Several people have confirmed that the administrator of UMTA, Carlos Villareal, referred to Anderson and others who supported PRT as "the enemy." At the time of the conference he ordered his staff not to attend and called a special meeting for the UMTA staff to ensure that none of them could attend the conference.[18]

Villareal does not recall these events, but people who both support and oppose his position support this version of events. The motives for these actions are unclear, since Villareal himself will not discuss them. Several people refer to a problem of "personalities"—perhaps a euphemism for more serious disagreements regarding policy. Issues of personality and policy are often linked, particularly in innovative ventures, which are perceived to carry high risks. It is only human nature to wish to reduce those risks by working with people in whom one has confidence. It is not the purpose of this study to determine if personality clashes cause policy disputes, or the reverse. In the case of PRT, however, the two are inextricably tied together in a pattern of mutual causation, and one cannot understand the development of policy without being aware of these differences.

All this is somewhat ahead of the events as they were unfolding for Aerospace Corporation, however. Herb Richardson, the chief scientist for the Department of Transportation (DOT), also attended the meeting in Seattle, and he became interest in PRT. Following discussions with him, Lloyd Money, a deputy assistant secretary of DOT, visited Aerospace to see what they were doing. A few people from the Transportation Systems Center also visited the West Coast, and some of them were impressed with the test facility. Gradually Aerospace was getting a few champions scattered around in DOT and in their research organization, the Transportation Systems Center. With the possible exception of Charles Broxmeyer, none of these were within UMTA or the transit political subsystem, nor did Aerospace seek outside political support.

New Technology Opportunities Program

Early in August 1971, Irving decided to look for other agencies to support the Aerospace program. He called on an old friend in the Office of Science and Technology who, as it turned out, was just leaving government service. He suggested that Irving speak to Lawrence Goldmuntz, who at that time was working on a special and (at that time) confidential program called New Technology Opportunities (NTO).

This program, initiated at the time of the demise of the Supersonic Transport (SST) program, was to be a sweeping new approach to a variety of urgent national needs ranging from housing and health care to environment protection.[19] It has been suggested that Nixon was looking for his own Project Apollo to match what he saw as the accomplishments of John Kennedy. More immediately there was a desire to put people in the aerospace industry back to work. With these purposes, the people working on this program were looking for major new technological ideas, and Aerospace Corporation presented them with a developed concept that met their needs perfectly.

Goldmuntz liked the idea and began pushing for its inclusion in the NTO program. The Transpo systems were already being developed, but Goldmuntz thought these were toys that could do little to solve the transportation problems of cities.[20] Therefore, he set up a series of high-level executive branch meetings for Aerospace over the next several months. Goldmuntz also had on his staff some people from NASA, who were looking for new projects where their expertise could be applied. One person had already been to visit Aerospace a few months earlier, and the NASA people also became interested in this project.

On October 31, 1971, a story on the New Technology Opportunities Program broke in the New York Times, and in it a project for developing "small vehicles that would run on special 'guideways' " was mentioned.[21] Other papers seeking further information on this project called the DOT, and the people there knew nothing about it—a situation that apparently embarrassed and therefore angered them.

Although many of the people from DOT do not recall the incidents that follow, there is enough public documentation to reconstruct what occurred. In the fall of 1971 when the early budgets for fiscal year 1973 were being prepared, UMTA put in a request for $30 million to develop two of the Transpo systems for use in a city.

At the same time, the city of Denver had done some studies that indicated PRT would be an ideal system for their city. Their concept of PRT was not entirely clear, but they sought through Senator Gordon Allott, a Republican on the Appropriations Subcommittee for the Department of Transportation, to get some of the Transpo development money for Denver. There were a number of mutual benefits in this proposal, since the funding would also help the Senator's reelection campaign. In addition, the system would gain international recognition, for at that time the 1976 Olympics were scheduled for Colorado.

Goldmuntz interfered with these plans when he persuaded the people in the Office of Management and Budget to wipe out the Transpo items and use the $30 million to develop a real PRT system. This forced UMTA to publicly oppose PRT, since it interfered with some of their existing projects. To defend their own projects they claimed PRT was impractical given the state of the technological art, that it would be too costly, that it would take at least 10 years to develop, and so forth. This set a pattern of resistance to PRT that has persisted to the present.

Initially PRT may not have been perceived as a paradigm challenge for UMTA; instead it was a specific competitor to specific programs. Outsiders were trying to tell UMTA what to do in its research program, and this was resisted. Nonetheless, the president's State of the Union message in January 1972 mentioned the New Technology Opportunities program giving its primary purposes: "(1) to apply advanced technology concentrated up to now in the space and defense fields to solving urgent domestic social problems; (2) and to improve the nation's deteriorating competitive position in world markets."[22]

Although no specifics were mentioned, the idea was "to improve our everyday lives" through the application of technology. An article on the front page of the *New York Times* quoted administration sources who gave more details regarding various projects, and the first one mentioned was PRT. They called for "development of an automated high-capacity transit system using four-to-six passenger vehicles that would travel on guideways and provide fast non-stop transportation from starting point to destination."[23]

Based on this statement of presidential will, the NTO people believed UMTA would take on the development of PRT.[24] There are differences and confusion regarding the UMTA position on this point, although several UMTA people insist the presidential message referred to a NASA project. It could not be determined if this was a confusion of facts due to later events or if this was the actual interpretation within UMTA at that time. Whatever the case, UMTA did not mention a PRT project in their testimony before the congressional sub-committees on appropriations.

Instead the $30 million was earmarked for an urban demonstration of the Transpo systems. The Transportation Technology, Inc. and Rohr Systems were in the PRT category, but this was not what the NTO people had in mind. When the DOT statement to the House Appropriations Committee went to the Office of Management and Budget (OMB), they showed it to Goldmuntz who pointed out the discrepancy.

The people from OMB went to see the secretary of transportation on this, but he refused to change the program. When a department secretary and the OMB disagree, only the president can overrule the secretary, and the president was in China at the time. Therefore, the Transpo project was left in. The fact that the Office of Science and Technology and the Office of Management and Budget favored a PRT program was never made known to the House committee as far as the author could determine.

With problems developing in UMTA, talks continued among the people in the Office of Science and Technology and the people at NASA. The president's State of the Union message had suggested that some of the New Technology Opportunities projects might be handled by NASA. In addition, a number of people lacked confidence in the ability of UMTA to handle a large technological program such as implied by full-scale PRT development. Under-secretary of Transportation Jim Beggs, had been with NASA before going to DOT. He had a great deal of confidence in their capabilities, and he had considerable reservations about the capabilities of UMTA.[25]

In testimony before Congress in 1972, Beggs had also noted that many line organizations have a blind spot in the area of research and development. They tend to do what they have been doing, to extrapolate from the past rather than breaking with tradition to look at new systems.[26] They do not challenge the existing paradigm. This was not a specific criticism of UMTA, it referred to all the line organizations in DOT, but it reflected his concerns regarding research-and-development and suggests why he was open to having innovative research-and-development programs handled by another agency.

When it appeared that UMTA was unwilling to take on the project, Beggs, Goldmuntz, the people from NASA, and perhaps others (various versions of these events do not entirely match on this point) began working out a proposal whereby PRT would be developed by NASA.

Apparently as a response to this competitive threat (although this is denied by a number of principals who were in UMTA at that time) the UMTA people contacted Aerospace Corporation to discuss the possibility of developing a PRT program of their own. The Aerospace people had a long meeting with the UMTA technical people and some of their consultants from Mitre and Applied Physics Laboratory. The UMTA people apparently liked what they saw and said they would push through a program for $1.5 million during the first year. This took place after the House appropriations hearings, but the UMTA people said they would have enough money from holdover programs and various technical programs to fund the first year.[27]

The people who were within UMTA at the time claim that they were going to fund this project on their own because they thought it was a good idea. Irving recalls some of the UMTA people expressing the hope that this project would "stave off NASA." At the working level of UMTA, the idea of NASA doing transportation research seemed to cast direct aspersions on their own abilities.

After examining the evidence available, the author concludes that the sudden interest of UMTA in PRT was a direct result of the NASA threat. Almost certainly it forced UMTA to take a hard look at the Aerospace proposal, something they had not done earlier. Upon close examination, the proposal may have appeared to be more attractive, and they then genuinely wished to pursue it.

Their earlier resistance may have reflected their assessment of their political support and the earlier obligations they had made to the Transpo contractors. The UMTA research-and-development budget has always been subject to sharp congressional scrutiny. It was frequently criticized for lacking in direction, having too many projects, not pursuing the most productive projects, and so forth.

When preparing the fiscal year 1973 budget, UMTA was forced to choose between its own Transpo program and the program of an outside agency, and it was only natural that they support their own program. Their constituents, the transit manufacturers and operators, wanted operational systems and resisted "far-out" and "exotic" proposals. This attitude may have made the Transpo systems appear more viable and in greater demand than the more radical PRT system.

When pressed by NASA, however, the UMTA people apparently felt they could develop a smaller project out of existing authorizations and appropriations. The details of a contract with Aerospace Corporation were settled and signed off by the UMTA administrator, Carlos Villareal, and Associate Administrator for Research and Development Robert Hemmes.

The contract also had to be signed off by the under-secretary of transportation, Jim Beggs. At that time he was working out an agreement with NASA. He may also have thought the Aerospace people were making an end-run with Congress, since they had recently presented their ideas to some of the House Appropriations Subcommittee staff. Beggs still recalls that he had much more confidence in NASA than in UMTA, and he refused to sign the Aerospace contract to allow them to work with UMTA.[28]

Irving recalls a phone call with a key person in UMTA who said "We lost. I don't know what we can do. You better get in touch with NASA." As happened, NASA had already been in touch with Aerospace, and they were seeking to use Aerospace as a systems analyst on their project. One person directly involved in the NASA effort said Aerospace had done by far the best work they had seen in this area, and they planned to use the Aerospace analysis and design as the starting point for their (NASA's) work.[29]

As the budget deliberations in Congress developed during 1972, Hemmes reports that he was trying to sabotage the effort to have NASA do this project.[30] As envisioned by the Office of Management and Budget, NASA would officially work for UMTA, and it would be UMTA money that would pay for the project. NASA requested $20 million for the first year on a 5-year project they estimated would cost $100 million.[31]

At that time the whole UMTA research and development budget was less than $70 million, most of which was going to Morgantown. Hemmes felt that NASA had so much more money to spend on research and development than did UMTA that if they wanted to have this project, they should have been willing to spend their own money on it. After he left UMTA, he wrote a report to this effect suggesting that PRT be made a NASA project.[32]

Hemmes also cites the responsiveness program of the Nixon administration, which was to pressure departments and other governmental agencies to spend money for projects (and in certain cities or states) that would help the president's reelection.[33] There is widespread agreement that such overtures were being made at the time, but the author could find no evidence the PRT program was part of that effort.

Everyone directly involved with the program states categorically that PRT development had nothing to do with the responsiveness program, and the ultimate failure to push it through indicates this is probably accurate. Again, it is a question of motivation, and motives can be mixed. The New Technology Opportunities program may have been designed to help with Richard Nixon's reelection, but for the people involved it was essentially a program to apply the best of American technological skills to help solve domestic problems.

Hemmes believed, however, that the technology was not yet available to bring off successfully a true PRT project. He was still seeking a step-by-step approach as he had planned earlier. The Morgantown project, which was believed to be much simpler than a PRT project, was proving to be both difficult and expensive to bring to fruition. Even acknowledging the extremely short time frame, the difficulties of designing, testing, and building an operational system at the same time, Hemmes asks rhetorically, "If we couldn't do a Morgantown, how could we do a PRT like Aerospace [Corporation] proposed?" Even BART with its updated train technology was having problems at the time, and Hemmes felt the true PRT program was likely to fail.[34]

There is some similarity between this situation and the situation experienced when two innovators were attempting to design a trolley to pick up power from overhead wires to run electric streetcars. Each had a different conception of the technological problem and each tried a different approach. Van Depoele's overrunning trolley could not negotiate switches satisfactorily, and he was forced to abandon it. At the time, many people said that Van Depoele had proved electric trolleys were technologically infeasible.

The other innovator, Sprague, spent a great deal of time developing a reliable underrunning trolley. There were numerous difficulties, but his approach proved to be technologically feasible, and electric streetcars were widely adopted. Despite the skeptics there were ways to overcome the problems that had defeated others. Often there are many more ways to do something wrong than there are ways to do it right. Therefore, the difficulties of one group of innovators cannot necessarily be assumed to prove other innovators will have similar problems and lack of success. Nonetheless, such an analogy is easy to draw.

Finally there was the question of costs. NASA had asked for $100 million over a 5-year period, but the cost escalations of other projects, especially Morgantown, made the UMTA people suspicious regarding final costs. In 1976 Villareal mentioned vaguely a cost of $1 billion, and Hemmes suggested a cost of $10 billion—"comparable to a major weapon system."[35] These costs are clearly exaggerated, but such recollections may reflect the thinking that went on at the time.

Throughout 1972, however, there were a myriad of maneuvers to get more money for one or another favored program. In the spring, the House Appropriations Subcommittee cut out the money to develop the Transpo systems stating it was premature to plan demonstrations in cities when the systems had not yet appeared at Transpo or been tested by UMTA. The problems with Morgantown that were beginning to surface and its cost increases may also have influenced this decision.[36]

In taking out the money for Transpo, they did not put in any additional money for PRT. The proponents of various programs then took their respective cases to the Senate Subcommittee on Appropriations. There Senator Gordon Allott, Republican from Colorado, wanted the Transpo money restored to get a demonstration project for Denver. The local Denver people were concerned that if NASA started their project, there would be no additional money for Denver, so they sided with UMTA against NASA.

Ultimately the Senate-House Conference Committee appropriated $11 million for PRT projects. On October 12, 1972, it was announced that this money would be used for a demonstration of a Transpo system in Denver. The Office of Management and Budget, however, earmarked $3 million from the $11 million for the NASA project.

Hemmes still resisted the program, but he was ordered by Beggs to get a memorandum of understanding between NASA and UMTA to Beggs' desk "by eight o'clock tomorrow morning or else." Hemmes had to comply, but he inserted a sentence in the memorandum giving UMTA the right to approve the work program of NASA before the $3 million could be spent and the project proceed. He does not believe this addition was noticed by Beggs, who signed the memorandum to get the program started.[37]

Shortly thereafter came the 1972 election. Theodore White reports on how the various Cabinet officials were asked for their resignations. His report is confirmed by others that Secretary Volpe was stunned. He was apparently given half an hour's notice to decide whether he would accept the ambassadorship to Italy or leave entirely. "He accepted the embassy and, on inquiry later, learned that the Cabinet was being purged of people who 'had a base of their own.' "[38]

Under-secretary Beggs also left at that time. He had not been particularly "responsive" to the responsiveness program,[39] and he felt he had spent enough time in government. UMTA administrator Villareal also left, leaving Hemmes as the remaining holdover in the area of transit research and development policy. In January 1973, Frank Herringer, recently of the responsiveness program,[40] was named administrator of UMTA. He was very jealous of any invasion of UMTA territory and was supported in this by the Appropriations Subcommittee of the House.[41] The NASA project not only invaded the domain of UMTA, it also invaded the domain of the congressional committees that oversee DOT. They did not wish to see money they appropriated being spent for projects under another committee's jurisdiction.

In the meantime, NASA developed their work program and submitted it to the new under-secretary of transportation, Egil Krogh. Krogh was to resign in early May for his part in the Watergate scandal, and as the trial of Watergate burglars progressed, he apparently had little time to think about DOT issues. It is not known if he ever saw the NASA work program, but it is certain he never signed it. It is also certain that no one at a lower level in UMTA was willing to sign it, so once again a program for PRT died.

Ironically, the Aerospace Corporation had sided with UMTA in the early development of its competition with NASA. Only after the UMTA program was stopped and they were contacted by NASA did they become involved in the NASA plans. Nonetheless, a number of consultants and others associated with UMTA still believe that Aerospace "tried a Washington blitz" and lost. Few remember, or perhaps only a few knew, that Aerospace had been an ally of UMTA. If either the UMTA or the NASA program had gone through, the Aerospace development would have been a significant part of it. In the events of 1972-1973 they lost twice.

It is significant to note that they came closest to success when they moved outside the transportation subsystem. The New Technology Opportunities Program was looking for their type of idea and was able to press its case with some of the force of the Executive Office of the President. The department under-secretary, also outside the transit political subsystem, was eager to have a PRT program, although his concern was for adequate management of the program, which prompted him to support the project for NASA.

What was lacking was strong support from the secretary of transportation, who seems not to have taken a direct interest in this idea, and lack of support from the president, who was preoccupied with foreign affairs, the election campaign, and then Watergate. There was also a lack of strong congressional support. This was not to be a program to build an operational system in a particular state or district, so there was no direct benefit to individual members of Congress as was the case in Morgantown.

The Aerospace people did not directly seek congressional support because they did not want to appear to be going over the heads of the people in UMTA or DOT. When requested to brief the House Appropriations Subcommittee staff, they did so, but immediately (within 30 minutes) reported this briefing to Charles Broxmeyer of UMTA.[42] They were determined to operate within the transit subsystem, to avoid upsetting the people whom they assumed were their natural allies.

This may have been the only strategy open to them, given their not-for-profit status and their legal restrictions on competition. Nonetheless, they are still accused of going to the macropolitical system perhaps because of the activities of Lawrence Goldmuntz and Ed Anderson, who were active in promoting PRT in the macropolitical system.[43] The macropolitical system was not engaged, however, and the final decisions were left within the transit subsystem.

When the threat of NASA passed, UMTA took little action to promote their own PRT system development. There are some indications that the Advanced

Systems group would liked to have pursued this program (it coincides perfectly with their domain), but the executive impoundment of appropriated funds plus a lack of interest at higher levels of the organization precluded further action in 1973.

Hemmes claims he tried to get a small contract for Aerospace in 1973 to block out on paper the time and money needed for their project, but this was killed by Frank Herringer, the UMTA Administrator.[44] Hemmes believes the administrator opposed it because it entailed too great a risk. Certainly in the administrator's first testimony before the House Appropriations Subcommittee, the problems of Morgantown were of great concern, and this may have had some bearing on the question of risk.

Hemmes himself showed little inclination to push the Aerospace proposal with the House Subcommittee on Appropriations as the following exchange illustrates:

> *Congressman Yates.* What is the largest town or city where you can use this kind of system? [High Capacity PRT]
>
> *Dr. Hemmes.* The Aerospace Corporation was one of the leading exponents of the advanced or high capacity PRT used Los Angeles as a hypothetical example, and that is where they came up with the example of tens of thousands of vehicles over hundreds of miles of guideways.
>
> *Yates.* Did they tell you what the cost would be?
>
> *Hemmes.* No, they hadn't really nailed it down.
>
> *Yates.* It is pretty expensive, isn't it?
>
> *Hemmes.* Very expensive. Our position is—let's wait and see if we should cover a whole city with a PRT. Let's start with the simple loops and shuttles the cities are willing to have now and let's build on those.
>
> *Yates.* Thank you.
>
> *Hemmes.* A benchmark on the expense, Mr. Yates, would be the proposed Denver 100-mile PRT estimated at $1.6 billion.[45]

This information is a subtle distortion because it implies the Aerospace proposal is only for a massive system rather than for the immediate need—a test facility to complete development of the system. The larger system was a hypothetical example, as Hemmes states, but its purpose was to illustrate the potential of PRT as compared to a heavy rail proposal, which was being put forward in Los Angeles at that time.

More seriously, the cost estimates for the test facility and for the larger system had been developed in considerable detail with far greater precision than other new transit proposals. Granted that absolute cost precision was, and is, impossible to develop in the absence of a test facility and final design specifications, the costs had been nailed down in a way that was reportable within specified limitations.

The comparison to the Denver proposal exaggerated the costs of the Aerospace proposal by a factor of 5, leaving the impression that such a system was beyond the realm of possibility. It also helped to deflect interest from this system to the systems that were being promoted by UMTA at the time.[46]

There were more attempts to develop a PRT program within UMTA in 1974, and a small budget of $2,750,000 was allocated by Congress for fiscal year 1975.[47] The incoming associate administrator for research and development, George Pastor, stopped this program shortly after he took office, however, saying there was no market for such a system.

Automated Guideway Transit Technology

In its place, he substituted the Automated Guideway Transit Technology (AGTT) program, which was a more generalized program to deal with technical problems common to all types of AGT systems. The definition of PRT was again blurred. PRT was described as a system using "small 4- to 12-passenger vehicles . . . operated at headways of 0.5 to 3 seconds . . ."[48] The differences between group and personal systems were minimized, and, as a result, there was some confusion regarding program requirements and objectives.[49]

Although some argue that this program will eventually lead to the development of PRT, or could lead to such development, the vagueness and ambiguity of the objectives, the confusion regarding the types of AGT systems, and the implicit assumption that service needs and technological development can be separated, all lead to the conclusion that this program is a retreat from the development of more advanced systems. In addition, much of the work that was to be done under this program had already been completed, by manufacturers of shuttle-loop systems and in the case of PRT, by work in England, France, Germany, and Japan. It also duplicated much of the work already accomplished by the Aerospace Corporation in the United States.

Whether this retreat from more advanced systems was necessary is open to dispute, but at the time the decision was made, Congress was still extremely upset over the situation in Morgantown. UMTA was told to get a better focus on their research-and-development programs and to bring something to immediate fruition. There is considerable evidence in the hearings that they were not interested in funding long-range programs with uncertain payoff.[50] Even though the PRT program had congressional approval and the RFPs (request for proposal) had been prepared, Pastor apparently believed he could only maintain support for a limited number of programs.

The AGTT program would keep PRT and dual-mode development alive while UMTA actively supported the high performance personal rapid transit

(HPPRT) program, which they believed showed greater promise of quick success.[51] The rationale was that PRT would "evolve" out of the development of GRT and HPPRT systems. In the meantime, HPPRT and GRT systems would not challenge the existing transit paradigm and therefore would be more acceptable to the transit industry.

Local Politics and Federal Programs

What would eventually become the HPPRT program evolved out of a series of events at the federal level and in the city of Denver.[52] The Federal program developed out of the Morgantown and Transpo experiences as described earlier. The next step after testing the Transpo vehicles was to have urban demonstrations of at least two of these systems.

The decision was made in DOT to use the $11 million allocated by Congress for PRT projects in fiscal year 1973 for a demonstration in Denver. The details of this decision-making process are complex, and there is some disagreement regarding particular elements. For example, a number of observers believe the decision was part of the president's responsiveness program, others say it was not. It is widely agreed that Senator Gordon Allott, who was a member of the Senate Subcommittee on Appropriations for DOT, was instrumental in getting the grant for Denver.[53] Allott apparently wanted this project to help his reelection campaign.

The announcement of the decision was made in Denver on October 12, 1972, by Allott, Secretary Volpe, UMTA Administrator Villareal, and other political dignitaries. The announced reasons for the choice of Denver included the "strong local support for such a demonstration project"; the suitability of the site—"a dense clearly defined urban core where PRT can fill an obvious need"; the suitability of the site for potential expansion; the capability of the local coordinating organization, the Denver Regional Transportation District (DRTD); and also the capability of the local area to provide fiscal support for the completion of the project.[54]

The last point referred to the plan to place a sales tax/bond issue before the voters the following year to seek funding for major transit development. In Washington, the point was also made that Colorado was to be the site for the 1976 Olympics, and this would offer an ideal showcase for a new transit system.[55]

The origins of this project began much earlier in Denver itself. In 1969, the Colorado Legislature established the Regional Transportation District to develop a comprehensive public transportation plan for the six counties in the Denver area. A major ecological study of the area was done and a transportation plan produced by Development Research Associates, Inc. and Wallace, McHarg, Roberts and Todd, Inc. In examining the transit needs of the area they found that: "The key transportation need is to develop a transit system that attracts riders, reduces dependence on the automobile, reduces total transportation costs, and provides benefits to both users and nonusers of the system."[56] The system chosen to meet these requirements was PRT, but the characteristics of PRT were not clearly defined. The service characteristics were clearly those of a real PRT system. The network designed, however, was a 100-mile corridor system, completely inappropriate for true PRT service.

The size of the vehicle was also left vague—six to twelve passengers—potentially it could have been either personal or group service. The confusion was only natural given the characteristics of the systems at Transpo and Morgantown, which were then called PRT. Harry Parrish, the executive director of the DRTD at that time, said the idea was to have a PRT service concept eventually, although the state of the art of the technology might have required larger vehicles initially.[57]

Clearly there was need for development work to build such a system. Denver was apparently encouraged by DOT to apply for a demonstration project in early 1970. The DRTD was given a grant to study the feasibility of a PRT demonstration in November 1971, apparently as part of the Transpo developments.[58] Parrish also claims to have convinced some of Allott's staff people to push for the demonstration in Denver, which, as it turned out, fit in nicely with Allott's need for a visible project to help his reelection.[59] Therefore, as in Morgantown, there was a mutuality of interests that led to the decision to put the demonstration in Denver.

Clearly there was confusion at both the federal level and the local level regarding just what the system called PRT was to be. Secretary Volpe described the system as a kind of "horizontal elevator."

> When you enter the PRT station you push a button—the same way you summon an elevator. When the small, personalized passenger cab arrives—they are usually designed to accommodate about a *dozen people*—you enter and push another button indicating your destination, and off you go.[60]

Nonetheless, $11 million was allocated to the project. There were immediate problems, however. Part of the money was diverted by the memorandum of understanding between DOT and NASA regarding the development of a real PRT system. Parrish joined with those in UMTA who fought the NASA project. In his view the concepts being tested at Transpo represented the potential for a workable PRT system, and the NASA project "suggests to me a policy of not doing anything now, despite the crying needs of urban transit, but going back to the warmth of a government laboratory and playing around with it."[61]

> He said the proposed NASA study is "certainly of no immediate value to anyone. And I also have fears, that knowing NASA a bit, this is only

the beginning with them. And then of course we'll have a lot of fine research and maybe some technical stuff, but we won't have any transit system to serve people."[62]

Parrish faced other problems as well. In the election that followed a few weeks after the announcement of the demonstration program, the primary champion of the project, Senator Allott, was defeated. The Olympic Games were voted down. Volpe and Villareal left DOT in December. The Morgantown project was going very sour, and the incoming people at DOT were uncertain about the advisability of continuing the Denver project.

In the Spring of 1973, the new UMTA administrator, Frank Herringer, and the new secretary of transportation, Claude Brinegar, decided not to have another urban demonstration project. They were clearly concerned to prevent another Morgantown, and they moved the project from downtown Denver to a more remote site in Broomfield, Colorado.[63] They did not move the test site too far from Denver, for fear of upsetting the election to support transit, which was coming up in September 1973. For that election the DRTD presented a transit plan to the voters that called for a 100-mile corridor system of "personal rapid transit."

The service concept sold to the voters was clearly a pure PRT system such as that envisaged in *Tomorrow's Transportation* or by the Aerospace Corporation. The plan and map they were shown were imcompatible with such a system, but there was no real understanding of the inherent conflict. In talking to a number of people involved with the project, the author gets the impression that the misunderstanding was as great within the DRTD as it was among the public.

The confusion did not prevent the bond issue/sales tax from passing, however, and from this point forward the HPPRT program and the transit plans of Denver separate. This was not immediately apparent as there was considerable interaction between UMTA and the Denver RTD, but in retrospect, it was at this point that the federal research-and-development program split from the local planning effort.

At the federal level there were no prominent supporters of a PRT demonstration for Denver still in office. Hemmes was still head of Research, Development and Demonstrations for UMTA, but he had never favored the Denver project.[64] Locally, Harry Parrish became caught up in a battle involving an interstate highway. The powerful interests who favored the highway wanted him out, and he left the DRTD almost immediately after the election. There was really no one left of the original group that had pushed for a PRT demonstration in Denver. The differing interests of UMTA and the Denver RTD rapidly became apparent, and Herringer decided to run a separate research project at Broomfield, Colorado, a Denver suburb (later it was moved to the DOT test facility at Pueblo, Colorado). Denver was left to apply to UMTA for a capital grant for its transit system, and the events that took place there are reported in chapter 9.

At the federal level, however, the UMTA people were still getting considerable heat from Congress on why they were still pursuing PRT after the Morgantown "fiasco." The HPPRT program developed in the midst of a struggle between those who thought any development beyond Transpo and Morgantown was too ambitious and those who thought DOT should go further and develop a system capable of the fractional-second headways needed for true PRT.[65] Up until the time UMTA announced the specs for the Denver project, many people thought this would be the project where a true PRT system would be tested. There was certainly a great deal of pressure from Ed Anderson at the University of Minnesota and some people from Denver and the University of Colorado to make this a real PRT system.

The specs as published, however, called for vehicles with a maximum of twelve seated passengers with a theoretical maximum throughput of 14,400 seats per hour. This requires 1,200 vehicles per hour or one vehicle every 3 seconds. There was nothing to prevent a manufacturer from producing a smaller vehicle at a shorter headway, but industry is unlikely to spend money to advance the state of the art more than is required by the contract specifications.

The key need was seen as increasing the line haul capacity of the existing Transpo and Morgantown systems. Single-lane capacity was thought to be important and total network capacity and dispersal were largely ignored. The lack of a service concept was noted in the Office of Technology Assessment study: "No clear urban transportation need is apparent for the short three-second headway performance specified for the 'HPPRT' program."[66]

The HPPRT program apparently developed not only out of the needs of Denver but also from the needs of industry, which put considerable money into the Transpo program in the expectation that further development and deployment of these systems would be encouraged and funded by the government.[67] It was hoped that the HPPRT program would provide a quick return on earlier investment.

For those who felt the HPPRT program was poorly conceived, it was difficult to criticize the program for fear of further eroding the confidence of Congress in the UMTA research-and-development program.[68] There was also a concern that if the program were stopped, this would be construed as a signal to industry that government lacked commitment to new transportation technology.[69]

The dilemma has been compounded by the concern that the problems of GRT systems noted in chapter 6 would eventually become obvious to all concerned, including Congress. Another failure in the UMTA research-and-development program will almost certainly impede any further developments of automated transit systems with federal government funding.

Although essentially the HPPRT program reflected a compromise among a number of factions, it satisfied almost no one. In some instances it is justified as an evolutionary step, which will lead to the development of true high capacity PRT. At other times it is justified as presenting a viable alternative to existing transit systems that would serve existing community needs. As of 1978, three prototype systems are being developed by three different manufacturers with UMTA support, with plans to build a test facility at Pueblo to test two of the three which seem most promising. The key problem may be on the emphasis to develop hardware without an adequate conception of the service need to be fulfilled by the hardware.

Downtown People-Mover Project

While the HPPRT, or AGRT, research effort continues, however, there has been continuing pressure to build something now to help keep the automated transit manufacturing industry alive. This led to further retreat to safe systems such as the SLT systems, which were already operating in airports and amusement parks. Rather than doing advanced research, UMTA would now fund a Downtown People-Mover (DPM) project to develop data regarding "the reliability, maintainability, safety, and capital and operating cost of such systems when used in an urban area."[70]

> Before cities will opt for the advantages of fully automated and unmanned vehicle operations, they must be assured that the potential risks of deploying such systems are reasonable and prudent. The Downtown People-Mover Project is intended to provide an operating fully automated and unmanned people-mover system placed in an urban environment that cities can examine and evaluate.[71]

Although the DPM project is to be funded through the Capital Assistance program (80 percent federal funding), the Office of Research and Development is to administer the program. This reflects the difficulty of getting the Capital Assistance Office to fund any automated system, and the DPM program is one way of evading an institutional block.

The program is justified as a legitimate research-and-development enterprise on the basis that SLT systems need to be tested in harsh urban environments to determine their viability. There is also an assumption that local agencies need to be sold on automated systems, perhaps reflecting the problems encountered with the Skybus and TERL (Transit Expressway Revenue Line) projects in Pittsburgh. The validity of this assumption is open to question, since thirty-eight cities applied for the DPM program. The real problem may be in the relationship between the Research and Development Office and the Capital Grants Office of UMTA regarding what is a "proven" system ready for capital assistance.[72]

The idea of a proven system is, and has been, ambiguous at best. In 1972 the UMTA Capital Assistance Office granted funds to the Dallas-Fort Worth Airport to build the LTV Airtrans system.[73] This was not a fully developed system as subsequent start-up problems indicated. A former highly placed

UMTA official claims this capital grant was part of the responsiveness program discussed earlier. Interestingly, after the Airtrans system was running reasonably well at the Airport, Congress specified that research-and-development money should be spent for an urban demonstration of this particular system.[74]

The use of research-and-development funds means that the urban demonstration of this particular system will receive 100 percent federal funding as opposed to the 80 percent funding for the DPM program. Aside from the propriety of preselecting a contractor on a sole-source basis without competition, there is a question regarding how this will affect the separate, parallel, ongoing, and competitive DPM program, which offers 80 percent federal funding, as well as the HPPRT program, which is also competitive and intended to lead urban deployment of an AGRT system.

It may be that the specification of the Airtrans system in the Federal Highway Act of 1976 is purely special interest legislation included without careful consideration of the larger policy implications. It does indicate, however, that Congress as well as people in the AGT manufacturing industry are concerned to support the industry with government funding for urban deployment of existing systems. This position was also supported by the Office of Technology Assessment study, which reflected considerable industry influence.

The DPM program is also seen as reducing the risks of another technical failure for UMTA. The systems function technically as has been proven over several years of operation in airports and amusement parks. Risk is most often defined as technical risk. Doors that do not open or wheels that stick seem to get more publicity and therefore cause more criticism than do high operating costs or a lack of social usefulness.

If people do not ride the systems in cities, or they prove to have little use in the urban context, that will be the fault of city planners or more likely, the public, which is "spoiled" by the automobile. UMTA will have a technical accomplishment on its record—a success—an operating system that can be proudly displayed to Congress. UMTA has also protected itself by requiring the local community to operate the system from their own funds after an initial shakedown year of operations.

The relatively low cost of DPM systems, and their viability for smaller cities, has allowed UMTA to approve more systems for more areas. It cannot match the Federal Highway Administration (FHWA) with projects in every congressional district, but it can help broaden the base of its support. From an initial proposal to fund three systems, the project has grown to four initial sites plus two cities that can divert funds from rail rapid transit systems to a DPM should they desire, and a second tier of five cities selected to do planning for such systems.

The eleven proposed test sites have now been reduced to ten as the new mayor of Cleveland requested that UMTA drop his city from the program. He declared, "It's stupid and it won't work."[75] This was interpreted by George Pastor of UMTA as indicating that the mayor had made a technical judgment regarding the workability of the equipment.[76] There is also the possibility, however, that the social and economic desirability of the program was the issue in question.

This is buttressed by the report of the Citizen's Advisory Panel to the Community Redevelopment Agency of Los Angeles, which said the DPM program was a poor idea for Los Angeles. They cited adverse social and economic impacts, not technical problems, as the basis for their recommendation.[77] Civic leaders are still supporting the project despite the citizens' recommendations, but it is unclear if they will continue to support it when significant amounts of local matching funds will be required to continue this project.

There is also strong dissent in St. Paul due to rising capital cost estimated for the DPM project. The mayor and the City Council president both said the project will be scrapped unless costs can be reduced.[78] The operating costs also look very high, adding to the project's difficulties.[79] Although the project was pushed hard by the Metropolitan Transit Commission and the City of St. Paul, the Metropolitan Council (a regional governing body) and some members of the state legislature resisted it. With the rising costs this resistance is likely to escalate. One local columnist put it this way:

> Keep in mind that ultimately, St. Paul does not have a people-moving problem. You can drive anywhere downtown in 10 minutes . . . during rush hour. A walk will take 15 minutes.
>
> The $130 million "experiment" should be labeled for what it is—political pork barrel and it is a barrel filled with spoiled pork.[80]

Thus the overall merits of the DPM Program are being called into question by those who would supposedly benefit from its development. Although it may serve as a political pork barrel, its adequacy as a major research expenditure is also questionable. It appears to be researching that which is largely known. Although it is clearly necessary to collect data and analyze the outcomes of all major UMTA projects to determine the social, economic, technical, and political viability of any project, this does not constitute advanced research into new systems.

The HPPRT (or AGRT), AGTT, and DPM programs can all be seen as efforts to reduce the risk of UMTA failure and the ensuing congressional disapproval. This may be an important objective considering the extremely negative effects generated by the Morgantown experience. These programs also evade, however, the PRT paradigm challenge. In the DPM program plan, PRT is specifically denigrated:

> At one end of the spectrum, short-headway PRT systems are still in the basic research and advanced development phases. The technology is complex and has been tested only in the form of computer simulations

and scale model demonstrations. No system application is currently being seriously planned.[81]

This statement ignores the full-scale test facilities operated in France, Germany, and Japan, as well as the plans for urban deployment of these systems in each of these countries. It also implies that anyone who suggests that such an approach might be more appropriate should not be taken seriously.

Implications for Theory

This chronology of events and the reactions of various elements of the political system to PRT gives a bit of perspective to the development of federal research-and-development programs in transportation. It was suggested that the Aerospace proposal offered a paradigm challenge to UMTA, and as such, it was rejected. This does not mean, however, that it was consciously perceived as a paradigm challenge. This theoretical concept is used to explain the various types of rejections that occurred at different times.

Initially, the PRT proposal did not fit into the operational goals of either the administrator of UMTA or associate administrator for research and development. The administrator wanted action now—immediate demonstrations—and the associate administrator wanted to structure his own research and development program, not simply to respond to every inventor who walked in the door. In addition, UMTA lacked established institutional procedures for dealing with a not-for-profit systems management firm, which had to be hired on a sole-source basis. There were procedures for dealing with consultants or with suppliers of hardware as well as with local governments who had demonstration ideas, but Aerospace Corporation did not fit any of these categories, and their proposal did not fit any existing categories either. Hemmes, the associate administrator for research and development, appears to have thought of his own organization as the systems manager of research and development. This may have made the Aerospace proposal appear as a threat that was usurping his organizational functions, which would explain his initial negative reaction to both Aerospace and their proposal.

There was apparently little recognition of the appraisal function as a significant part of the agency domain. Unsolicited proposals appear to have been handled in an extemporaneous and often cursory manner, perhaps due to the small staff that was available. Although the numbers of unsolicited proposals is reported to be large, there were no effective and efficient means of screening the more promising ideas from those which were poorly and/or partially conceived. The Applied Physics Laboratory did examine six proposals from manufacturers, but this was only a small percentage of the proposals submitted.

The Aerospace proposal suffered from this lack of systematic procedure as they were successively moved out of the mainstream of UMTA's decision-making process. The ability to get the attention of busy actors in the political process may be a key factor in explaining political outcomes.[82] The Morgantown people were able to get such attention through their congressional and executive branch clout.

The Aerospace Corporation lacked such support, and the administrator of UMTA had no time for them. He said his associate administrator for research and development examined unsolicited proposals.[83] The associate administrator was also too busy and reported that he depended on the head of the New Systems Division to study such proposals.[84] That person was also too busy and referred them to the Transportation Systems Center (TSC) in Boston.

Not only was TSC physically removed from the center of UMTA power in Washington, it was also operationally removed, since it had been a NASA agency, the Electronics Research Center. It was scheduled to be closed due to cutbacks in the NASA program, but DOT Secretary Volpe, having been governor of Massachusetts, wanted to save the center and the 400 jobs of the people who worked there. He managed to do this by transforming it into the Transportation Systems Center, but the domain of the new TSC was unclear for some time, and its relationship to DOT and UMTA was tenuous at best.

Sending a proposal there appears to have been a way of doing something while in fact doing nothing. Even at that level, it was difficult to get an adequate analysis of the proposal. A number of people both within and outside UMTA have reported that their job was to create ideas, not criticize the work of others, confirming the point that the appraisal function was not viewed as a significant part of the agency domain.

Even if the appraisal function were recognized and supported, it is unlikely that a proposal that challenges the existing agency paradigm would be found acceptable. One of the reasons given for the cursory examination of the Aerospace proposal was that it was "preposterous on its face."[85] Any proposal that involves a "reconstruction of the field from new fundamentals" is likely to be viewed in such a light.

To accept such a reconstruction is, in a sense, to deny one's own expertise and training. It may also call into question the existing roles, skills, and technologies and thus threaten the positions of those who are judging its adequacy. Therefore, a good system of appraisal within a functional subsystem can most usefully screen innovations that remain within the boundaries of the existing paradigm. This is clearly a significant task, but it is not sufficient to deal with more radical innovation.

The Aerospace people were not aware, however, that they had a problem because of their paradigm challenge or the lack of an adequate system of appraisal. The validity of the technical questions that had been raised by their critics concealed the larger problems that would confront them later. Their immediate problem as they saw it was to demonstrate that their switching mechanism would work, the safety systems would function, and that the computer technology existed to control a complex system reliably. Certainly the demonstration system helped them perfect their ideas, and it did convince many people that PRT was technically feasible.

The demonstration was clearly a necessary step, but it was not sufficient to overcome the political problems that had been concealed by the technical issues. Essentially, the Aerospace proposal presented a series of problems rather than an opportunity for UMTA. First it created a problem by competing for scarce time and attention. A detailed and complex proposal takes considerable time to analyze adequately.

Secondly, it did not fit into existing organizational categories and operating procedures. Creating new procedures to deal with a specific proposal threatened to cost more time and might also draw attention from Congress or outside consultants, which could cause difficulties. It was not that this was a particularly difficult problem, but it was annoying and made it easier to reject rather than to accept the troublesome idea.

Perhaps most important was that by the time Aerospace had completed its test facility, UMTA had put its own program into operation (including Morgantown, which had been forced on them, and Transpo '72, a pet project of the secretary of transportation—see chapter 5). The Aerospace proposal did not fit into this program, and with resources for research scarce, it would have been a competitor to the existing program.

An agency, any agency including the strong ones, can only sustain congressional support for a limited number of programs. Therefore any new program must initially be suspect, since it may take money away from ongoing projects, which in turn threatens those who are working and involved with the existing projects. With the weakness of the research-and-development program within a weak agency, the chances of any new proposal were considerably reduced.

Thus the Aerospace proposal was not only incompatible with UMTA's operational goals at the outset, over time it became more competitive with their existing programs. The reasons given for rejecting the proposal—the lack of a development plan, the multibillion-dollar cost, the idea that Aerospace wanted to build such a system in Los Angeles rather than doing the necessary testing—are all so spurious, that one must conclude they are rationalizations used to justify the decisions taken, not reasons that determined the decisions. The later reversal of policy under the competitive pressure of NASA also leads to this conclusion.

Finally, the Aerospace proposal could not help UMTA and might hurt them in their relationships with their congressional committees. It called into question their own program, and it would require more research-and-development money, which was always difficult to justify. Further, it offered no incentive to any member of Congress as a piece of the pork barrel. It was not a plan to build something in a particular congressional district.

In this latter respect, it differed considerably from the Morgantown plan and the DPM program, which did offer rewards for key congressional figures. Morgantown and the DPM program fit into a classic pattern of mutual rewards, where it is proper for congressional figures to represent their constituents to gain benefits for a particular locality. Congressmen may also represent certain manufacturing interests from their districts as well, but the legitimacy of seeking contracts for particular interests is more suspect than are demands for projects for a local area.

Even if the congressman representing their district had been willing and able to push their case, it is unlikely the Aerospace people would have sought such support. As a not-for-profit firm working only for government, they were anxious to avoid any appearance of an "end-run" to Congress to achieve their purposes. They believed it was important to keep a good relationship with UMTA and other executive agencies, since eventually they might work together on some project, whether PRT or something else. Therefore when they again appeared to be at an impasse with UMTA, they sought out other executive agencies that had science and technological development as part of their domain.

It was through the Office of Science and Technology that they first gained the attention of the macropolitical system, as this agency was part of the executive office of the president. Here the timing was perfect as the Aerospace proposal offered an exciting solution to an immediate problem being faced by the New Technology Opportunities program within the OST. They were looking for large-scale, high-technology solutions to pressing domestic problems, and they had already identified urban transportation as an area with potential for their purposes. Instead of a problem, Aerospace offered them an opportunity.

The NTO-NASA-UMTA conflict offers a classic example of bureaucratic politics as agencies are assigned overlapping policy space and compete for programs and funds. Both the NTO program and UMTA were assigned responsibility to look for new public transit ideas, but UMTA had to operate within the existing transit subsystem, and most of its people were at least partially conditioned in their thinking by the existing transit paradigm.

The NTO people were clearly operating at the macropolitical level, and the existing transit paradigm and subsystems were largely irrelevant to them. Their rewards would come from developing new and challenging ideas. Their power came from the presidency, and their positions would be enhanced not threatened by a paradigm challenge. They were consciously operating as a system of appraisal—looking for new ideas—and their criteria for judgment differed considerably from those of UMTA. In essence, the Aerospace proposal fit their needs and offered an opportunity, whereas it did not fit the needs of UMTA and offered them more problems.

When these differences led to conflict, it was not only the executive agencies that competed for policy space and power, the congressional committees were also part of the struggle as their domains were threatened. The House Subcommittee on Appropriations was particularly concerned that money they were appropriating might be spent by an agency (NASA) under another subcommittee's jurisdiction.

Thus the outcomes rested on the power and skill of the opponents as well as the timing of deadlines—budgets, presidential messages, and elections—which forced decisions on busy actors. The UMTA people had an advantage in the bargaining, since transportation development was clearly part of their domain. Even the NASA program recognized this, since it was UMTA money that would be used to hire NASA to do the development work.

Under-secretary Beggs was in a strategic position, since he had to approve any contract to be let by UMTA. He was also in a position to negotiate with other agencies such as NASA, and his background with that agency predisposed him to favor their involvement. The power of NASA stemmed not only from their relationship with Beggs but also from the aura of technical competence that attached to them after the successful moon landings. Their accomplishments were in stunning contrast to the stumbling efforts of UMTA with Morgantown and Transpo '72. Whereas the comparison is not entirely fair for reasons discussed earlier, it did represent bargaining power.

The NTO people had power from their position as representatives of presidential interests. As such they were able to work closely with the Office of Management and Budget, which also represented presidential interests as opposed to those of particular departments. The OMB was in a powerful position to enforce the presidential will as expressed through the Office of Science and Technology and the NTO people. This was not enough, however, to determine the final outcome of events. Whereas the OMB could shift $3 million from the Denver project to the NASA project, they could not control the terms of the agreement between UMTA and NASA. In the end it was these terms, combined with the timing of the NASA program, that were its undoing.

The NASA work program was submitted to the under-secretary of transportation within days of the time he left office after the 1972 election, but without his support and signature, the program could not go forward. As was noted earlier, proposals that are submitted late in a presidential term are likely to be terminated as their proponents leave office. One may speculate regarding the impact of Watergate on the new Under-secretary Egil Krogh, but any new under-secretary would probably have been less disposed to sign an agreement giving part of his department's policy space to another agency. Once the original principals to an agreement are out of office, sustaining their policies is much more difficult. Again the ad hoc characteristics of those who favor change are likely to be overpowered by the continuous forces for the status quo, which are largely centered in the permanent civil service.

Within the bureaucratic system there is a constant battle for programs and priorities. This goes on within agencies as well as between agencies. Even after a program has been adopted by higher executive authority or by Congress, the struggle goes on to recoup losses or reverse unfavorable decisions. There are no final victories or defeats.

Although unique events such as Watergate or the impoundment of funds do influence the outcomes of events, they seem to reinforce underlying patterns more often than they overturn them. Both Watergate and the impoundment of funds may have contributed to the lack of further UMTA activity to start a PRT program of their own. Nonetheless, one is left with the impression that they never really wanted such a program, and the slightest problem would have been an excuse not to pursue it.

For UMTA, PRT was a revolutionary technology that challenged the existing transit paradigm along with the goals, objectives, values, roles, statuses, and power relationships of a variety of members of the transit subsystem. The paradigm challenge came closest to success when parts of the macropolitical system were engaged. Its ultimate failure at the federal level of government resulted from its relative unimportance in the larger scheme of events in the macropolitical system and the resulting lack of full macropolitical intervention.

The primary focus of the macropolitical system is the presidency, in part because the president has the authority to manage all areas within the executive branch of government.[86] Those who operate through the centralized, presidential bureaucracy are authorized to deal with any area that requires presidential attention. Therefore it is easier to gain macropolitical attention through the executive since it is part of their job—part of their legitimate domain.

This contrasts with the situation in Congress and other legislative bodies, where there is a strong resistance even among the top leadership to intrude on the domains of fellow legislators as defined in the committee system. An issue must become exceedingly public and/or disagreeable before the prerogatives of committees and committee chairmen will be overridden. Such things do occur, as in the case of the SST, but they are the exception rather than the rule.

This is a serious problem for innovators when the congressional subcommittees and the executive agencies have developed symbiotic relationships that give them essentially the same perspective. It may be less serious when the congressional subcommittees are not so tightly enmeshed in the political subsystem as is the case with UMTA and its congressional committees. Such committees may be more willing to push for change.

Nonetheless, it is difficult for a congressional committee to force an agency to undertake a program they do not want, since it is easy to divert funds from an unwanted project into another, more desired project. Even the Morgantown project with its heavy congressional support was substantially changed from the intentions of its proponents. A less tangible program, such as a research-and-development program, would be even more easily diverted. Therefore, in the absence of a genuine emergency or threat to existing programs and policies, it is very difficult to gain both executive and legislative macropolitical attention for any particular issue, especially for a revolutionary innovation that does not fit into existing organizational domains and relationships.

The UMTA program developed can be seen essentially as a series of responses to the pressures and forces within the transit subsystem. The felt need was apparently to demonstrate success after the problems of Morgantown. It also meant developing a research-and-development program that appeared to be coherent and directed rather than simply a series of projects. Each program was justified as evolving out of preceding programs and as being a step toward the ultimate goal of urban deployment. The DPM program not only offered immediate urban deployment, it also expanded the pork barrel as more systems could be offered to more cities to gain the acceptance of more members of Congress. UMTA still cannot offer something for everyone as can be done with the highway program, but they have expanded their constituency with the DPM program.

To get rapidly to the deployment stage, anything that could be termed radical was rejected in favor of immediate action. More limited research objectives were justified on the basis of limited analyses, which were often little more than rationalizations. Risk was largely defined as technical risk, and the fact of utility risk was largely ignored. While stressing the need to do what "the market" (transit operators) demanded, there was a turning away from an analysis of the real needs of the users (transit riders).

The HPPRT (AGRT) program, which, if it had been conducted in a close relationship with Denver might have revealed the technical requirements of a transit system in a twentieth-century automotive city, was instead separated from this contact with reality. The intimate and iterative relationship between service needs and technical solutions was lost. "First it must be the engineers who are convinced that the system works. Only after that can we look at whether the service characteristics and all the aspects of the system are indeed deployable in an urban scene."[87]

Thus the research-and-development program continues to operate within the existing transit paradigm. Future prospects for change probably lie in the continuing failure of this paradigm to solve the real problems of urban transportation, which will once again force the problem to the attention of macropolitical system actors. This is already occurring at some local levels of government where urban transportation problems have most direct impact.

There will also be a turnover of people in UMTA, in the Department of Transportation, and to a lesser degree in the Congress. With the entrance of new people, the commitment to existing programs is likely to be reduced. The combination of new people along with events that illustrate the inadequacy of the existing paradigm may open the way for more innovative approaches.

Part III
A Tale of Four Cities

Introduction

The focus of this study has been at the federal level of government, but the transportation subsystem is really an interorganizational network that operates at all levels of government—federal, state, and local. This interorganizational network is linked by a common concern for the problems of urban transportation, although the relationships within and among the various organizational actors are quite varied. Most critical for an understanding of these relationships and their implications for technological innovation is an understanding of the resources that each actor commands.

The two basic resources of interorganizational networks are money and authority. In the transportation subsystem, as in so many areas of domestic public policy in the United States, these two basic resources are not evenly distributed among the many diverse organizational actors. Local governments are highly fractionated both spatially and functionally. In metropolitan areas there are numerous governmental bodies—cities, counties, regional planning organizations, councils of governments—and within each there are functional departments with both cooperative and competitive objectives.

Frequently there is a transit-operating agency with quasi-independent authority to plan, build, and operate a transit system. It may also have some powers to tax, although this varies from community to community. Often the local operator was once a private organization, or perhaps several private organizations, which were taken over by municipal authorities to prevent the collapse of public transit service. This financially weak organization may still retain authority to plan, build, and operate public transit systems, but it has only limited funds from fares and must receive subsidies from local, state, and/or federal governments to continue to function. Thus authority and financial resources are divided, and a large number of agreements are required to take any action regarding public transit.

To plan for and to build a new public transit system requires many agreements at the local level regarding what type of system to build and where it should go. When there are differences among various actors, there is considerable negative power to stop actions that one or the other does not like, but there is little positive power (in most communities but not all) to push through a plan over determined opposition.

There is pressure to find some common denominator of agreement, however, because few local communities have enough financial resources to build a transit system on their own. They must compete for federal money, and local decisions appear to be heavily influenced by the actors' perceptions regarding the types of proposals that will gain federal support. In this situation, there is reason to question the reality of local control even though public transit is widely agreed to be a local function.

The federal Department of Transportation (DOT) acknowledges that the authority to operate transit systems resides at the local level, but there is some ambivalence regarding who is to control the planning and building of such systems. On the one hand, it is up to local authorities to decide what kind of system they want—what they consider the most effective way of moving people.[1]

> Our (DOT) position is that we don't favor one system over another, and that we advocate buses where they can solve the problem and we will advocate rail systems wherever they can solve the problem. We have no preconceived notions as to the type of system that a local community would like to have.[2]

On the other hand, "We are going to try to use the leverage of the Department's grant programs to bring about this planning and implementation."[3] Thus the federal government through DOT and UMTA espouses the need for and desirability of local control of transit planning, but uses "leverage," that is, money, to influence the local plans. To build a public transit system requires enormous amounts of capital. Even new buses may cost more than local transit districts and local governments can afford, given their limited financial resources. Therefore, the federal government through UMTA can effectively control policy outcomes by granting or refusing to grant money.

Until 1975, the federal government only offered funds for capital expenditures, but with the passage of the Urban Mass Transportation Act of 1974, some operating subsidies were also authorized. UMTA cannot force the local governments to take action and request federal money, but so far the requests have exceeded the available funds. This has allowed UMTA to set priorities to determine who gets the money available. Frank Herringer (UMTA Administrator 1973-1975) set forth a policy that each capital grant application would have to be accompanied by an analysis of alternatives:

> We should require that people do not preselect technology but rather consider the whole range of alternatives. I do not believe we should require the selection of the cheapest or any other single parameter. We should leave that decision to local authorities but we may have to regulate the federal funding level based on cost effectiveness.[4]

In other words, the federal government will pay 80 percent of the costs of the most cost-effective system. In practice the emphasis is on low cost rather than high effectiveness, but the local governments are free to build any system they want, even a more expensive system if they pay for the difference themselves. As a practical matter such freedom is illusory, since the cities find it difficult to come up with even 20 percent of the funding for a major transit project, let alone additional funds to produce a better system.

Using cost, especially initial capital cost, as the basis for funding decisions makes it virtually impossible for a city to choose a new technology, which in its early applications is likely to cost more than established systems. In addition, cost data for these new systems may not yet be entirely reliable: "Pre-production engineering and tooling costs allocated to the first few AGT installations could make them appear more expensive than conventional systems where such costs have been distributed over many installations for many years."[5]

This approach also reinforces economic values without consideration for improved quality of service. It adds further weight to the traditional transit criterion of endurable hardship rather than seeking higher service quality to attract a larger ridership. Another problem with alternatives analyses is reflected in the state of the art of transportation planning: "The failure of computerized transportation planning models is that they require numerous dubious assumptions about the relative value of these [land-use and transportation] relationships."[6]

Cost effectiveness essentially rests on assumptions regarding future ridership. Thus it is possible for transportation planners and their consultants to create a huge analytic apparatus essentially to justify their prior conclusions. The analyses done for the BART system in San Francisco exemplified this approach: "Within the boundaries of the task as defined, the work performed was credible. It is just that the boundaries were not valid."[7]

Even within the boundaries, the work may not have been credible as ridership was overestimated by a factor of two while the costs were underestimated and almost doubled from the original projections. The estimated maintenance and operations costs were $13 million per year, while the actual costs have been $64 million per year.[8]

Thus the outcomes of alternatives analyses may be essentially predetermined based on the boundaries of the studies and the assumptions used to generate data. It therefore becomes significant to examine the pressures that determine the policies that are then justified and rationalized with analyses. The processes that have led to the adoption of rail rapid transit systems have been well documented.[9] The decision processes regarding more innovative systems such as PRT have not been well documented.

PRT systems have been seriously considered in several cities, most prominently Denver, Minneapolis-St. Paul, and Las Vegas. In each of these cities PRT became part of the public agenda, openly debated and discussed in public meetings and the news media. In other cities, a few people—some in official positions, others acting as individual citizens—have discussed and proposed PRT for their respective communities. They have not, however, succeeded in making PRT a public issue. Los Angeles is one example of the latter situation, although it is not the only one.

By examining what occurred in these cities, it may be possible to define more precisely the meaning of a public agenda. It may also be possible to analyze the pressures which lead to adoption or rejection of innovative systems and the interactions among local, state, and federal interests.

The political problem of innovation is not limited to the federal level of government. As shown with the HPPRT program, federal programs may be initiated to meet local needs. The AGTT program illustrates the way federal officials may analyze local demands for new systems, rejecting some ideas on the basis of lack of demand. Local analyses of alternatives are used to justify federal research-and-development decisions. Nowhere does the confusion between market risk and utility risk become more serious than in the interpretation of local demands.

Certainly local demands are not entirely clear, and there are considerable differences among the multiplicity of local actors. A number of transit operators have made it clear that they are uninterested in new systems and have testified frequently that they need assistance now, not exotic new systems for the future. Other local and state government officials (usually in the local or state macropolitical system) are concerned about the quality of service offered by existing systems and the continuously rising costs that must be subsidized by taxpayers. They are more likely to want some new approaches, but their influence on UMTA has been negligible to date.

In considering new systems, there is something of a chicken/egg problem as local officials find it difficult, if not impossible, to plan for systems that do not exist and that they believe lack federal support. Certainly the actions of UMTA in Denver and Las Vegas have strongly reinforced the local opinion that there is an unwillingness to fund advanced systems.[10] Therefore it is considered a waste of resources to analyze such systems, even though some actors may consider them potentially useful.

As a result, UMTA in looking at local plans finds no demand for new systems and justifies its lack of support for such systems on the basis of the lack of local demand. In such a situation, it is difficult for proponents of new systems to gain serious consideration at either local or federal levels of government. An examination of the experiences at the local level of government helps illuminate the problem.

Notes

1. Paraphrased from the testimony of Assistant Secretary of Transportation Hurd in U.S. Congress, House, Committee on Appropriations, *Department of Transportation and Related Agencies Appropriations for 1972, Hearings before a Subcommittee of the Committee on Appropriations,* 92d Congress, 1st Session, 1971. Similar statements are found in Appropriations Committee Hearings of the House and Senate, particularly in the period 1969 through 1973.
2. U.S. Congress, Senate, Committee on Appropriations, *Department of*

Transportation and Related Agencies Appropriations for 1973, Hearings before a Subcommittee of the Committee on Appropriations, 92d Contress, 2nd Session, 1972, p. 604.

3. Ibid., for 1975, p. 530.

4. Frank Herringer, administrator, Urban Mass Transportation Administration, quoted in ibid., for 1974, p. 1260.

5. H. William Merritt, quoted in ibid., for 1976, p. 1485.

6. S. McCausland, "People, Politics, and Transportation: California Style," California Legislature, Assembly Committee on Transportation, Sacramento, 1974, p. F-7.

7. S. Zwerling, *Mass Transit and the Politics of Technology* (New York: Praeger Publishing, 1974), p. 137.

8. M. Webber, "The BART Experience—What Have We Learned?" (Berkeley, Calif.: University of California Centre for Planning and Development Research, 1976), Working Paper #143, p. 18.

9. See, for example, A. Hamer, *The Selling of Rail Rapid Transit* (Lexington, Mass.: Lexington Books, D.C. Heath, 1976); G. Marine, "Big Bad BART: Rapid Transit as a Tool of Foreign Policy," *Coast Magazine* 15 (1974):26-28; Zwerling, *Mass Transit and Politics.*

10. This point was made in a number of interviews with officials, consultants, and other observers in several cities.

8 Denver

The analysis of what occurred in Denver is particularly enlightening since presumably the officials had selected PRT for their city, and this selection was approved by the people in the form of a sales tax/bond issue. This election was followed by the required alternatives analysis, wherein the PRT alternative was rejected in favor of a GRT system called by the Denver Regional Transportation District (DRTD) Advanced Rapid Transit (ART).

This rejection of PRT is frequently cited by critics as proving PRT is not a viable concept. The assumption is that PRT could not stand up to harsh unbiased analysis. It is therefore important to find out precisely what was done and the legitimacy of the case against PRT. Such an analysis will reveal the variety of pressures that help to determine policy outcomes.[1]

The origins of the Denver transit plan for the use of PRT were discussed in chapter 7. As was noted, the concept of PRT was not clearly articulated, and the thrust of the program was to get an urban demonstration of one of the Transpo systems for Denver. Even before the people of Denver voted on the transit proposal, however, the project was in jeopardy.

The problems began with the defeat of Senator Allott in the 1972 elections. As revealed by "informed sources" in Washington,

> . . . Denver's real problem with the PRT demonstration is political. Former Senator Gordon Allott, R-Colorado, pressured a reluctant DOT and the White House into giving the project to Denver, and now Allott is gone the pressure to go through with the project is no longer there.[2]

The Olympic Games of 1976 were also voted down by the people of Colorado in the 1972 elections. These two defeats were followed by the resignations of the secretary of transportation, John Volpe; the under-secretary of transportation, James Beggs; and the administrator of UMTA, Carlos Villareal, all important supporters of the Denver project.

In January 1973, the *Rocky Mountain News* carried a story, "Future of 'PRT' Still Clouded." In it they said that DOT officials were including no money for the project in the fiscal 1974 budget. Thomas Hoadley, UMTA's director of Financial Management, was quoted as saying the Denver project "was not compatible with the overall regional mass transit plan."[3]

Harry Parrish, executive director of the DRTD, said this statement was false. He also said the statement of outgoing Under-secretary Beggs regarding the connection of the project to the Olympics was false. (When Frank Herringer quoted the Denver people regarding the separateness of the PRT demonstration and the holding of the Olympic Games in Colorado to the House Subcommittee on Appropriations for Transportation, the chairman, John McFall replied, "You should have been in the Conference Committee.")[4]

As was discussed in chapter 7, however, the fear of "another Morgantown" may have been paramount in the decision not to have another urban demonstration with an unproven system.[5] The Transpo systems clearly were not ready for urban deployment without further development, and with no political pressure to force the urban demonstration in Denver, UMTA could safely abandon the project, which is ultimately what was done.

This was not done immediately nor in a single decision that made the cutoff obvious. Early in 1973 the new administrator of UMTA, Frank Herringer, testified that ". . . we are not saying Denver needs a 'PRT.' Denver is planning and we are in the process of reviewing their plans."[6] Denver was given another technical studies grant of $179,000 "to very carefully consider the alternatives of express buses and exclusive bus lanes."[7] This suggestion that other alternatives be examined was a clear indication of the limited federal support for a Denver PRT project. Denver had already done an extensive analysis, which concluded that vastly improved service would be needed to attract people to a public transit system.

It appears, however, that the alternatives analysis was to determine not so much which system would provide the best service but which system would be most cost-effective with emphasis on initial capital outlays, that is, cost, not effectiveness. Such alternatives analyses would become a standard UMTA procedure to screen requests for capital grants and to determine which should be funded.[8] As was pointed out earlier, such a screening process emphasizes costs not service and virtually precludes the introduction of new systems.

The latter point may not have been entirely clear on July 18, 1973, when Secretary of Transportation Brinegar announced that a "complete analysis of alternatives" would have to be done to determine if PRT was the best approach for Denver. He also announced at the same time that the Denver demonstration would be moved to a nearby site at Broomfield, Colorado.[9] These announcements were made in such a way as to minimize their impact on the September 1973 election. "Brinegar (Secretary of Transportation) told the Colorado delegation that DOT 'firmly' supports the implementation of improved transportation in the Denver area."[10] He backed his verbal support by stating that DOT would provide "substantial funding" for the alternatives analysis to help speed the conclusion of the required studies.

After the election, however, UMTA was facing considerable congressional heat over the funding of the Denver project, and UMTA Administrator Herringer backed away from the commitment to Denver. "The Denver project is no longer called the Denver project. I think it is referred to in the budget as high-performance PRT."[11]

It was still assumed, however, that the results of the HPPRT program would be applied first in Denver.[12] Shortly thereafter this assumption proved to be unwarranted, as the commitment to the Denver project was categorically denied. While acknowledging that the people of Denver had voted for a PRT system which assumed 80 percent federal funding, Herringer indicated that UMTA had "taken pains to inform the people who are in charge of the Denver PRT that there is no such commitment."[13]

> There is no . . . there is absolutely no commitment to Denver that we would participate in such a project. Proceeding with the PRT test project should not be read as a commitment to that, either. It is quite independent of the Denver situation, and as I mentioned, Denver is analyzing alternatives right now under a contract to TRW. They are looking at all ways in which they might solve their transportation need and problems.[14]

Essentially what had happened was that Denver chose PRT at the time UMTA was pushing such systems as an extension of the Morgantown and Transpo projects. These projects had a number of problems, and with the turnover in key personnel in UMTA, the commitment to automated transit was substantially reduced.

There is apparently a strong desire among governmental officials to avoid saying, "I changed my mind." Other rational-analytical methods are used to accomplish the same purpose. Requiring alternatives analyses because "[I] . . . don't want applicants pre-selecting technology," served such a purpose.[15]

Such an approach also allowed UMTA to take control of the research program, which apparently was important to Herringer: ". . . I question whether we can allow the Federal program to be driven solely by the ability of the locals to raise the 20-percent share . . . should we go on and develop technology that is going to place additional demands on the capital grant program several years out?"[16]

While these are valid concerns, they do not relate solely to the Denver situation. Such concerns reflect on the need for and desirability of a federal research program. The federal research program was still pursued, however, and the opportunity was lost to work in close cooperation with a typical American urban area to simultaneously develop a concept of desirable service with the equipment appropriate to provide that service. Instead UMTA put out the specifications for the HPPRT program, which called for a twelve-passenger (or less) vehicle capable of carrying 14,000 persons per lane per hour. In so doing, a true PRT system was effectively rejected by the federal government for its testing program.

This left the transportation planners in Denver in a most difficult situation.

In the election of 1973 the people had voted for a system called PRT. The service concept presented to the people was that of true PRT, whereas the network shown on the ballot was for a more traditional corridor type of system such as GRT.

There is no evidence that this disparity was understood by the people who supported the system or that it was fraudulently presented to the voters. To the contrary, interviews more than two years later indicated some of these people still did not understand the problems of their design. Nonetheless, the small group of people within the RTD who directed the development of the transit plan have been described by one observer as an exceptional group who were great teachers of the community.[17]

They were still traditional transit people, however. Harry Parrish, the executive director, had had a lengthy career as an engineer in transit consulting and was involved in the BART system and worked for 2 years at the Southeastern Pennsylvania Transportation Authority (SEPTA). Whereas they belie the idea that public transportation planners are generally opposed to new systems, they still did not see the full implications of the type of service they were proposing. They remained tied to corridors, and even though they called the system personal, what they really designed was an automated bus system.

In addition, the plans had proceeded based on several assumptions which later proved to be false: (1) The Transpo systems would be ready immediately for an urban demonstration. (2) UMTA would fund such a demonstration in Denver. (3) The demonstration would be successful (provide a service the people liked and operate satisfactorily at a reasonable cost). (4) Capital grant funds would be allocated by UMTA to complete the entire system based on the successful demonstration.

None of these assumptions were accurate, and the people in the Denver RTD were faced with a situation after the election where they had promised something they could not deliver. The key people such as Harry Parrish who had been there before the election left immediately after, and a new executive director, John Simpson was appointed. He was a retired military officer who had also worked at the Port Authority of New York. He began bringing in a large number of new people to handle expansion of the bus system (also a part of the package approved by the voters) and to plan and build the new "PRT" system.

The immediate problem of the planning and development group was to get started on the alternatives analysis required by UMTA. Early on, this new group was embroiled in controversy regarding the selection of a systems manager for the study of alternatives. The final selection was between TRW, Inc. and General Motors. One well-placed observer believes General Motors would have been selected except that a number of supporters of PRT objected strenuously. The resulting publicity changed the swing vote at the last minute. (The concern was that the country's largest producer of buses might find it difficult to be objective when analyzing various transit alternatives.)[18]

TRW received the contract, and although they are an excellent systems analysis firm, they had had no experience in the field of transportation. The transportation-planning expertise was supplied by De Leuw, Cather & Co., a newly acquired division of TRW with a long history in transportation planning. Other subcontractors were Ralph M. Parsons Co. (associated with the development of BART), and Owen Associates. Despite their traditional transportation-planning knowledge, by their own admission, they knew little about new transit systems such as PRT.[19]

This inexperience was added to the inexperience of the people within the Denver RTD, who were both new to the district and new to transit planning. As one participant described it, "It was the blind leading the blind." They had to learn as they went along, for it was the first time a study of this type had been done. They were also operating under a number of constraints. Many of these stemmed out of the election process, which was necessary to get local funding for any transit system.

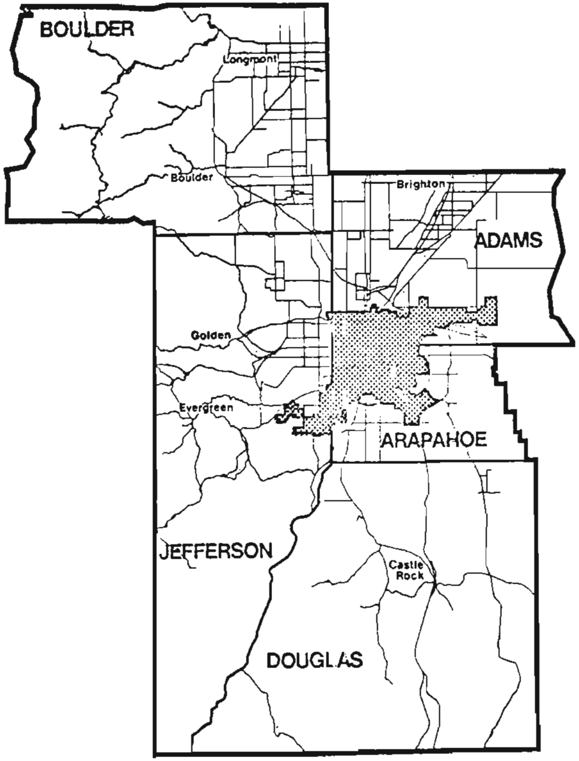
The Denver Regional Transportation District (DRTD) is made up of six counties centered around the city and county of Denver. As can be seen in figure 8-1, the population of Denver makes up 42 percent of the total population of the region, but in terms of transit dependents, Denver has the greatest need for public transportation. The elderly, the poor, the households without autos, and the handicapped in Denver far exceed the surrounding counties.

Nonetheless, people from all parts of the six-county region had to vote for the system, and all would have to pay for it. This meant that in developing a transit plan, some part of the system would have to operate in each county. Although the city and county of Denver received slightly more than their share of system relative to total population, the plan did not reflect the greater needs of the central city. Several observers have noted that the amount of PRT guideway corresponds very closely with the amount being contributed by each county.[20] Such a balancing of particular jurisdictional interests to gain region-wide support is typical of many local planning efforts.

All these interests were also represented on the Regional Transportation District's Board of Directors (see figure 8-2 for organizational relationships). Therefore the basic outlines of the network approved by the voters became sacrosanct to the DRTD management. (See figure 8-3.) This decision meant that there would be no possibility of examining a true PRT service concept, since the existing network was incompatible with such a system. Much of the proof regarding the infeasibility of PRT systems was based on the assumption that a two-way corridor network was essential.[21]

At least two different analysts sketched rough plans for a real PRT network, but these were rejected. In one case the proposal was ripped out of a report, and the analyst was told not to show it to anyone. The primary reason given for this rejection centered on the costs of a greatly expanded network of guideways.[22]

A number of analysts on the scene contend that PRT costs were stipulated



City and County of Denver in comparison to the Regional Transportation District

	Denver	Total RTD Service Area	Denver as % of RTD Service Area
Area (sq. miles)	117.51	2,000 square miles (approximation)	5.9%
Population			
1975	529.700	1,480,900	35.8%
2000	773,280	2,350,000	32.9%
System miles	38.6	73	52.9%
Stations	20-25	44	50-57%

Transit Dependency in Denver as Compared to the SMSA

	Denver	SMSA	Denver as % of SMSA
Population '70	514.673	1,227,529	41.9%
Age 5-17	114,576 (22.3%)	326,058 (26.6%)	35.1%
Age 65+	58,786 (11.4%)	95,046 (7.7%)	61.9%
Income below $8,000	48,889 (38.4%)	93,106 (30.6%)	52.5%
Units w/o auto	34,902 (18.8%)	44,338 (11.3%)	78.7%
Handicapped (age 16-64)	30,836 (11.3%)	64,539 (10.1%)	47.8%

Figure 8-1. Denver Regional Transportation District.

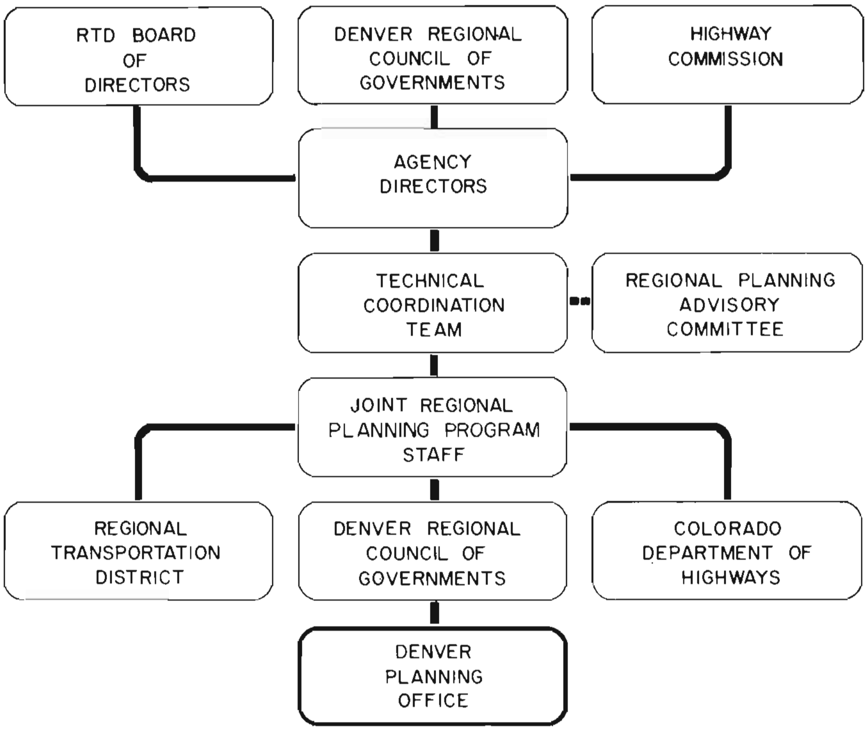


Figure 8-2. DRTD Organizational Network.

rather than analyzed. To the extent there was analysis, traditional costs of existing systems were used to cost out PRT. In one instance the costs of a fifty-passenger bus were used to determine the costs of a vehicle that would carry one or two people.

It was also assumed that a PRT guideway would be just as expensive to build and maintain as a GRT guideway. Several of the traditional analysts reported that any guideway would have to be at least the same width as the vehicle (see figure 6-1), and therefore there would be little or no difference in construction costs.[23] Although this is probably inaccurate, even allowing the same costs, a one-way PRT system could cover 200 miles for the same price as a 100-mile two-way corridor system such as the one proposed. Although "bad economics" have been continuously cited as a principal reason for rejecting PRT,[24] the lack of adequate cost analyses indicates that it is more a justification for decisions made on other bases.

A larger PRT system would have required many more vehicles carrying fewer passengers, and traditional transit planners have found through experience

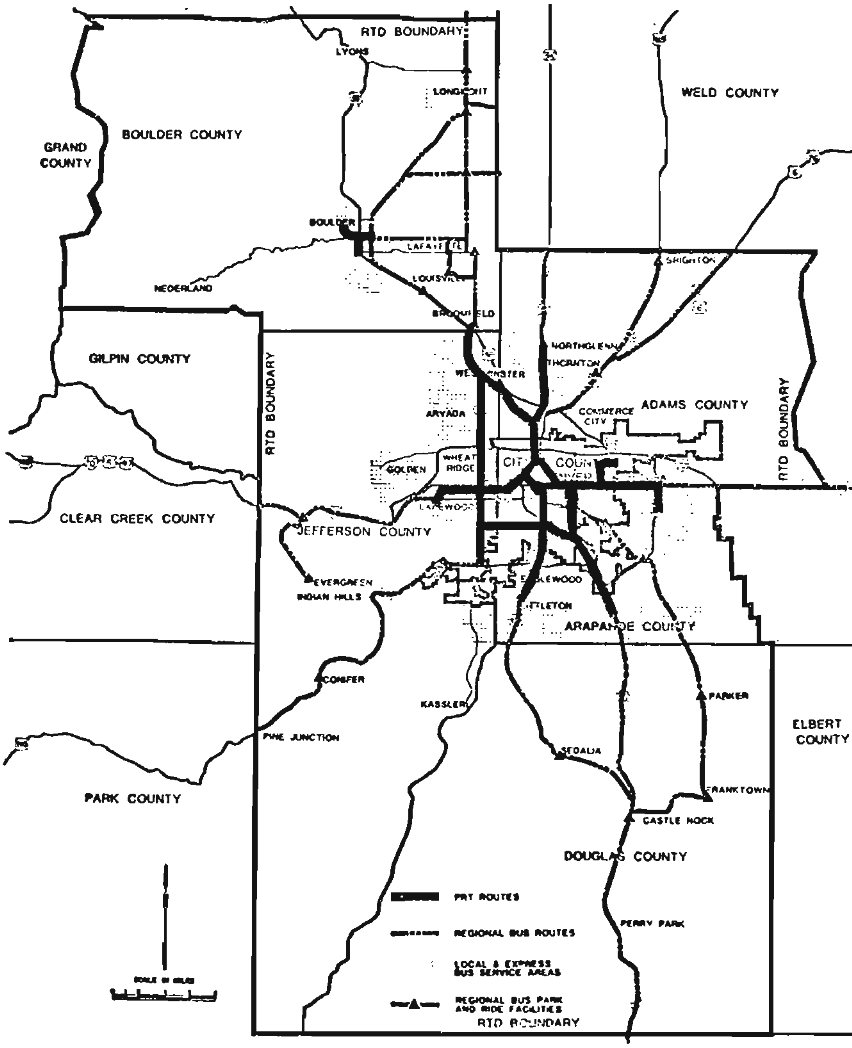


Figure 8-3. Denver PRT Network Approved by Voters, 1973.

with trains and buses that bigger vehicles are less expensive to maintain. In addition, there are fewer vehicles to have problems, and thus the system should be more reliable and safe for passengers.[25] These assumptions about reliability and safety may have resulted from some misunderstanding of PRT systems.[26] In commenting on some of the misunderstandings, an Aerospace Corporation analyst stated: "... the negative conclusions expressed in the memo are largely based upon misuse or misunderstanding of some of the information contained in our Denver briefing."[27]

He then went on in considerable detail to refute the erroneous ideas, but there is no evidence that this letter was widely read or used in the Denver analysis. At least one analyst present at the time states that the Aerospace work was ridiculed, that some people felt even to critique it was beneath them, and that the fact of a review might lend credence to a system that was too ridiculous to discuss.[28]

The DRTD people also justified their decision against PRT by noting citizens' objections to having guideways going down their streets. Even the merchants along Colfax Avenue preferred the routing to be 100 feet north of Colfax, behind businesses that lined the major east-west highway.[29] The objections were based on the DRTD's claimed need for a 50-foot right-of-way, which would carry a dual guideway system roughly 20-feet wide plus a 2-foot walkway for emergencies.

Guideways of this size would create blight along their paths much as the old elevated railways created blight. They would also have required the removal of some of the existing property for rights-of-way, thus reducing the tax base.[30] Such objections are valid, and citizens can hardly be blamed for not wanting such a system "on my street." The objections do not, however, relate directly to the problems of a guideway less than three feet wide that does not require additional right-of-way and is much less intrusive.

The degree of acceptability of the smaller guideway is still open to question, but it is important to note that in Denver, the acceptability of a smaller guideway was never tested. Objections to large guideways were directly transferred to small guideways without checking if such a transfer were valid. As one newspaper reported, "the fate of personal rapid transit (PRT) in metropolitan Denver may depend on whose neighborhoods are served—or whose blocks get gored."[31]

Prof. J. Edward Anderson was brought in as a consultant to help analyze PRT but found little or no support for his work. Eventually he came to be called the PRT freak, and after 9 months he left the organization.[32] Anderson summarized some of the inadequacies of the analysis being done on PRT in a memorandum to Carlos deMoraes, deputy director of the DRTD:

> The subject statement [a report entitled "Evaluation of Automated Demand Responsive Transit System on the Joint Venture Network"] recommends no further development and implementation activity on the automated demand responsive concept *if it is to operate on the two-way guideway of the modified Joint Venture network.* This memorandum analyzes each of the bases given for this conclusion and finds that the only valid one is that the "hardware will not be available to meet the deployment schedule requirements of RTD." The statement assumes too low a rush-hour vehicle occupancy, a fleet size too

> large by a factor of 1.5 to 3, and a minimum headway too low by the same factor. The cost analysis is at variance with other studies which show advantages of small vehicle systems if adequate attention is made to designs for minimum cost; the patronage analysis takes no account of important behavioral differences between private service and shared-vehicle service in both vehicles and stations; and the estimates of reliability are much too pessimistic. Finally, the negative statements in regard to research on short-headway systems are unfounded.[33]

As Anderson correctly points out, there is no technical reason not to modify the network and that without such modifications a PRT system is not feasible.[34] He also points out the weaknesses in the other arguments against PRT, but these arguments had nothing to do with the real reasons for rejecting PRT.

The real problems seem to have been that the federal government was not supporting PRT, and as one observer stated, "The systems analysis was colored by what they thought UMTA want[ed]."[35] The executive director, Simpson, frequently stressed the problem of raising money and the need to satisfy UMTA.[36]

Secondly, there was nothing "on the shelf." The DRTD had a 1986 deadline based on the 1973 ballot proposition. They had promised the voters they would start the demonstration project immediately based on the assumptions noted earlier.[37] PRT required research and development, and it was assumed the people would not tolerate funding such a program when they had been told a system was ready to go.

In addition, a research program would leave a gap in the development group that had been hired to plan and build a system. A large number of people had been hired, and these would not be necessary for a research-and-development program. These aerospace people had experienced or been threatened by unemployment before coming to the DRTD, and a number of observers believe (and heard statements confirming) that these people wanted to save their jobs.[38]

Therefore the alternatives analysis had to be manipulated. The management of the DRTD denies such manipulation, but almost all others involved in the project confirm that some manipulation took place although they disagree on the extent and type of manipulation. In one sense some manipulation is necessary, since all transportation analyses are based on assumptions and constants. Decisions must be made regarding what can be changed and what cannot be changed, and these decisions will determine, to a large degree, the outcomes of the analysis.

The necessity to leave the network unchanged is one example. Another is the report that patronage figures for the GRT system chosen were announced before the analysis took place and that design decisions were made to make the announcement come true.[39] A different type of manipulation is suggested by the report that the GRT system did not come out as a cost-effective system in an early computer run, so a high-level manager said it would be necessary to apply "creative economics."[40] To make these adjustments less obvious, new terms were developed to replace group rapid transit and personal rapid transit.

The final report examined six transit alternatives: (1) baseline bus—bus service developing along existing trend lines; (2) advanced bus—including express bus lanes and other improvements; (3) light rail—streetcars; (4) CRT—conventional rail transit, or a BART-type train; (5) ART—advanced rapid transit—an amalgam of SLT and GRT characteristics, essentially a simple automated system with forty-seat vehicles; and (6) DRT—demand responsive transit—essentially a GRT system with off-line stations and twenty seats.

As is immediately clear, PRT was not part of this analysis, nor was it seriously analyzed at earlier stages despite some statements to the contrary. Instead "creative economics" were used to make the analysis come out as had been earlier determined through political processes. Evidence for this can be found in the patronage figures for the ART and DRT systems. With slightly different networks, different mileage, different numbers of stations, different size vehicles, and different service characteristics, the annual patronage on both systems is identical to the first decimal point.[41]

Some analysts report that other systems were made less cost-effective through the use of subway or aerial configurations, which increased their initial capital costs. The ART system, which seems to have best met the needs of the development group, came out of this analysis with the best ratio of benefits to costs—1.40, with the highest net present value—597, and with the highest internal rate of return—7.0.[42]

Many outside observers believed that buses would have been the least costly system, but such an outcome would have infuriated the people of Denver, who were already complaining about expanded bus service when they had been promised an advanced system. It would also have left the development group with nothing to do, just as a research-and-development program for the PRT would have reduced the requirements for their services.

The outcome of all this was that UMTA rejected the Denver alternatives analysis and refused to fund their ART system. Although there was a deep concern to please UMTA, the final report was unsuccessful. UMTA's priorities had changed and they no longer wished to fund a large-scale automated system. Instead they made a $100-$200 million commitment to Denver for bus and bus-related improvements.[43]

One observer reported that the governor of Colorado is a "bus man" and that other powers in the state legislature were out to destroy the DRTD's efforts to get better transit. There have been some bitter battles between the highway department, the DRTD, and other groups regarding particular highway construction, and part of the DRTD's problems may stem from this source. The author could not determine the degree to which this type of conflict might have influenced UMTA's decision, but UMTA has its own battles with the highway interests, so it appears unlikely that this problem influenced their decision greatly.

Nonetheless, the negative outcome was unfortunate for the people of Denver, who had been promised a PRT system and had voted money for that purpose. It was also a very unfortunate experience for the concept of PRT as a whole. Many people throughout the country who are considered to be experts on transit systems now cite the Denver study by TRW as proof that PRT is an unworkable idea. The fact that PRT was rejected out of hand, based on the necessity to keep a particular network configuration, is not widely known. What is reported are the "problems" of economics and technical feasibility that were used as justification without adequate analysis. Thus UMTA may have in part rejected PRT because the Denver study proved its impracticality, whereas Denver rejected PRT because they thought UMTA would not fund it.[44]

As the preceding discussion indicates, the issues were more complex than this, but such local studies have had a tremendous influence, especially among those who are seeking reasons to reject an idea they would like to reject for less rational reasons. In this sense, the Denver alternatives analysis is surely an example of analysis being politics carried on by other means.

9 Minneapolis-St. Paul

In the Twin Cities, personal rapid transit (PRT) has become a publicly debated, emotionally charged issue. Here the issue is real PRT, which has been advocated by a group centered in the University of Minnesota led by Professor J. Edward Anderson. The University proposal is seen as competing with the backbone fixed-guideway proposal (rail/subway) of the Twin Cities Metropolitan Transit Commission (MTC) and a busway proposal of the Metropolitan Council, a regional planning and governing body.

There is also a fourth proposal, which stems from a study of all three systems by the Citizen's League, a nonpartisan group of 3,000 who make a number of wide-ranging "good government" proposals.[1] This group believes it is necessary to reduce the need for transportation and advocates the construction of major diversified centers with good short-distance internal circulation. They also advocate greater use of paratransit as a more effective and efficient means of attaining better service for all urban residents.

The confrontation of groups in the Twin Cities offers an almost classic case of the transit planning debate that is occurring in urban areas in the United States. It also illustrates the difficulties inherent in the attempt to introduce a new technology into an old debate. The old debate being the highway versus transit controversy, which has exercised various groups in the United States since the 1960s.

One can begin with the Metropolitan Transit Commission, which was established in the mid-1960s by the State Legislature upon the recommendation of the Citizen's League.[2] Its purpose was to present a plan to the legislature for improving public transit. Phase I of this plan was presented in 1969. It recommended public ownership of the bus transit in the area and noted that substantial improvements were needed to improve bus service and equipment. The plan was approved, and the MTC bought the Twin City Lines Bus Company in 1969.[3] There has been a continuing effort to improve bus service since that time, and this aspect of the MTC plan is supported by the Citizen's League.[4]

Phase II of the transit plan involved going beyond buses to seek out other types of transit systems. A major study was done for the MTC by Alan M. Voorhees & Associates (a traditional transit planning firm), which recommended a 71-mile, fixed-rail transit system to serve eight travel corridors. Whereas this specific plan was rejected by the MTC due to unfavorable public reaction, essentially similar systems with varying lengths of "backbone" guideway plus collection and distribution subsystems have subsequently been proposed.

The one officially adopted by the MTC in December 1972 was a 57-mile intermediate capacity rapid transit (ICRT) system. Although the type of equipment was left open, the service described was essentially that of a train system—much of it as subway. This approach is strongly supported by the staff of the MTC, its development director John Jamieson, and Douglas Kelm, chairman of the MTC.[5] Downtown business interests and land developers have also supported a traditional rail-type system.[6]

The Metropolitan Council to which the MTC nominally reports does not support any type of fixed-guideway system, and they have recommended a system of express busways, which could serve as collectors and distributors as well as providing the line haul functions of the more capital-intensive trains.

In 1971, the Center for Urban and Regional Affairs at the University of Minnesota received a grant from the 1971 Session of the Minnesota State Legislature to develop a proposal for demonstration of an advanced form of transportation (PRT) in Minnesota.[7] With this grant a plan was developed for the demonstration and incremental implementation of a PRT network in the Twin Cities.

The Citizen's League examined all these plans and found them at least partially unsatisfactory. They rejected the MTC plan because of its high cost and low projected ridership. The Metropolitan Council plan for busways was rejected as being too unappealing and over time being too costly to operate. PRT appeared to them to offer an excellent service concept, but they were concerned that a fine-grained system had not yet been developed, and even if it were developed there were questions regarding its acceptability in residential neighborhoods.[8]

Their recommendation was to reorient long-range transit planning in the metropolitan area to focus on reducing the amount of travel by encouraging short trips and discouraging longer trips. They saw the need for diversified centers where people could live, work, and shop with a variety of internal circulation systems. They also advocated a major expansion of transit service in small, usually privately owned vehicles, such as the van pool program initiated by the 3M Corporation or jitneys, part-time taxis, subscription buses, and so forth.[9]

With this multiplicity of groups and proposals, public transit became a widely discussed public issue, but it was difficult for any one group to impose their will on the others. The MTC was forced to back away from their rail proposal, and even their intermediate capacity rail proposal was stymied by the Metropolitan Council.

The people supporting PRT spent a great deal of time trying to influence the others and gained some support within the Citizen's League, on the Metropolitan Council, and in the State Legislature. This support could not be translated into action, however, due to the need for further development work on PRT and the lack of consensus that this was an appropriate solution.

In this situation, the State Legislature became a key actor, especially the

Metropolitan and Urban Affairs Committee of the Senate. In November 1973 they issued a report, which was adopted as an official policy statement with the following positions:

1. They rejected the MTC plan because the benefits did not justify the costs.

2. They thought bus improvements were essential but rejected a system that was based solely on buses.

3. They liked the PRT service concept but rejected a pure PRT finegrain network "which would physically intrude into neighborhoods and have prohibitive capital costs."

4. They agreed with the Citizen's League finding that low-cost alternatives must be part of any transit solution.[10]

Finally, they ordered the Metropolitan Council to plan development of an "automated small vehicle fixed guideway system for consideration by the Legislature. . . ."[11] The description given of this system was essentially a description of PRT despite policy statement 3. This was followed in April 1974 with a bill from the State Legislature ordering the MTC to do a study of small-vehicle fixed guideway systems, which would make a direct comparison of such a system with the intermediate capacity rapid transit system of the MTC.[12]

The purpose was to have a thorough examination of the concept of PRT to determine if it was appropriate for the Twin Cities.[13] The people who favored PRT had worked diligently with members of the State Legislature, and several key members of both the House and Senate with responsibilities for urban affairs and transportation were persuaded that PRT deserved greater consideration.

They apparently hoped for a definitive study of PRT, and there was some consideration that Aerospace Corporation should do the study, since they were not manufacturers and they had considerable expertise in the field. The State Legislature could not, however, conduct the study themselves and turned the responsibility over to the agency with the appropriate domain—the Metropolitan Transit Commission.

This agency selected consultants with whom they were familiar and in whom they had confidence. The team was headed by De Leuw, Cather & Co., with the local firm of Bather, Ringrose, Wolsfeld, Inc. (BRW), and Honeywell, Inc. to do some of the computer simulations with data supplied by De Leuw, Cather. Both De Leuw, Cather and BRW were strong in traditional transit design with little experience in small-vehicle systems. BRW had worked closely with Jamieson and the MTC staff on other studies, and those who favored PRT felt such an organization would be less than objective in their analyses of new systems that would compete with MTC proposals.

The outcome of the study seemed to confirm their concerns, and they cite several objections to the work that was done. One of the key studies done by BRW was a careful examination of citizen's attitudes toward aerial guideways in residential neighborhoods. This was done through a series of meetings with local agencies, interest groups, community planning staffs, and other local groups of citizens. The essential findings were that such aerial structures were unacceptable in residential neighborhoods. On this basis, fine-grain networks, such as those required for PRT, were eliminated from the analysis.

The problem with this study according to the proponents of PRT was in the types of systems shown to the local groups. Very large guideways exceeding eight feet in width were used rather than the slim guideways that proponents believe give PRT a significant advantage over other systems.[14] A second weakness of the study was its concentration on existing systems from manufacturers rather than an analysis of what was needed to best accommodate the transit needs of the Twin Cities. The Aerospace proposal was not considered. The existing PRT systems from France, Germany, and Japan were included at an early stage of the study, but their actual characteristics were largely ignored in favor of a generic definition of high-capacity PRT.

The actual descriptions of this generic system vary in different parts of the final report. On page V-14 the vehicle is assumed to weigh 2,400 pounds when empty. On page V-26, it is assumed to weigh 3,000 pounds.[15] The actual weights reported for the existing systems are: *Aramis* (French): 1,430 lbs., *Cabinentaxi* (German): 1,320 lbs., CVS (Japanese): 1,698 lbs. The estimated weight of the vehicle proposed by Aerospace is 1,800 pounds.[16]

There was also a considerable amount of extrapolation of data from existing group systems that the PRT advocates felt was inappropriate. The problems of existing experimental systems at Morgantown and at the Dallas-Fort Worth Airport were given more weight than was perhaps justified considering their early stage of development. One cannot assume a PRT guideway roughly 36-inches wide will cost the same as a dual guideway 22-feet wide, which was built under conditions of extreme speed and inadequate planning, as was done in Morgantown.

The proponents of PRT also felt that the analysis put forward potential problems of PRT that could easily be resolved and assumed these were real drawbacks to the adoption of such a system. For example, the study noted the difficulty when two people wish to share a ride to close, but not identical destinations. It was assumed this could not be easily done, yet the advocates of PRT claim that this is not a difficult problem.[17] The study also notes a potential problem of being forced to share a small vehicle with an unwanted stranger, but advocates point out that PRT was designed to avoid this.

At a conference to discuss the early findings of the study team, eighty-six representatives of industry, local, state, and federal government, staff members of the MTC, members of the study team, and various other agencies and institutions arrived at a consensus, which determined the final screening and evaluation of alternatives. They concluded:

1. HCPRT is not a viable option without a long-term development period.

2. Reliability of automated systems should be recognized as a serious problem.

3. Safe stopping distance (K greater than 1) assuming a brickwall stop should be adopted as a design policy. Collison survivability is not a realistic goal.

4. All-seated systems are unrealistic. Low ceilings cannot be used to enforce seating.

5. Provision must be made for access to and egress from guideways both for emergencies and maintenance. Walkways are required on aerial guideways.

6. The system and stations should be easily surveillable to assure patron security.

7. Aerial stations would have a significant impact on surrounding neighborhoods. Land use and development controls are needed preceding implementation of neighborhood stations.[18]

The key factors seem to have been safety and development status. The study team either did not know or chose to ignore studies that dealt with safety and reliability issues of HCPRT. The traditional transit standard of the brick-wall stop and K dominated their thinking:

> Use of HCPRT technology in urban transit also requires substantial changes in institutional attitudes regarding safety. There is no objective basis on which to forecast the time required for the changes that would make HCPRT transit acceptable to passengers and to transit agencies in this country.[19]

Finally, the study notes the federal government is supporting the development of GRT and HPPRT systems, but that no comparable work is taking place on HCPRT:

> The HCPRT concept requires an independent, massive and expensive research and development program. It is not likely that a satisfactory HCPRT technology will evolve from a GRT installation without heavy infusion of funds. There is no objective basis for assessing the probability that the Federal Government would support this effort and that funding would be made available by Congress. . . .[20]

They do suggest that such development is likely to take place if the current research programs in France, Germany, and Japan continue, but they implicitly, if not explicitly, reject the idea of an American city buying a system from another country.

The chairman of the Urban Transit Subcommittee of the Senate Metropolitan and Urban Affairs Committee has said that Minneapolis-St. Paul will probably stress short-term bus improvements and paratransit alternatives until 1985, when they will have to make a decision regarding a transit system that will absorb a large percentage of the trips now made by automobile. He is not sure what such a system will look like, but he said it will not look like the systems that are being promoted in this country at this time. He did suggest that the Twin Cities might consider the PRT systems that are being developed in Germany or Japan if such systems are not available in this country.[21]

Apparently what he and others in the State Legislature wanted from the small-vehicle study was an examination of a new transit paradigm. This had to be done, however, by an agency that was dominated by the old transit paradigm. Thus it is not surprising that a radically different concept such as PRT was rejected on its face rather than being subject to harsh analysis. Rather than gathering the data that were available from those who had studied and developed PRT systems, assumptions regarding these systems were made based on the old ideas and problems of group/corridor systems.

To the opponents of PRT, the Twin Cities study is frequently cited as definitive in its conclusions that PRT is not an acceptable solution for the transit problems of most American cities. The fact that numerous public officials, especially in the State Legislature, favored such a system, which was then rejected on the basis of objective analysis, carries considerable weight. The study was frequently cited in the Office of Technology Assessment examination of *Automated Guideway Transit.*[22]

What is interesting, however, is the limited amount of analysis devoted to HCPRT. It appears to have been rejected on the basis of the existing transit paradigm, the lack of existing systems available from manufacturers within the United States, and the lack of support for such a system by the federal government. Those who favor a less advanced system believe it is necessary to do something now, not wait for future developments. They see the PRT proponents as being in league with the highway interests to prevent any constructive action. To date, the impasse remains, although PRT has received a severe setback in Minneapolis-St. Paul.

One break in the impasse came when the Metropolitan Transit Commission and the City of St. Paul pushed hard for the selection of St. Paul as a site for the Downtown People-mover program. This was resisted by the Metropolitan Council and some state legislators, but authorization to do a detailed feasibility study (with UMTA money) was approved. When the costs of the system were published in the summer of 1978, considerable opposition developed. Even with 80 percent capital funding from UMTA, local officials indicated they would not support the project unless it was cut back considerably.[23] High operating and maintenance costs including ice and snow removal may also threaten the project.[24]

A member of the consulting team indicated that he doubted that the project could be done for less than $80,000,000, so the project may be stopped.[25] If this happens, the MTC reportedly has another plan to build a fixed rail system to take people from near-loop neighborhoods and fringe parking into and around downtown. "They used to call them streetcars."[26] The impasse continues.

10 Las Vegas

A different type of political conflict developed in Las Vegas, where private entrepreneurs proposed building a monorail to serve McCarran Airport, the Strip, the downtown Casino area, and the Convention Center. (See figure 10-1.) This was to be a privately financed system designed to make a profit, which in the original proposal was to have been split 50-50 between the developer of the system and the county government.

After nearly three years of controversy, the project was abandoned. The reasons for this rejection and the difficulties encountered illustrate the problems of implementing a new technology in the public arena where governments have essential control of the market. They are, in effect, the purchasing agent for the public, and their decisions are subject to a multiplicity of political forces.

Such forces are not abstract flows of power, but real human beings and organizations, which have different and often conflicting interests and values that can be enhanced or damaged by particular government decisions. In the case of the Las Vegas monorail proposal, privately owned bus and taxi companies, the public transportation planners, a few Strip hotel owners, and some environmental groups believed the monorail would hurt their particular interests. To them, it was a restructuring innovation. The promoters of the monorail, certain elected officials, and some businesses believed it would enhance their interests.

Therefore to the outside observer, the controversy seems to have centered on Lasswell's most basic question of politics, who gets what. Political debates are rarely won by those who openly seek their own private interests, however, so all sides claimed the protective cover of the larger "public interest" and professed to be serving the community as a whole.

This meant that the underlying issue of conflicting interests was sublimated into a debate regarding the nature of the public interest as it was affected by the construction or nonconstruction of the monorail. Instead of a debate regarding conflicting values, a single value was postulated by both sides—to serve the needs of the citizens of Las Vegas.

This in turn reduced the debate to rational-analytical terms, where "facts" would determine the outcome. All that was needed was to determine the "real" needs of the people and then to determine which proposal would best serve those needs. There were repeated calls for more studies, for more data, and each study was countered with another study, which purported to refute the facts of the earlier study. There were factual questions to be determined, but the facts,

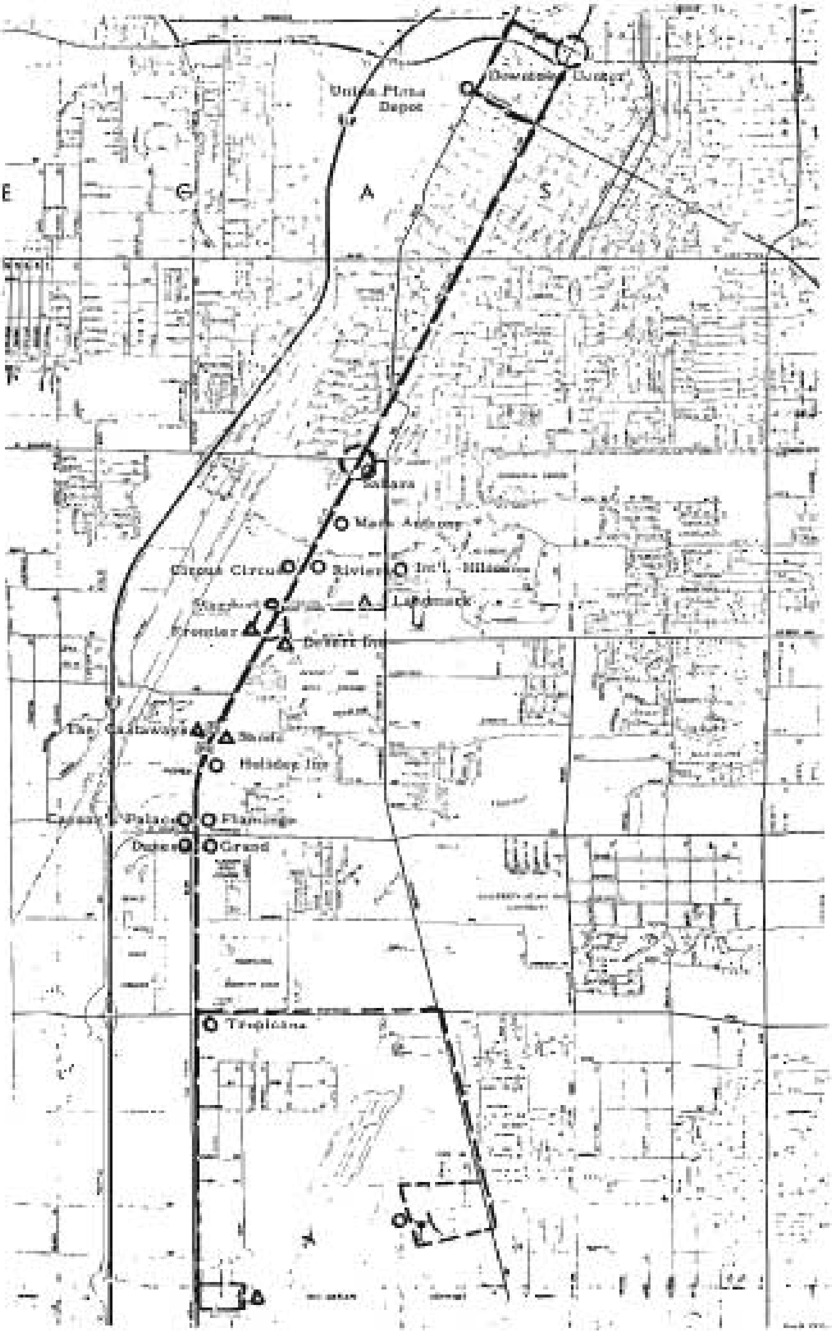


Figure 10-1. Proposed Las Vegas PRT Network.

in and of themselves, could not resolve the underlying value questions that would determine who gets what.

Nonetheless, in a democratic society, elected officials dislike voting in opposition to the position of any significant group of voters or financial supporters. Therefore they seek to show that their vote is based on the facts, that they really had no choice, and that therefore their responsibility for the outcome is diminished, if not entirely obscured. In this situation, "objective" analyses are again a continuation of politics by other means.

Certainly this is what occurred in Las Vegas as the issue of the monorail developed. To better understand the complex and confusing events that occurred, there follows a description of the principal actors involved, a brief chronology of events, and an analysis of the issues that were raised at various times.[1]

Actors

A.J. Kavanaugh, a wealthy Oklahoma City investor, was one of the key proponents of the monorail; he acted as the entrepreneur to bring together all the various elements needed to build the transit system. He was brought to Las Vegas by Clifford Jones, a former lieutenant governor of Nevada, and Art Olsen, a one-term state assemblyman, who were both principals in Custom Cabs, Inc. of Las Vegas, a firm set up to run the transit system.

Kavanaugh set up a consortium of firms including the American Bridge Division of U.S. Steel to act as overall systems manager; Hudgins-Thompson-Ball and Associates, architects and engineers; and Investors Diversified Services represented by John Nuveen and Co. to do the financial analysis and develop a plan for selling bonds to finance the project. This consortium was to look at all available systems and choose the system that was most attractive and appropriate for Las Vegas.[2]

The three finalists in the competition were Rohr Corporation with its Monocab PRT system, which had been demonstrated at Transpo '72, LTV Aerospace Corporation of Dallas, which proposed using its Airtrans system that was being installed at Dallas-Fort Worth Airport, and Aerial Transit System of Nevada, a wholly owned subsidiary of Pullman, Inc., which had been one of the original competitors. Pullman joined forces with Bendix Corporation to form Aerial Transit, and they proposed creating an entirely new system, which they claimed would precisely fit the needs of Las Vegas.[3] The Palomino system they developed, however, strongly resembled the Morgantown system already under development by Bendix.

These private actors were essentially promoters of the system (although the losers in the final competition would later oppose the firm finally chosen), and they had considerable support from members of the Clark County Board of Commissioners, who represented the areas to be served by the monorail and the

Las Vegas Board of City Commissioners. Private support came from the Chamber of Commerce, the Las Vegas Sun (a somewhat skeptical supporter), the Downtown Casino Association, construction and labor interests, and some hotel owners along the Strip, who indicated a mild interest but were not leading advocates.

The primary opposition came from the Checker Cab Company, the largest of the taxi companies and the one that served most of the customers at the Airport and along the Strip. Eugene Maday was the owner of the firm; Robert Smith was his general manager; Myron Leavitt, a county commissioner who opposed the proposal, had a 10 percent interest in the firm; and Robert Maheu, after he left the Howard Hughes organization, became a business partner of Maday and helped the opposition.

Checker Cab set up and financed the Committee for Effective Mass Transit, which led the fight in opposition to the new system. Delores Neonis headed this committee, but Robert Smith would also identify himself as a spokesman for CEMT. They were joined by O'Farrell Estes, President of First Gray Line, the owner of the City Transit System (buses), the airport limousine service, Gray Line Charter, and Avis Car Rental.

At a public hearing on April 19, 1973, Estes supported the monorail proposal on the condition that it would be part of a total transportation service. He suggested that if the Pullman-Bendix system were chosen that they would buy the bus system. He noted that for the fourth year in a row, the bus system had lost money and that it was being subsidized by the firm's other operations.

Later, however, Estes and his firm would oppose the monorail even though Kavanaugh and Rohr Corporation (the winner of the manufacturers' competition) agreed to take over the bus system. Presumably the threat to the firm's airport-related businesses exceeded their desire to get rid of the unprofitable public bus system.

These private interests formed an alliance with the Clark County Regional Planning Council (RPC), which wanted a comprehensive areawide study to provide the community with a "balanced transportation" system. By law it was their function to plan for public transportation in Las Vegas, and their organizational domain was invaded by proponents of the monorail.

Although Checker Cab and other highway interests entered into an alliance with the RPC, at least one observer believed this was merely a delaying tactic to gain time to defeat the monorail, which would have cut substantially into the taxi business. They could be expected to fight areawide transit too, as soon as the monorail threat was eliminated.

A third force in opposition was the Nevada Open Spaces Council, an environmental group that supported the Regional Planning Council. Later they would be joined by the Consumers League of Nevada, as both these groups believed the PRT system would destroy any chance for federal support of an areawide transit system.

This belief was reinforced by the Federal Department of Transportation and UMTA when the Nevada Open Spaces Council sponsored a public forum in April 1973. Public officials from all levels of government met to examine an areawide, balanced transportation system. At this meeting, Stuart Eurman, a field representative of UMTA, warned the people of Las Vegas that before any transportation system was built in the Las Vegas Valley, area officials must have a comprehensive transit plan.[4]

After the monorail proposal was put forward and a contract signed with Kavanaugh, the Regional Planning Council applied for a planning grant from UMTA for $130,000.[5] The key to the study was "to develop a multi-modal balanced transportation system."[6] After determining what types of public transit would be feasible, they would apply to the federal government for 70 percent funding.

Eurman noted in a discussion later in the year that a unified work program, which identified all projects in the area, must be submitted before federal officials could act on an application for a transportation planning grant:

> "I have yet to see a transit system pay," he said regarding the claims of some that a monorail system in Las Vegas would be self-supporting.
>
> Eurman added that while few people would choose mass transit over automobiles, inducements to use it can be built into a system as a matter of policy.
>
> "You've got to insure that you're providing transportation for all the citizens and not just for the gambling tourist," he warned.[7]

In using these arguments, Eurman was supporting the position of the Regional Planning Council and the Nevada Open Spaces Council that government should control and government should pay for public transit. He echoed the argument of the opponents of the monorail that it would only serve the gambling tourists, not all the people of Las Vegas, and he illustrated the position of UMTA that the service they were selling—public transit—was inherently unattractive, requiring inducements and unable to be self-supporting. There was even a suggestion that building the monorail could "foul up any funding for a community mass transportation system."[8]

In December 1973, after the first feasibility study on the monorail project was submitted, Jerome Premo, acting associate administrator for capital assistance for UMTA, wrote a letter suggesting the project be delayed until the Regional Planning Council's transportation study was finished.[9]

In 1974, the secretary of transportation, Claude S. Brinegar, visited Las Vegas to address a convention. He said the federal government was not against a monorail for Las Vegas but was against federal funding of the system. He indicated the most feasible form of mass transportation for Las Vegas would be buses.[10]

Thus UMTA effectively entered the debate in opposition to the privately developed monorail, despite the fact that they were promoting such systems as part of their own organizational objectives, and despite the control of a Republican administration that claimed to favor private enterprise over public enterprise. Nonetheless, the private PRT system invaded their domain, did not conform to their procedures for regional planning, and perhaps appeared to be competitive with both their research-and-development and capital grants programs. If private enterprise was willing and able to build PRT systems and these proved to be effective transportation systems, the need for UMTA would become more problematical.

Chronology

The idea for a monorail to serve the airport and the Strip in Las Vegas was publicly originated in the Las Vegas Valley Transportation Study, which was done from 1965 to 1970 and published in 1971. It was a result of a cooperative effort of the cities of Las Vegas, North Las Vegas, Henderson, Clark County, FHWA, HUD, and the Nevada State Highway Department, which set up the Las Vegas Valley Transportation Study Policy Committee to do the study.[11]

This highway-oriented study was adopted as the new master plan for transportation for the Las Vegas Valley. The study noted the urban sprawl and the widespread distribution of population in the area and concluded, "the urban characteristics of Las Vegas have precluded the development of a major system of public transportation."[12]

There was a suggestion, however, that a feasibility study for a tourist-oriented transit service for the Strip, airport, downtown, and the Convention Center be undertaken if private financing could be found. A local attorney, Art Olsen, suggested a monorail might serve such a purpose, and he joined with Clifford Jones to form Custom Cabs, Inc. of Las Vegas to run such a system.

Together they brought in A.J. Kavanaugh of Oklahoma City who had considerable experience in building public projects, including the Oklahoma Turnpike, a $50 million water line project, and a $19 million FAA center at the Oklahoma City Airport.[13] Kavanaugh also had experience in devising an unusual method of funding such projects.

Twenty years earlier he had been one of the proponents of a public trust law in Oklahoma, which allowed governments to create a public trust that could sell tax-free bonds under the name of that government but without any taxpayer liability should the bonds fail.[14] Such money could then be used by private organizations, which would contract with the trust to build private ventures as long as they served a public purpose. The collateral for the bonds would be the same as that for private bonds, the assets of the project for which they were used. The bond payments were to come from the profits of the private venture.

After all expenses and the bondholders were paid, the profits were to be split 50-50 between the trust (which would turn the money over to the local government which had created it) and the private firms which built the project. In his one term in the State Assembly, Olsen pushed for and won passage of a similar bill in Nevada, the Nevada Public Trust Act of 1971. To safeguard the public interest, the Nevada law required approvals of several public agencies including the local governments involved, the Nevada Public Service Commission, and the State Board of Finance before bonds could be issued.

Unlike the Oklahoma law, the Nevada law did not specify that there must be competitive bidding for contracts or to sell bonds. Once formed, the public trust did not have to give notice of its meetings or open such meetings to the public. Although the first trust formed involved public transit, it was not subject to the controls of the Public Service Commission as were buses and taxis. This so-called lack of safeguards would later lead to considerable controversy.

The next step in the process would lead to even more controversy. On December 20, 1971, shortly after the Public Trust Act was passed, a last-minute item was added to the agenda of the County Board of Commissioners:

> At this time Chairman Ryan vacated the chair to Vice Chairman Brennan and moved that the county enter into the following agreement with A.J. Kavanaugh and Associates, Inc., and Custom Cabs, Inc. and the City of Las Vegas for the exclusive right to design, manufacture, engineer, construct and finance, operate and maintain an automated rapid transit system for the Las Vegas metropolitan area.[15]

This led many, including Hank Greenspun, publisher of the Las Vegas Sun, to believe that some of the proceedings were held in secret and that there might be questionable activities in the letting of the monorail contract.[16] Nonetheless, a contract was signed to have A.J. Kavanaugh and Associates do a feasibility study to see if the monorail proposal would make money.

The contract specified that in the event the city-county did not enter into a definite contract with the contractors to construct and operate the facility, or if they should contract with others for construction of the project within 5 years of December 30, 1971, none of the plans of the contractor could be used unless the contractor was paid for his costs and expenses. This became a major point of contention when the public officials wanted to negotiate directly with the manufacturers of transit equipment and not pay Kavanaugh.

On March 16, 1972, Dr. Samuel Ford, a Las Vegas dermatologist, filed suit against the County Commissioners charging that the construction and operation of a monorail was "not a proper function of the County."[17] In November 1972, the Nevada Supreme Court upheld the constitutionality of the trust arrangement and the agreements that had been made with the monorail developers.

In April 1972, the final resolution approving a monorail trust was adopted by the County Commissioners with Clark County named beneficiary. Three county residents were named as trustees for the Clark County Transit Authority, a public trust under the 1971 act.

At about the same time, Mayor Oran Gragson of the city of Las Vegas and Don Saylor, Las Vegas director of Planning, sought federal funds for a transit study after a group of citizens and the privately operated bus company requested they do so. They complained to the City Commission "that the county should have a transportation study before it approved funding for the proposed monorail."[18] Thus began a parallel effort of public officials to provide a "comprehensive" plan for "balanced" transportation throughout the Las Vegas Valley, which continued during the entire period of the debate over the monorail. To the outside observer, this effort appears to have been used to help undermine the monorail proposal and to reduce the legitimacy of private entrepreneurs' operations in the public domain.

After the November 1972 Supreme Court ruling, however, Kavanaugh was free to proceed with his feasibility study and to develop a specific proposal regarding the type of system and who should build it. Kavanaugh pulled together his consortium of U.S. Steel, Hudgins-Thompson-Ball and Associates, and Investors Diversified Services to develop a complete feasibility study.

In January 1973, the Las Vegas City Commission expressed irritation at the method used to name the monorail trust. They felt the City should have more say in the matter, and they insisted that the consensus of both the City and County would be required before the monorail could be approved.[19] Two months later they would demand that the trust be enlarged to include two city representatives, but this was never done.[20]

Nonetheless, Mayor Gragson became one of the staunchest supporters of the monrail even while a fellow city commissioner expressed misgivings over the amount of money being spent on the project, which was essentially for tourists rather than providing an areawide system for everyone. The commissioner also raised the issue of what would happen to the system if the promoters went bankrupt in the middle of construction.[21]

At a public hearing on February 12, 1973, Kavanaugh announced the selection of the three finalists in the competition to construct the system. These were Pullman-Bendix of Chicago operating through a local subsidiary, Aerial Transit Systems of Nevada; Ling-Temco-Vought of Dallas; and Rohr Corporation of San Diego.

At this hearing, a number of people spoke favorably regarding the proposal including Buck Blaine, president of the Golden Nugget; Don Ashworth, secretary of the Downtown Casino Association; William Weinberger, president of Caesar's Palace; and Ralph Aiken, president of the Plaza Shopping Center[22]:

> The hotel owners and operators that I have talked to are solidly behind this transportation system.[23]

> How can anyone object to this? It isn't going to cost the taxpayers a cent. It will bring more people to the Strip, more people to the Downtown area, and benefit business for everyone.[24]

> This would be better for us than building two or three 2,000-room hotels. Every traffic engineer and politician in the country would have to come here to see and study the system.[25]

These strong statements of support would weaken over time as opponents of the system became more active. At the end, most of the hotel owners were vaguely neutral or slightly opposed to the system for reasons that will be discussed in the following section. In the meantime, the first major public hearing on the project was scheduled for April 19, 1973.

In March 1973, however, a major advertising campaign was launched by the Citizens for Effective Mass Transit (CEMT), which was a group sponsored by the Checker Cab Company. Eugene Maday, owner of Checker Cab said he would sink "unlimited" money into the campaign until proponents of the monorail answered the questions raised by CEMT.[26] These questions were primarily based on the financial facts and figures of the proponents of the monorail. The aesthetics of an overhead railroad were also attacked. This campaign broke immediately after the Consumers League of Nevada had described the monorail as a "potential disaster" in their *Nevada Consumer* newsletter.[27]

These were followed by an attack by a *Las Vegas Sun* columnist who repeated some of the same questions and attacks.[28] At the same time, the Las Vegas Transit System (private bus company) announced their opposition to the monorail, saying their Strip run was the only profitable run they had and that it helped to keep other failing routes in business.[29]

Dr. Samuel Ford was continuing his efforts to sidetrack the monorail by seeking passage of a "safeguards" bill through the Nevada State Legislature to protect the public from public trusts that could sell bonds for private developers. This bill failed because the Legislature was told that any additional legislation might hinder the plans for the Las Vegas monorail, since the trust was already operating under the 1971 law. Ford claimed that the county would have had to pay $5.5 million to Kavanaugh to "get off the hook," although there was never any evidence to show the basis for that figure.[30]

In early April, the Nevada Open Spaces Council held a workshop on transportation and invited public officials from all levels of government to discuss mass transit systems. It was here that John Hirten, assistant to the secretary of transportation, said that local government must begin planning for multimodal mass transit systems. He also said they would need a regional plan to get federal funding. He further attacked the financial feasibility of the proposed monorail which was being promoted as a profit-making system by saying: "The idea that mass transit should pay its own way out of the farebox must be eliminated if we are going to create effective mass transit systems."[31]

The Regional Planning Council of Clark County also entered the fray by applying to UMTA for a grant to study the mass transit problems of the Las Vegas Valley: "The monorail is considered one mode of transportation and not a mass transit system. . . . Hanzel said the monorail is not a viable mass transit system and certainly not comprehensive."[32]

It was in this atmosphere of questions and doubts that the public hearing of April 19, 1973, was held. County Commissioner Myron Leavitt (an opponent of the system, who, it was later revealed, owned 10 percent interest in a cab company operating on the Strip) had announced that U.S. Steel would present their complete report on all facets of the proposal and would also recommend the best system for Las Vegas.[33]

Actually what was presented was a status report on what had been done and what would be done to prepare a final feasibility report in December. Each manufacturer presented their own proposal and the representative from U.S. Steel spoke of the "ideal situation" in Las Vegas for the application of a new transit technology.[34]

Peat, Marwick and Mitchell reported that the system was financially feasible. Their representative claimed his organization had sold a billion dollars worth of revenue bonds in the preceding 5 years, and such bonds could be sold to finance the Las Vegas monorail. He said they projected a ridership of 22.7 million people by 1976 (mostly tourists) with revenues of $22.7 million (at $1.00 per ride). He further projected a 4 percent increase in subsequent years. A 7.5 percent interest rate on the bonds with a 40-year amortization was forecast. With amortization of debt plus operating and maintenance costs, the annual profit of the system was projected to be $8.4 million. Therefore he believed the project would be "highly financially feasible."[35]

After the proponents made their presentation, other speakers who were in favor of the project could speak. One of these was O'Farrell Estes, president of First Gray Line, owners of the City Transit System. Despite opposition expressed earlier to the system, at this meeting he supported the idea and noted that Pullman-Bendix had offered to buy the city bus system, which had been losing money for 4 years. There was considerable public support expressed for the system as it would bring needed jobs to the community, it could later be extended to other parts of the community, it would help the tourist industry, it would reduce congestion and pollution, and so forth.[36]

The opponents of the system objected that they had no chance to speak until after lunch, but at the urging of the Committee for Effective Mass Transit the floor was thrown open to all speakers. The objections they and others raised had to do with performance standards—did the county have them? There were also complaints that this was a tourist-oriented system only and would not serve the whole community.

They questioned the ridership figures, claiming they were impossible to achieve. Morton Galane, representing the Checker Cab Company, demanded that the system be turned down today if it was limited to serving tourists and not the whole community. He spoke of "creaming" the most lucrative customers while ignoring the needs of all the citizens.[37]

Questions were also raised regarding whether or not accepting this private proposal would jeopardize federal funding by allowing a private enterprise to offer a limited public service, whether or not adequate land-use planning had been done, whether adequate weight had been given to mass transit, whether the County was receiving the best engineering and technology possible, whether Las Vegas was being used as a test site for manufacturers seeking markets elsewhere.

There was also concern expressed over service to low-income people, the high price to ride the system, competitors such as Westinghouse who were excluded by Kavanaugh, how people would get from the elevated structures to the casinos without creating an architectural or structural mess, the lack of an in-depth study such as that required for federal aid to really analyze the need for the system, the lack of competitive bidding, the question of community liability in case of a default on the bonds, and where the money (assumed to be $5.5 million) spent by Kavanaugh had gone.[38]

Just about every issue that was ever to be raised by opponents of the system was raised at this meeting, primarily by the Checker Cab interests. Delores Neonis of the Committee for Effective Mass Transit claimed to have done a study in two days that established the economic infeasibility of the monorail by demonstrating there were not enough tourists in Las Vegas to generate the ridership projected by Peat, Marwick and Mitchell.[39]

The League of Women Voters called for a comprehensive balanced plan and said neither the monorail proposal nor its feasibility study answered that need. Another citizen said all questions raised should be answered before any construction began. Other citizens suggested other systems such as jitneys or minibuses, electric cars, a subway. Finally, Mark Kozlowski of the Nevada Open Spaces Council called for an independent study because of the means used to choose Kavanaugh and the lack of safeguards in the Nevada Public Trust Act. The key point was that first the planning should be done, then the hardware selected.[40]

By raising numerous doubts about the adequacy of the system and its financial feasibility, the opponents seemed to fare better in the public hearing than did Kavanaugh and his associates. Throughout the months that followed, these same questions would be raised by the same people plus some additional county officials such as the County bonding consultant and the County Counsel.

In June the Las Vegas City Commission approved a monorail feasibility study to be done for the city by Wilbur Smith and Associates of New Haven, Connecticut. This consultant had done an early highway study of Las Vegas in 1962 and was selected by A.J. Kavanaugh who would pay for the study even though the Smith organization was to work for the City.

As the time drew closer for the presentation of the "final" feasibility study, more criticisms were raised. Peat, Marwick and Mitchell was accused by the CEMT of unprofessional conduct and an investigation was called for.[41] A Las Vegas Sun columnist criticized the lack of a feasibility study.[42]

Stuart Eurman of UMTA spoke to representatives of the municipal governments of the Las Vegas Valley as well as county, state, and federal officials at an urban transportation planning seminar, and he warned them that the county should make no major commitments to the monorail until a mass transit study was completed sometime in 1974. "Since the monorail hasn't started, it would behoove you to wait for the planning to be done before beginning capital improvements. . . . You've got to insure that you're providing transportation for all the citizens and not just for the gambling tourist."[43] Regarding the claims of some that a monorail system in Las Vegas would be self-supporting, he said, "I have yet to see a transit system pay."[44]

In October, a unified work program for a Comprehensive Transportation Planning Study for Clark County was approved by the U.S. Department of Transportation, and reports of rising costs and technical problems with the BART system in San Francisco received prominent attention in the news.[45]

Since Rohr was one of the contractors on the BART system, this became even more significant when Kavanaugh announced early in November that Rohr had been selected to build the monorail in Las Vegas. Kavanaugh said he chose the system because of its lower initial costs, the "continuing and substantial economic advantages of their 30-year operations and maintenance contract," and the fact that the system required less air and ground space.[46]

He also said that bankers had advised him it would be more prudent to finance and build the Strip segment of the system first, get it into operation and proven, and then finance the two ends to the Airport and Downtown out of net cash flow without selling additional bonds. Kavanaugh further claimed to have a large amount of money pledged at that time and could finance the system completely by January if the required approvals from the government entities were made.[47]

The feasibility study was only six pages long and included a report from Wilbur Smith and Associates, which estimated that a Strip-only system would carry 45,900 persons daily in 1978 and 78,500 persons per day by 1990. These figures were based on a series of assumptions that were later called into question.

1. a 1978 opening date for the Mark Anthony Hotel
2. an average station waiting time for passengers of 1.5 minutes
3. continued free parking at Strip hotels
4. a flat fare of $1 for all patrons regardless of the distance traveled
5. a direct luggage service from the airport to all monorail stations
6. location of all stations in the hotel or casino they serve
7. an opening date of January 1, 1978, for the monorail system[48]

The cost of the system seemed to confuse the reporters who covered the announcement. The *Los Angeles Times* referred to a $100 million system; the

Las Vegas Review-Journal headlined a \$101 million system; and the *Las Vegas Sun* indicated a cost of \$120 million.[49] These discrepancies apparently were due to the breakdown of costs and what was included or excluded from the totals.

The cost of constructing the Strip segment was placed at \$77,200,814. In addition there was an \$8 million contingency fund, \$2 million to purchase the city bus company, and \$2 million to finance the public trust. Nearly \$25 million would have been required to build the airport and downtown segments, so with the rounding of figures, a number close to \$120 million could be reached. This confusion of the actual costs proved to be a significant factor in the ultimate defeat of the proposal.

A hearing on the technical and economic feasibility of the project was scheduled for December 17, 1973. Prior to the hearing, the Las Vegas Sun ran a series of articles that examined the monorail project, which was finally being referred to as PRT, and came out essentially in favor of the project. They even noted that the Rohr system had "the stamp of approval of the U.S. Department of Transportation."[50] This apparently referred to the demonstration of the Rohr system at Transpo '72.

The opponents of the system were active, however, and the Consumers League of Nevada (CLN) blasted the system "as the sacred cow of a few 'fat cats,' who do not care about the community as a whole." The financial feasibility of the project was questioned in light of the deficits plaguing most U.S. transit systems, and it was suggested that the credit of Clark County would be hurt if the system failed.[51]

The opponents also received help from the losing competitor for the construction contract, Aerial Transit Systems of Nevada. Burrell Cohen, president of Aerial Transit, claimed his system would be cheaper to build—\$30 million cheaper—and that if Aerial Transit were selected, all the costs that were being paid to Kavanaugh, U.S. Steel, and the architects could be saved.[52]

UMTA also entered the picture with a letter from Jerome Premo, acting associate administrator of the Office of Capital Grants, who suggested the project should be delayed until the UMTA funded transportation study by the Regional Planning Council was completed.[53] On the other hand, Thomas E. Smith, vice-president of Rohr Industries, stressed that delays could increase the costs of the system due to rising costs of materials and energy.[54]

Then 2 days before the public hearing the Clark County administrator, David Henry, reported to County Commissioners that the feasibility study presented by Kavanaugh in November did not contain enough information to warrant their approval of the project. Similar recommendations from the president of the Greater Las Vegas Chamber of Commerce (which supported the system in principle) and the county financial advisor were attached to the County administrator's report.[55]

The main problems were financial and legal ambiguities, particularly "unverified cost estimates," and no data for evaluation of certain costs reimbursable to Kavanaugh. There was also concern over "current economic trends," especially the rapidly developing energy crisis, and some difficulties over the right-of-way. Portions of the contract between Kavanaugh and the trust were criticized as being "unclear, imprecise, and could prove deleterious to the operation of the 'monorail proposal' itself."[56]

Guild Grey, the county financial advisor, estimated that $127 million would have to be borrowed to finance the Strip portion, and that $167 million would be needed to build the whole system at once. He claimed the project was only "marginally feasible," and that more information was needed regarding ridership figures, which he suggested should be generated by a disinterested engineering company.[57]

Even an advertising campaign run by the proponents of the system, extolling its virtues, may have backfired, as a *Sun* columnist claimed they were misleading.[58] Certainly some observers who tended to favor the project felt the advertising showed poor judgment and may have been counterproductive.

At the hearing, proponents once again presented their case and tried to show the potential benefits for the entire Las Vegas Valley should the system be built. The opponents of the system, particularly Morton Galane of Checker Cab and Delores Neonis of CEMT, were most effective in raising issues of financial feasibility, financial responsibility, and the question of who would tear the system down should it fail.[59]

Perhaps most devastating was a New York bonding consultant, Donald Kummersfeld of First Boston Corporation, who did the financial analysis for Aerial Transit. He noted that the City and County would have their names on the bonds that were issued by the public trust, and even though they were not legally liable for worth of the bonds, they might find it necessary to pay off investors should the project fail. The State of New Jersey had issued similar bonds for a sports complex that failed, and they decided to pay them off because they did not want bonds with their name on them lying around investors' portfolios reminding them of a default.

Kummersfeld also said that he believed $115-120 million in bonds would have to be sold to finance a $90 million project (just the amount Aerial Transit said they would need to build the project). He added that he had serious doubts that if there were any significant cost escalations that the bonds could be sold.[60] (Later he would increase the estimate of the amount of bonds that could be sold to $140 million as the costs of the Aerial Transit system escalated.)[61]

Kummersfeld further stated (inaccurately, but his statement was unchallenged) that Denver had rejected an overhead system because it would use more energy than other systems. With fuel costs going up, he said these should be reflected in all projections of costs. Another increase in costs became apparent as the cost of debt service for $120 million in bonds was projected to take the total cost to $173 million.[62]

Throughout the hearing, questions kept recurring regarding the financial feasibility of the project and who would pay for what, who was or was not committed to buy bonds, who would be responsible for the debt if the system failed, and who would tear the system down in such a circumstance. The responses of Kavanaugh to these questions were not reassuring. He seemed to hedge on the question of who would tear the system down if it failed. Smith of Rohr Corporation replied that his company would still be obligated to a 30-year contract to operate and manage the system, and he could not understand why anyone would want to tear it down under those circumstances.[63] Nonetheless the question persisted.

There were also seeming contradictions regarding who was going to buy the bonds. Kavanaugh implied that U.S. Steel was committed to buy $25 million of the bonds, but later Bruce Glidden, representing U.S. Steel, said his company would consider buying the bonds when the final feasibility study was ready.[64] Of course all questions of financial feasibility centered around the projected ridership, and Kavanaugh was hurt by the absence of a final report from Wilbur Smith and Associates, who could not produce a final estimate of ridership until the federal government announced a policy on private gasoline usage (such a policy was never forthcoming as the 1973-1974 energy shortage abated).

Even without this, Kavanaugh wanted tentative approval of the Rohr system to enable him to negotiate with bankers, investors, hotels, and so forth. This was vehemently attacked by Morton Galane of Checker Cab as a violation of the 1971 agreement that had initiated the process. Galane also listed numerous failings of the existing feasibility study and demanded all the answers before approval was given.

Burrell Cohen of Aerial Transit suggested that Kavanaugh had acted improperly in rejecting their proposal and that he had further misrepresented the actual costs of the Aerial Transit system. He suggested reimbursing Kavanaugh for his work in generating the program and then removing him from the project. This, he suggested, would save unnecessary costs generated by a third party and allow the trustees to negotiate directly with the manufacturers to get the best system.[65]

Another manufacturer, Unitran of Torrance, California, had a representative who suggested that an overall study was needed because they could move more people cheaper than anybody who was considered by Kavanaugh.[66]

Kavanaugh did note that U.S. Steel had looked at fifteen different systems before eliminating most of them in favor of the three finalists. He also noted that the Aerial Transit proposal was rejected because they would not guarantee the system for more than 10 years, whereas Rohr guaranteed it for 30 years. Cohen countered that they would guarantee it for 10 years, but claimed it was not the responsibility of the suppliers to guarantee the system, that was the responsibility of the operators.[67]

A few days later, the County Commissioners agreed that a complete feasibility study would be required before they would approve the system. The contract with Kavanaugh was due to expire April 24, 1974, and at least one commissioner who opposed the system said he would not vote yes on any system before that time. The idea of getting Kavanaugh out of the picture was beginning to take hold.[68]

In January, Rohr Corporation also began to take a stand independent of Kavanaugh and suggested they had a less expensive financing plan. They would not reveal the details at that time, but they indicated that if the County were unhappy with Kavanaugh, they were free to negotiate individually with monorail contractors without going through Kavanaugh.[69]

The debate raged throughout the winter as a Citizen's Advisory Committee working with the federally funded study of transportation suggested that a mass transit system emphasizing home-to-work trips should be the backbone of any transit plan in Las Vegas. Aerial Transit distributed a survey that purported to show the tourists in Las Vegas preferred the Aerial Transit system to the Rohr system by a 5-to-1 margin.[70]

In February, the City Commission held an unannounced meeting (which was discovered by the press and labeled "secret") where they decided they would like to build the monorail but without Kavanaugh.[71] A few days later, Rohr suggested that private funding without revenue bonds and public ownership of the system would be possible if Rohr received the contract.[72]

Finally, early in April, Kavanaugh submitted his final proposal for the monorail. The cost of the total system from the airport to downtown was estimated to be $134 million. Wilbur Smith and Associates said they still could not make a final feasibility report without a federal gasoline policy, but Kavanaugh had obtained the services of Simpson & Curtain, transportation engineers of Philadelphia, who said the energy crisis would have little effect on the monorail unless it became much more serious. They noted that more people were arriving in Las Vegas by air rather than driving during the energy shortage and suggested this would help the monorail.[73]

Kavanaugh also said that he would be willing to take payment of $1.2 to $1.8 million to cover his expenses if the City or County wished to remove him from their plans. (The difference was due to contracts that specified expenses due to various contractors if they did not receive the construction contract.) In doing this he was giving up his claims to one-half the profits of the system, which Simpson & Curtain estimated to be $191 million over 30 years, $8.7 million per year by 1990.[74]

In early May, the County Commission endorsed the concept of the monorail and authorized the formation of a monorail committee, which was to compile all the data collected and make a recommendation to the City and County as to what their alternatives were and what should be done. This committee agreed to hear Unitran as a third entrant in the competition (although this firm was soon after rejected). This committee was to determine the economic and technical feasibility of the proposed systems. They dissolved as a group in July without making any recommendations.

In August, opponents of the monorail on the County Commission suggested another study to be done by consultants hired by the County, but this proved to be too costly in light of all the work that had already been done. The executive director of the Regional Planning Council endorsed the Rohr system 1 week before leaving his post, and the Las Vegas Sun supported it editorially, especially because of Rohr's plan for entirely private financing.[75]

The opponents still kept up a steady commentary of protests using the costs of BART and Morgantown and the pending lawsuit involving LTV and Dallas Airport as examples. The CEMT brought in Raymond Dirks, author of "The Great Wall Street Scandal," which exposed the chicanery of Equity Funding of Los Angeles: "He said it will never work as proposed." He claimed the bonds could not sell without the full faith and credit of the City and County, and the small tax base of the City made Las Vegas a shaky place for good investment.[76]

Then on September 5, 1974, the County Commission voted 3 to 1 to abandon the project. It was declared to be "technically and economically unfeasible," since any other finding would have obligated the County to pay Kavanaugh for his expenses.[77] The official reasons given for the decision to reject were the indifference of the business community and the reluctance of citizens and the resort hotel industry to support the system.[78]

Two of the votes against the system came from longtime opponents, Bob Broadbent who represented the County's outlying areas, and Jack Petitti who represented North Las Vegas—both areas with little interest in the system. Tom Weisner, who was a consistent monorail supporter, cast the only dissenting vote. Myron Leavitt, another opponent, abstained from the voting due to his conflict of interest, and Aaron Williams left the meeting before the vote was taken. James "Sailor" Ryan, who had signed the original contract with Kavanaugh, had not attended a Commission meeting since May because of his conviction on bribery charges in another matter.

Efforts continued in the City to develop the system as a city project with Rohr Corporation, but that involved complex problems of rights-of-way in the County, which required state highway department approval as well as approval of the FHWA. The final snag, however, was over how Kavanaugh was to be paid off if the City used his plans before December 31, 1976. Rohr offered to pay him \$250,000 immediately, a second \$250,000 when financing of the system was arranged, with the final payment due when the system was operational. This was agreeable to Kavanaugh, but he would not sign a release for the City until he had his money, and the City would not sign a contract with Rohr until they had such a release.[79]

Seemingly at an impasse, some of the debate continued, but inflation coupled with losses on other major transit contracts caused Rohr to diminish its transit operations, while skyrocketing interest rates made it much more difficult to sell bonds. Thus interest in the project waned. With the passage of the Federal Mass Transit Act in November 1974, Las Vegas recognized the need for a comprehensive plan to qualify for some of the federal money. There was also some urgency expressed that their request get in early because the bus company was facing a $150,000 deficit and their service was inadequate.[80]

Issues

The main tactic of the opposition was to put forward as many questions as possible to raise doubts about the project. Ultimately it was the issue of financial feasibility and responsibility that appears to have been most important. Kavanaugh did not help himself in this matter when he would claim at one time there was enough money within his own consortium to finance the project,[81] and at another time speak of selling the bonds to the investing public.[82]

The issue regarding the cost to tear the system down if it failed was probably a red herring thrown up by the opposition, since the selected contractor agreed to operate and manage the system for 30 years, but Kavanaugh's handling of the issue in public meetings made the opponents appear more credible than the facts warranted.

Much of his trouble began, however, with the Public Trust Act itself. One issue was that of safeguards for the public, which opponents said were inadequate. Despite required approvals of the local governments, the Nevada Public Service Commission, and the State Board of Finance, the lack of provisions for competitive bidding for contracts, the lack of public oversight of the trust, and the lack of a requirement for the trust to open its meetings to the public were all cited as potential hazards.

The hasty manner in which the public trust was formed by Clark County and their signing of a contract with Kavanaugh and Custom Cabs aroused further suspicions, even among those who favored the project.[83] The self-serving nature of Olsen's promotion of the law—and then becoming its first beneficiary smacked of old-time political corruption.

This hint of chicanery never really left the project as Kavanaugh was dubbed an "eastern promoter" by the opposition, and his potential profits became a subject for public debate. The bribery conviction of Commissioner Ryan added to the problems faced by the promoters. The author did not investigate the question of corruption deeply as it was peripheral to the issues of this study. More significant, in light of the issues raised in this study, was the promoters' idea they could make a lot of money with a public transit system. Nonetheless, it is worth noting that the press in Las Vegas did not report any actual illegality or corruption in the project, even though there were dark hints of such from the opposition.

In checking on Kavanaugh, the *Las Vegas Sun* reported he had a good record in Oklahoma, where he had devised the Public Trust financing procedure 20 years earlier. At that time, Route 66 was just about the only paved highway in the state. Kavanaugh suggested replacing it with the Oklahoma Turnpike, financed with tax-free revenue bonds to be retired with toll revenues from the turnpike. The resulting financial success of the Oklahoma Turnpike enabled the state to improve and pave many other roads from the tolls—a substantial portion of which were paid by tourists.[84]

Kavanaugh had enjoyed similar success with a water pipeline project and the FAA center in Oklahoma City, but he was still called a "flim-flam man" with a "fly-by-night operation." Manufacturers who were not selected by Kavanaugh also questioned his capacity and his honesty, but his ultimate downfall seemed to come when it became clear he stood to make over $100 million over the 30 years of the project. At least one report indicated that the County Commissioners did not want to split that amount of money with a private entrepreneur; therefore Kavanaugh had to go.[85] The fact that the Rohr system was still the choice of the City after the departure of Kavanaugh gives credence to the report.

The question of community service as opposed to tourist service may have been a false issue. Homer Chandler, executive director of the Regional Planning Council, said the monorail and the bus system were compatible with each other.[86] The final feasibility study earmarked $50 million from the $191 million projected profits over 30 years for support of the bus system.[87]

In public hearings, however, Kavanaugh had hedged on the rate structure and the number of routes that would be maintained in the bus system. This was coupled with a lack of assurance that there would be reduced fares for senior citizens, the handicapped, and children. The public was certainly led to believe that their entire transit system might be endangered by the monorail.

The cost of riding the monorail was also cited as a problem for local residents. One dollar per person per ride was considered excessive. When it was later suggested that the cost per ride might vary up to $2.50 depending on distance traveled, more community opposition was aroused. It was widely resented that this would be a system essentially for tourists even though that was what the original Las Vegas Valley Transportation Study had called for and even though it was claimed that three out of four people in the area were employed by the tourist industry.

The faint support of the more prosperous hotel owners along the Strip may have been due to their concern that patrons at their hotels could easily go elsewhere with their business. The strong criticism of the project voiced by Fred Benninger, chairman of the board of the highly successful MGM Grand Hotel, was attributed to this motive.[88] Combining a myriad of attractions in one place, plus a large number of rooms, the Grand may have thought it better to keep their own customers.

Certainly the support for the system voiced by the Downtown Casino Operators Association indicates that they believed the system would bring more business into the downtown area, presumably from Strip hotels. There may also have been some concern over insurance liability for the system if stations were located within hotels. For a number of reasons, most hotel owners took a wait-and-see position.

There were also flurries of debate over the question of eminent domain with one columnist warning that people might lose their homes or businesses if the monorail were built.[89] The aesthetics of the system were also mentioned when the opponents described it as an overhead railroad that would reduce property values. Later at a public hearing, a Nevada Test Site Engineer claimed the Rohr system would be outdated and unsightly in a matter of years. The effects or lack of them on air pollution, energy usage, and congestion were also debated.

Ultimately, however, the question of financial feasibility became dominant. The varying and rising costs that were put forward for building and operating the system certainly contributed to a lack of confidence in the promoters. These estimates began at $80 million and ended at $173 million. Not all the same items were included in the varying cost totals, which added to the confusion.

The issue of who would pay to tear the system down if it failed, whether valid or not, also entered into the discussion and seems to have been a significant concern of the public officials and citizens of Las Vegas. Certainly the issue of whose credit was at stake should there be a default on the bonds concerned many.

The financial feasibility and the probabilities for success, however, ultimately rested on the question of ridership. This in turn led to the battle of the experts (consultants) regarding the number of trips taken along the Strip, the number of tourists, and how long they stayed in Las Vegas, the numbers of tourists coming to Las Vegas by car (opponents said these people would not use the monorail) and the numbers coming by airplane.

Each side produced their own studies with the preponderance of professional studies done by the proponents. Peak; Marwick and Mitchell, Wilbur Smith and Associates, and Simpson & Curtin Transportation Engineers all estimated ridership that indicated success for the system. The Citizens for Effective Mass Transit put together their own studies, one for $67.50, which indicated the opposite.

Certainly the state of the art in projecting transit usage is primitive at best, and it was difficult to determine which side was correct, despite the weight of professional expertise on the side of the proponents. The Las Vegas Chamber of Commerce reported that 11 million tourists visit Las Vegas per year, and Peat, Marwick and Mitchell estimated that each tourist makes about ten trips during their stay. That gives a total of 110,000,000 passenger trips per year of which 21 percent were estimated to use the monorail.

Later, Guild Gray, the County financial advisor, who was at least cautious if not in opposition to the project, said that hotel records indicated that 13.5 million persons had stayed in Las Vegas from July 1972 through June 1973.[90] In its series to present "both sides of the monorail story," the *Las Vegas Sun* noted that the 10-year old Las Vegas Transportation Study, which had served as the planning guide for the community highway system, had surveyed 51 million trips per year on the Strip. They suggested that this indicated there were enough people to make the system viable and further noted that similar systems in Disneyland and Disneyworld that go nowhere were ridden by millions of tourists annually.[91]

This dispute over numbers led to the repeated calls for more studies, more "objective" analysis, until the rising cost to do more studies and their obvious futility put a stop to the debate. The outcome of such studies depends on the assumptions that are made regarding the limited data that are available.

Certainly the projections of ridership on conventional transit systems indicate how wide the margin of error can be and how poor professional as well as amateur studies can be. With a new system such as PRT, the guesstimates become even more problematical, although its attractive service characteristics might enhance its ridership. Once private financing was agreed to, however, the probabilities of success would have been calculated by the investors. If they had felt the ridership potential was adequate to show a profit, enough money could have been raised to build the system.

One comes away from the Las Vegas experience with the impression that a great many people, both proponents and opponents, thought the venture could succeed. This made it all the more important to prove it would not be successful, since its success would surely have hurt the business interests of the primary opponents. For the elected public officials, there seemed to be a concern that a private entrepreneur stood to make a killing from the project, and they preferred to deal with a manufacturer that would make its profits from the construction of the system, leaving the operating profits to the city and county.

For other public officials in the Regional Planning Council and in the U.S. Department of Transportation, especially UMTA, there seemed to be a concern that private interests were invading their domains. These were the people who continually voiced the concern that development of the monorail might prevent the Las Vegas Valley from receiving federal funds and developing a comprehensive balanced transportation system.

In any major new project, there are many uncertainties, and there are also likely to be powerful opponents who are well served by the status quo and can play on the uncertainties to defeat a significant technological innovation when it must be approved by governments. If the opponents had not succeeded at the county and city levels in Las Vegas, they would have had additional opportunities to defeat it when approvals were sought from the Nevada Public Service Commission and the State Board of Finance.

Las Vegas presented a relatively simple situation in terms of the numbers of governmental organizations that had to approve the new system, but even there, jurisdictions that were not served or agencies that felt the new proposal was in competition or incompatible with their own domains could join forces with the opposition to block the proposal.

When it gets to the point of implementing a new system, who gets what seems to be the key question. Who gets the service; who gets the profits; who gets the contracts; who will control the project; who will pay for the project; who will lose money, power, or status—all these and more were the real issues. In this situation, PRT was a restructuring innovation—one that threatened to shift power and economic rewards.

All the concern for data, for more studies, for a comprehensive areawide study that would begin with the goals and objectives of the entire community and then consider alternatives, all these were "politics by other means"—tactics designed to delay, to confuse, to create uncertainty rather than to illuminate the issues. Certainly there were real issues that arouse suspicion about financial chicanery. The Public Trust Law, the secrecy, and the way the contract was let to Kavanaugh, the relationship of Olsen and Kavanaugh and perhaps other public officials are all questionable. It is important to note, however, that when these people were forced out of the project and private funding was proposed, the opposition did not disappear.

Other legitimate questions could have been raised regarding the size of the profits projected to go to the entrepreneurs at the expense of the transit rider. Proponents of PRT systems elsewhere suggest that an adequate profit could have been attained at much lower user costs. Still, this was a totally new and unproven system, which, as such, involved a high level of risk to the investors, therefore assuring a high level of profit may have been necessary.

Although the investors stood to make a great deal of money if the system were successful, they were also promising to build a viable, profit-making transit system at no cost to the taxpayers, which would, in addition, make a great deal of money for the County. In one sense, the proposal sounded too good to be true, and in another sense, if it were true, it was resented that private businessmen would make so much money supplying a public service.

There were also legitimate questions regarding the readiness of the Rohr system for urban deployment, but these were scarcely touched on. Nor were serious questions raised regarding the number of vehicles proposed for the system (far too few for a real PRT system) and the costs of those vehicles, which seems to have been quite high.

No one examined the possibility of using the profits from the system to expand it into other areas of the community, and there was no evidence that Rohr was asked for even a tentative price for expansion. The financial advantages of a PRT system may depend on mass production runs. If Rohr could not sell any more systems, or if better systems were developed elsewhere, Las Vegas might have been stuck with an "orphan"—a system that could not be expanded due to excessive costs because it was one of a kind, or whose manufacturer left the field because of competition from more attractive systems.

There are clearly risks to any community that installs a new and different transportation system.[92] These risks were not so much contemplated as they were hurled as opposing barbs to defeat a proposal, not on its merits but because it threatened powerful vested interests.

11 Los Angeles

In Los Angeles, the issue of personal rapid transit (PRT) has not become a public issue in the sense that it has been widely reported in the newspapers or became generally known to the citizenry. It is safe to say that the vast majority of people in Los Angeles have never heard of PRT and are unaware that at least one PRT system (the Aerospace Corporation design) was developed with their city in mind.

To understand what has occurred in Los Angeles regarding PRT, it is useful to know something of the development of transportation in the area and also something of the byzantine organizational and jurisdictional domains that have impact on the transportation planning process.

One can begin a description of the area with Los Angeles County, which covers an area of 2,600 square miles with a population of 7 million. Within it are eighty cities as well as a large amount of urbanized unincorporated territory. The largest of the independent cities is the City of Los Angeles with a population of roughly 3 million. Long Beach is next with over 350,000 people.

The Southern California Rapid Transit District (SCRTD) provides bus service to much of the urbanized area of Los Angeles County and parts of Riverside and San Bernardino County. In 1976 it served 185 cities and communities.[1] Its board is made up of eleven appointed officials—one designated by each Los Angeles County supervisor for a total of five, two by the mayor of the City of Los Angeles, and four by a city selection committee made up of representatives of the municipalities that are a part of the district.

The SCRTD board has had a variety of members, but they are a part-time body whose members have a number of primary responsibilities other than directing the SCRTD. Therefore the general manager and staff of the organization actually run the district. When one speaks of the SCRTD, one usually refers to the staff portion, even though the staff can only operate with the acquiescence of the board.

Figure 11-1 indicates in a simplistic fashion some of the key relationships the SCRTD has with its environment when doing transportation planning.[2] At the city level, the Technical Advisory Committee, known as the Ad Hoc Technical Advisory Committee on Rapid Transit, includes members from the city departments of Traffic, Planning, and Public Utilities and Transportation. Members of the county Road Department and county Regional Planning Department act as technical advisors to the board of supervisors.

All these people plus staff members from interested county supervisors, city

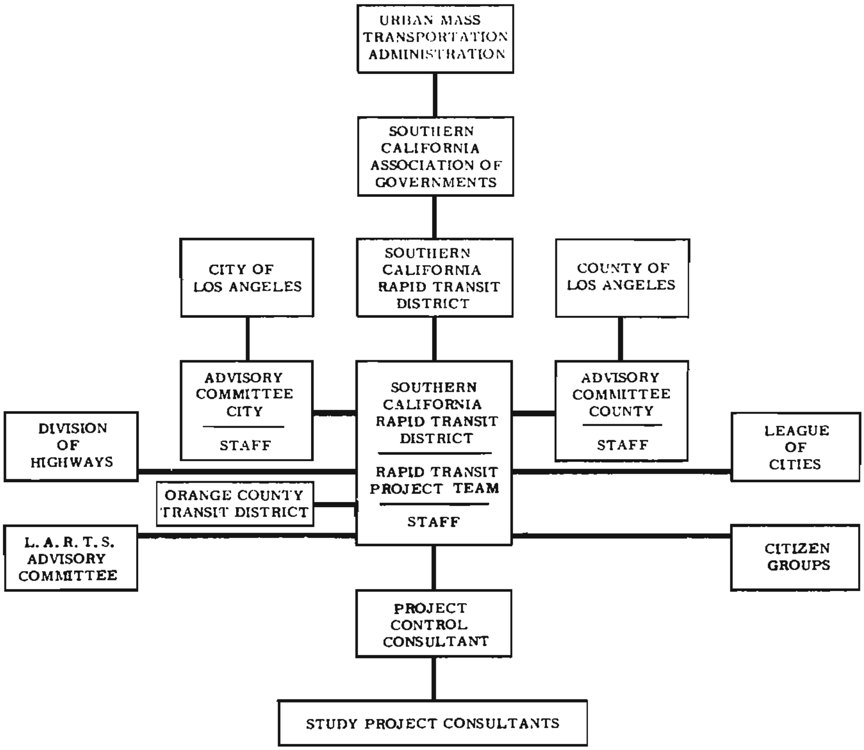


Figure 11-1. SCRTD Organizational Network.

councilmen, and the mayor's office meet as the Technical Advisory Committee to the SCRTD. In addition there are often staff representatives from the Orange County Transit District, Caltrans (California State Department of Transportation), other cities, and SCAG (Southern California Association of Governments). (After the defeat of the SCRTD proposal in 1974, essentially the same people were reconstituted as the Rapid Transit Advisory Committee (RTAC) to the SCRTD.)

Although SCAG as the main regional planning agency theoretically has power to control the SCRTD through its control of the allocation of federal and state funds, the decision-making officials of SCAG are all elected officials of the counties and cities that are part of the SCAG area (six southern California counties). The professional staff of SCAG operates continuously, but they can only make recommendations to the elected officials. These officials control what actually happens, and, when push comes to shove, the city and county of Los Angeles largely get what they want. Even though the SCAG staff lacks the power to enforce its ideas, it does act as the conscience of the community—raising issues of broad concern and questioning dubious work done by others. Although rarely appreciated, the SCAG staff planners make a highly positive contribution to the transportation planning process in southern California.[3]

Nonetheless, the bulk of the local money that supports the SCRTD comes from the city and county of Los Angeles; these two entities dominate any transit planning efforts. Because of his visibility, the mayor of Los Angeles is a key figure. At the state level, the legislature (or its transportation committees) is an influential factor, since it supplies the state money. The legislators get much of their advice from Caltrans, which is also involved in local transit planning. The passage of a state constitutional amendment allowing some gas tax revenues to be spent for transit also brings the State Transportation Board and the State Highway Commission (combined into the State Transportation Commission in 1978) into the picture, because each must approve the spending of such revenues whether for highways or transit.

Beyond all these official entities, there are other organizations that get involved in the transportation planning process. These include the California League of Cities, subregional groups from the South Bay area, San Gabriel Valley, San Fernando Valley, Marina del Rey, and so forth. The Los Angeles Chamber of Commerce along with an overlapping organization, the Committee for Central City Planning, Inc. (once the Downtown Businessman's Association, and as of 1976, the Corporation for Central City Development) have both been long-time supporters of a rapid rail system, as has the League of Women Voters.[4]

The Automobile Club of Southern California has opposed transit systems that took money from the Highway Trust fund but supported the 1974 train proposal. There are also the *Los Angeles Times,* the dominant news medium in the area, plus other radio and television stations, the Sierra Club, and a multitude of citizens' committees that are concerned with rapid transit. Finally there are the unions and the private corporations that manufacture transit equipment or do heavy construction. They are most anxious to get something started to promote economic development and jobs in construction.

At one time the author listed more than fifty organizations that had some concern with public transit, but their number is constantly in flux as old groups retire in exhaustion or frustration and new groups are formed. This identification of some of the key actors illustrates, however, the difficulty any proposal must encounter in obtaining the multiple approvals and concurrences required for action. This leads to a reluctance to change any decision once it is made, and it also leads to decisions that people have private reservations about but make anyway in the interests of "getting something started."

Despite all these groups and organizations concerned with the problems of public transit, Los Angeles is still known today as the city of the automobile—the birthplace of urban sprawl. Frequently these two facts are connected to imply that the automobile is the cause, or at least the facilitating agent, that resulted in the urban sprawl.

A convincing case can be made, however, that the existence of the Pacific Electric Railway Company (PE) with its extensive suburban and interurban electric railway system was the instrument of the initial widespread development of the area.[5] The expansion of Pacific Electric and the smaller gauge Los Angeles Railway Company was promoted by real estate interests who gained their profits from land development, not from the operation of the rail systems.

With the development of the automobile and the bus, areas between the rail lines and their stations become increasingly usable and attractive. Even with more than 1,000 miles of electric rail lines, the PE found it impossible to compete with its more flexible competitors. All the problems of rail systems noted in chapter 3 beset these systems, and, despite a revival during World War II, they could no longer continue with reduced passenger usage and increasing costs.

Although there is still considerable nostaliga for the "big red cars," the fact remains that when people could afford an automobile they preferred it. Even the most extensive train system could not take them from their many points of origin to their many destinations. There are widely believed conspiracy theories regarding the demise of the electric rail system, but the evidence from Los Angeles and around the world indicates that the rail systems were simply not viable as the city expanded into the areas between the rail lines.

Lack of performance, however, does not deter public institutions from redoubling their efforts to continue the failing institution. In 1951 the state legislature created the Los Angeles Metropolitan Transit Authority (MTA) to consider the construction of a monorail line from the San Fernando Valley to downtown Los Angeles. They concluded that the project could not be financed through revenue bonds as proposed and that a single public agency with broad powers was needed to assure continued service from existing private bus systems and to develop rapid transit.[6]

In 1957 the MTA was given the power to acquire and consolidate the existing public transit systems (take them out of private ownership) and to design and construct a rapid transit system, again employing revenue bond financing. These powers were exercised in 1958, and a rapid transit planning study was begun. It soon became apparent that such a rapid transit system could not be built with the MTA's limited financing powers, so in 1964 the legislature created the Southern California Rapid Transit District (SCRTD) with the power to go to the electorate with a rapid transit financing plan to fund bonds based on a property tax levy or by a general sales tax not to exceed 0.5 percent.

A major study of the transit needs of the area was done, which culminated in the submission of a proposed 89-mile, five-corridor rapid transit system to be funded by $2.5 billion bond issue based on a 0.5 percent sales tax increase.[7] Needing a 60 percent favorable vote to pass, the measure received only 45 percent and failed.

Proponents of the transit proposal raised $458,000 in 10 weeks for the campaign to pass the proposition. Only 22 percent of this money came from sources without an obvious direct financial interest in the outcome of the vote. Forty-two percent came from firms having interests in close proximity to proposed stations, and 36 percent came from those who would have a direct interest in the construction of the system.[8]

Seventy-eight percent of those voting against the measure reported in a subsequent survey that an important reason for their opposition was that "it would serve the few at a cost to everyone."[9] There was a correlation between distance from the lines and opposition to the proposal. Thus there seems to have been some understanding on the part of the public that the service characteristics of such a rail system were inadequate for the needs of the Los Angeles area.

This was not the understanding of the transit planners and their supporters, however. In 1971 the Transportation Development Act was passed by the State Legislature placing a sales tax on gasoline to raise money for rapid transit and public transportation. Its author, James R. Mills, said the intent of this legislation was to raise money for systems such as BART, not to fund the expansion and operation of bus systems.[10] The passage of this bill once again stimulated interest in rapid transit, and the SCRTD applied for a technical studies grant from UMTA to fund a planning study for rapid transit. As part of the agreement for this grant, the SCRTD agreed to "look at all transportation alternatives for corridors within Los Angeles County."[11]

Thus in October 1972, a consortium of five consulting firms began another study to come up with a transit plan for Los Angeles. This was to be the twenty-second major study of Los Angeles transit conducted since 1925, to say nothing of the countless minor studies done during that same period. Three of these consultants—Kaiser Engineers; Daniel, Mann, Johnson & Mendenhall (DMJM); and Stone and Youngberg had worked on the 1968 proposal. DMJM as well as Wallace, McHarg, Roberts and Todd, and Alan M. Voorhees and Associates, Inc. also were working for the Committee for Central City Planning, Inc.—a group of major downtown business interests who were pushing for a major urban renewal program and a "grade-separated 'express' transit system" to accommodate downtown development.[12]

After concluding in the Central City study that a train rapid transit system would be required for major downtown development, these same consultants were hired by the SCRTD to determine if such a system were needed in Los Angeles, and if so, where the lines should go. Not surprisingly they recommended a train rapid transit system with five separate lines going to the central business district (CBD), where only 6.6 percent of the employment in Los Angeles County was located.[13]

Some have suggested this was a conflict of interest on the part of the consultants or at least poor judgment on the part of the SCRTD. It seems clear, however, that the SCRTD fully intended to propose a rapid rail system patterned after BART in San Francisco. They even brought in George McDonald from BART to be director of planning and marketing and use his promotional skills to develop a salable plan. Nonetheless, the SCRTD and their consultants were required by UMTA to look at alternative transit systems, and in their *Phase I Progress Report*, 123 different systems are listed as having received at least cursory examination.[14] Of these, forty-four were selected for more extensive analysis. One of these was the Aerospace Corporation PRT system.

At the time (late 1972), the idea of PRT was still blurry because of the ongoing developments at Morgantown and Transpo '72, but in Los Angeles the people from Aerospace Corporation had spoken at some public meetings, and their idea appealed to at least one Los Angeles city councilman and to some high-level staff members of SCAG. These people pushed for more study of PRT, and this system was studied as one of three generic categories of transportation as reported in December 1972.[15]

This report and the subsequent *Phase I Progress Report* show how assumptions, both stated and unstated, as well as judgments are used to manipulate data to achieve the desired outcome. What purports to be expert analysis of hard data appears on examination to be exceedingly short on both data and analysis and rather long on assumptions and "judgment."[16] An analysis of this process shows vividly the interconnection of political and technical issues. It also demonstrates the difficulties of a new technology that is restructuring to some important interests and revolutionary to others.

One can begin with the assumption of the consultants that one of their first orders of business was to define transit corridors.[17] By assuming a corridor configuration, any analysis of a system that functions as a network was bound to be handicapped:

> In the Wilshire corridor, estimates of probable patronage indicated that substantial passenger carrying capacity would have to be provided. The apparent required capacity was greater than that which could be provided by *single lines* of either bus-on-busway or PRT; as a result, it was *judged* that the capital cost of providing the required capacity would be least for MRT (Mass Rapid Transit).[18] (emphasis mine)

There were several problems with this statement. First of all, the population projections on which the corridor analysis was based were from a 1967 study done by LARTS (the Los Angeles Regional Transportation Study). By 1973 the population projections had dropped dramatically, and instead of a projected 1990 population of 8.6 million, the estimates were reduced to 7.7 million. A later refinement of the data would reduce the original patronage projection of the Wilshire Corridor from 40,000 per hour to 17,900 per hour.[19]

Whatever the patronage projections, and all of them are suspect, no single of PRT could serve as a substitute for a rapid rail system. The system was not designed to do that. It was designed to supply a whole network with parallel lines offering access to more parts of the community and in the process accommodating even more people than the highest projection for a train system. Figures 11-2 through 11-5 illustrate this point.

In addition, no actual numbers are supplied to indicate the magnitude of the capital costs involved in any system. This was to be left for later evaluations.[20] Instead a comparative rating system was used to compare the three generic modes in six selected corridors. Each mode was examined based on engineering, traveler, and socioeconomic/environmental criteria. Table 11-1 shows the result of this evaluation. It is identical in both the December preliminary report from Peat, Marwick, Mitchell & Co. and the March 1973 *Phase I Progress Report* despite certain key changes demanded by the Technical Advisory Committee (discussed later).

First it is important to note how the evaluations were made. Although this is never fully revealed, the Phase I report does suggest how it was done:

> This section summarizes the selection of modal alternatives to be studied within each corridor by describing the evaluations that have been conducted by the functional area consultants, the rationale for the recommendations made by the study team, and the final selection of corridor/mode alternatives as a result of study team discussions.[21]

In other words, the consultants developed the ratings themselves—evaluated the alternatives—in ways they do not discuss. Although terms such as evaluation and analysis are used, there is no evidence that anything other than subjective judgments were the basis for the ratings.

This is confirmed in a later proposed work program for Phase III of the same planning project. There Alan M. Voorhees and Associates recommends that hardware evaluations prepared earlier be retained:

> Hardware factors are quite technical and substantially invariant. The hardware evaluations were made by experienced technicians very familiar with characteristics of various hardware. The evaluations probably would not change except due to development of new hardware.[22]

The political and value judgments associated with hardware decisions are thus effectively dismissed, as is the possibility that "experienced technicians" might not fully understand a radically new type of system. Rating of the various hardware systems will still be done in the manner of Phase I despite the "many inherent difficulties" with such a method. As Voorhees points out, "the main problem has to do with importance or value ratings of individual criteria. Different people attach different levels of importance to various criteria."[23] In other words, there are different subjective value judgments.

To help "control" the judgmental character of the "analysis," and perhaps

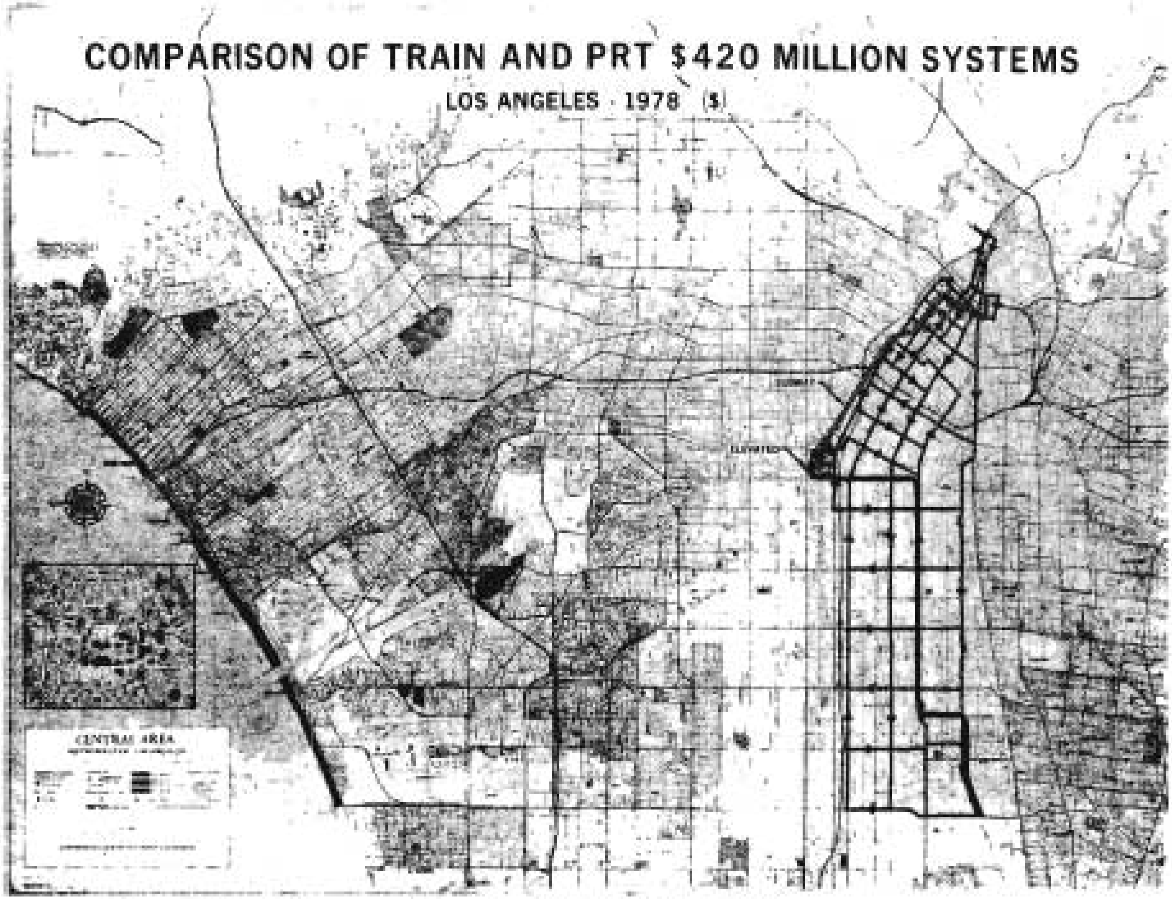


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Figure 11-2. Hypothetical PRT Network Compared to Rail Line, Los Angeles, Alternative A.

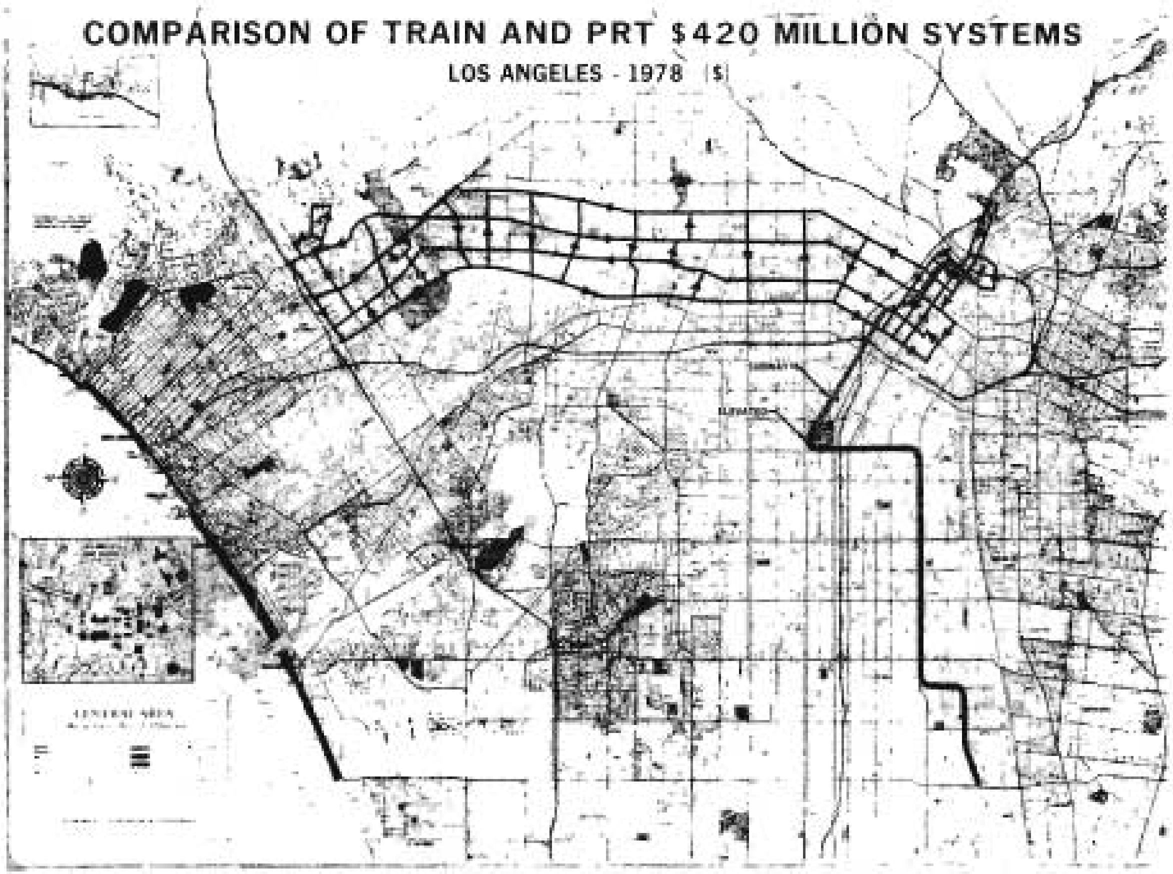

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Figure 11-3. Hypothetical PRT Network Compared to Rail Line, Los Angeles, Alternative B.

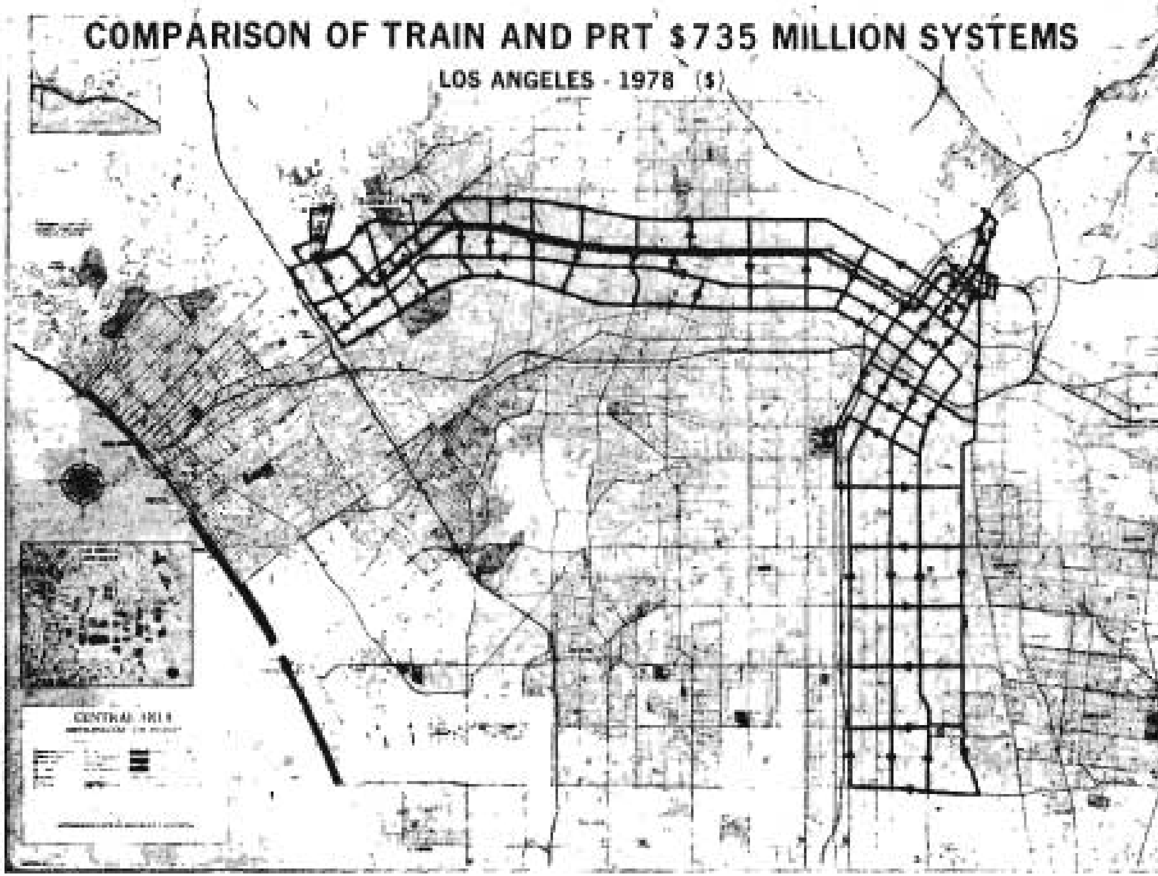

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Figure 11-4. Hypothetical PRT Network Compared to Rail Line, Los Angeles, Alternative C.

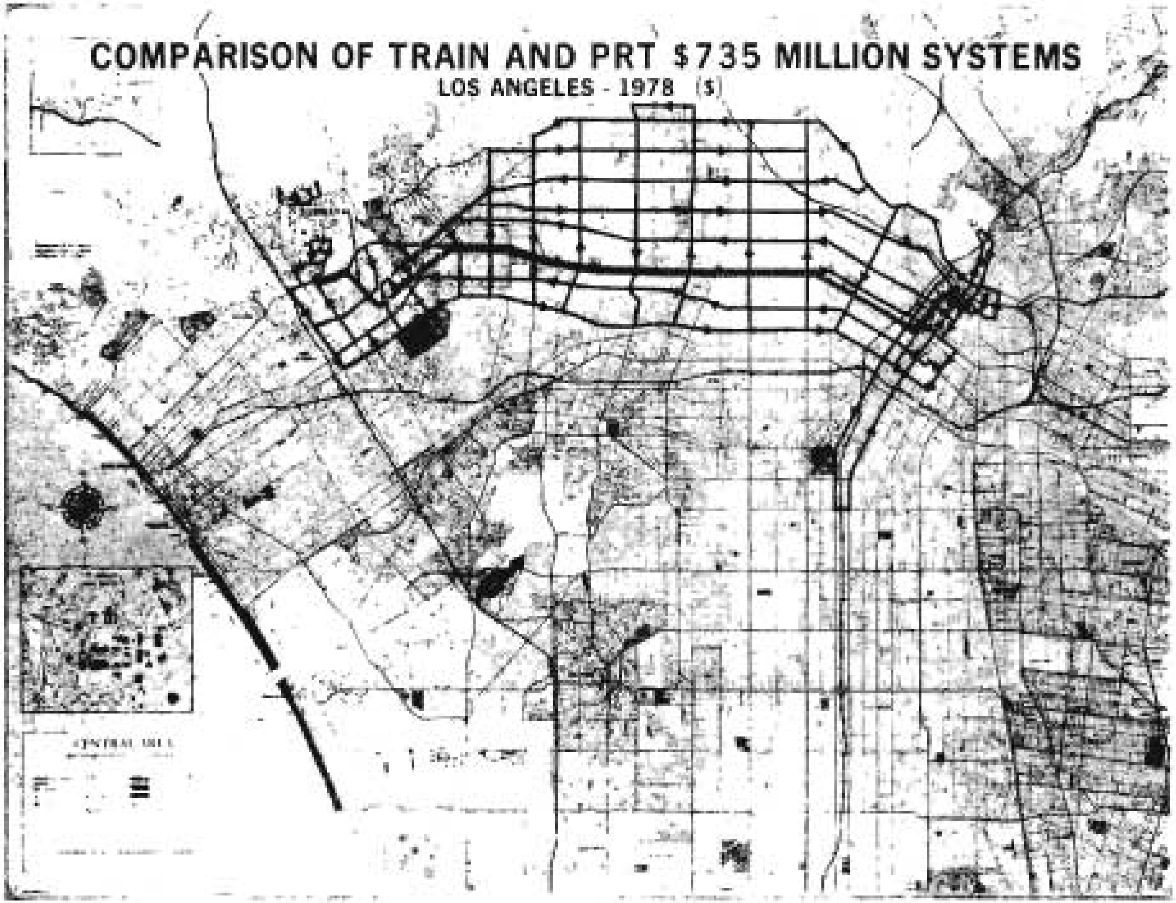

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Figure 11-5. Hypothetical PRT Network Compared to Rail Line, Los Angeles, Alternative D.

Table 11-1
Evaluation Matrix for Task IA12, Identification of System Alternatives

	Wilshire			San Fernando			San Gabriel			S.W.-LAX			South Central			Santa Ana		
Criterion	*MRT*	*PRT*	*Busway*	*MRT*	*PRT*	*Busway*	*MRT*	*PRT*	*Busway*	*MRT*	*PRT*	*Busway*	*MRT*	*PRT*	*Busway*	*MRT*	*PRT*	*Busway*
Engineering:																		
Capital cost	3	2	1	2	2	2	2	2	3	2	2	3	2	2	3	2	2	2
Operating cost	3	1	2	3	1	2	2	1	2	2	1	2	2	1	2	3	1	2
Flexibility	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2
Expandibility	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2
Reliability	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2
Maintainability	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2
Availability	3	1	3	3	1	3	3	1	3	3	1	3	3	1	3	3	1	3
System safety	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1
Predictability	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2
Special purpose	1	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1	3	2
Security	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2
Traveler:																		
Travel demand satisfaction	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1
Travel time	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2
Accident savings	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Net traveler-use costs	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Accessibility	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spec. mobility	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Simplicity	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Transferring	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2
Feeder/distribution	2	3	3	2	3	3	2	3	3	2	3	3	2	3	3	2	3	3
Fare payment	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Station comfort	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vehicle comfort	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
Psychol./scenic	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Patronage	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Revenue	n/a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Socioecon/Env:																		
Displacement disruption	3	2	2	2	1	1	2	1	1	3	2	2	3	2	2	2	1	1
Cultural/symbolic	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Aesthetic/design	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Planning policy	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2
Weather	n/a	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Geology/soils	n/a	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Water/hydrology	n/a	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Air quality	3	3	1	3	3	1	3	3	1	3	3	1	3	3	1	3	3	1
Noise/vibration	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Vegetation/wildlife	n/a	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Source: Southern California Rapid Transit District, *Phase I Progress Report, Study of Alternative Transit Corridors and Systems,* March 1973.

Note: 1 represents low attractiveness, 2 represents average, and 3 represents high attractiveness; n/a: data not available.

to prevent unwanted outcomes, the use of numerical scores was still advocated, but summation of the numerical scores was "to be avoided primarily in presentations to lay groups":

> Within the professional staff numerical scoring may be the best way to represent the relative attractiveness of various alternatives . . . [but] the summing of individual scores should be avoided even at the staff level. Decisions in all cases will be based upon the "sense" of relative attractiveness developed by the rater during individual evaluations.[24]

Thus what appears to be hard mathematical rankings evaporates into a "sense" of relative attractiveness. As will be shown, when the sense of relative attractiveness favors a system other than that favored by the analysis, the rating can appear as na—data not available. There is further evidence of the use of subjective judgment in the preliminary report:

> In this corridor [the Wilshire corridor], the consultant team *judged* that five criteria appear to present the most important basis on which systems selections can be made. In other words, the weights that we would assign to the five criteria would be significantly larger than to the other criteria. The criteria are capital costs, availability, patronage, aesthetics/urban design and planning policy.[25] (emphasis mine)

It is significant to note that on all these criteria, mass rapid transit (MRT) is rated more highly with the exception of patronage where data are said not to be available. Later in the report, however, the consultants state:

> From the standpoint of patronage, PRT *possibly appears more attractive* than MRT and busways. While ratings of patronage as a specific criterion were not developed by the project team, it is apparent that the product of the rating of travel demand satisfaction, and that of travel time, provides an indication of relative patronage. Since door-to-door travel time is expected to be considerably less for high-speed PRT service than for other modes, *higher patronage levels should result.*[26] (emphasis mine)

The progress report of March 1973 goes even further and says that "PRT appeared *clearly more attractive* than MRT and busways" from the standpoint of patronage[27] (emphasis mine). This judgment does not, however, appear in the numerical ratings. More importantly, the greater attractiveness of PRT is not weighed in its favor even though "it is ridership estimates, more than anything else, that determine whether any kind of new system ought to be built at all, and if it is, what its capacity ought to be."[28]

What is weighed heavily by the consultants are the initial capital costs of the various systems where the numerical ratings indicate MRT is the most attractive (lowest in cost) and busway systems are the least attractive (highest in cost).

Since these ratings are contrary to all experience and logic in transit planning, it is important to see how they were developed.

The most obvious way the cost of a bus system was elevated is the requirement that the buses be put on exclusive rights-of-way such as busways. The consultants cannot be faulted for this, however, since their mandate and the mandate of the SCRTD was to build a *rapid* transit system, which implied systems on exclusive rights-of-way. An improved surface bus system was not to be a part of their analysis.

Where they can be faulted is in their unstated assumption that all systems had to conform to a single characteristic of an MRT system, namely its capacity to carry a great many people per hour over the same line:

> With regard to capital cost, the ratings are based on the assumption that roughly equivalent hourly capacity would have to be provided by each of the three candidate modes. *While this assumption is not precisely valid, due to the difference in attractiveness of different modes,* it is considered to be reasonable as a basis for assessing relative capital costs.[29] (emphasis mine)

While acknowledging the difference in attractiveness among the various modes, these characteristics are effectively ignored in favor of an evaluation based on the single line-haul capacity of each. The one advantage of the train system—its greater capacity over a single line in a given period of time—is used to the detriment of the other two systems, which have different advantages. Both buses and PRT could be used as feeder and distribution systems requiring fewer or no transfers. PRT systems could give wider area coverage and nonstop service, yet these advantages are ignored in favor of the line-haul capacity characteristic. The potentially wider coverage of PRT and bus systems was actually turned to their disadvantage: "The capital costs have been based on the assumption that rights-of-way will largely be underground, rather than at grade or elevated."[30] By placing all the systems underground, the wider area coverage of the bus and PRT systems would require even more tunneling than the MRT system, thus increasing costs dramatically. As the consultants' own definitions noted, most busways would be likely to run along freeways, and the previous quotation was stricken from the SCRTD consultants progress report at the suggestion of the Technical Advisory Committee.[31] One member of the committee called the all-underground assumption "ridiculous." Nonetheless, the numerical ratings were not changed in the March report, and the following paragraph was left intact:

> The PRT and busway alternatives would prove to be of considerably lower cost if constructed on elevated guideways. However, in the opinion of the environmental consultant, such a method of construction would prove to be aesthetically unacceptable in that corridor.[32]

The aesthetic impact of a guideway is dependent on its size, placement in relation to other structures, and the type of environment in which it is located. The environmental consultants may have been looking at the Morgantown "PRT" system with its wide guideways and may not have been aware of the possibility of a small guideway such as that proposed by Aerospace Corporation. Therefore, the cost savings of an aerial network along with its greater service capacity were nullified, and need for a widespread network was used to make the PRT system less rather than more attractive. On this basis, the consultants concluded:

> . . . mass rapid transit would probably be the least expensive to construct in the Wilshire corridor, since the lower capacities of PRT and busways would require that more guideways be developed to handle capacities equivalent to that assumed for MRT. Busway is believed to be more expensive than PRT because of greater width of right-of-way requirements and for reasons of underground air conditioning and processing requirements.[33]

Even using underground construction for busways, it is difficult to see how bus systems could be rated lower than train systems in terms of capital costs, but this was the conclusion of the consultants. For new systems, such conclusions are easier to justify, since people are less familiar with their operating characteristics: "The rating of capital cost for PRT would be roughly the same regardless of whether the assumption is made that all PRT guideways are all concentrated along one street, or distributed among a number of streets."[34]

Thus the service characteristics of PRT are again nullified, and its advantages over MRT are effectively concealed. The fact that it would be nonsensical to run several PRT lines down one street to duplicate the service of a train is ignored. To arrive at the conclusions of the SCRTD consultants, one must assume that the characteristics of a MRT system are best and that other systems must measure up to them. This hidden assumption distorts all that follows.

Regarding other characteristics such as immediate availability, the PRT system could clearly be ranked last. It was not "on the shelf" at the time the analysis was done, and the consultants assumed that "a period of at least five years for research, development, and demonstration would be required before PRT could be considered" ready to build. This negative rating of PRT was based on the guidelines provided to the consultants by the SCRTD, which wanted "an action program that could be undertaken in the very near future."[35] Therefore PRT was considered to be unavailable. Furthermore the assumption of a 5-year development period was based on another assumption that UMTA would undertake a substantial program of development. As the consultants noted, "At the present time, there is no indication that such a program, of the required level of effort, will be undertaken with federal sponsorship."[36]

This ignored the programs in Morgantown and Denver, which many thought (at the time) would lead to PRT, and it also ignored the developments of real PRT in Germany and Japan. More importantly, however, there was no questioning of the assumption of the need for an immediately available system. The construction of any system would still be several years into the future even if the voters approved the proposal in 1974. As proponents of PRT pointed out, any time lost in the development of the system could be more than made up in the speed with which such a system could be built. The time to build PRT systems is measured in hours and days, not in years as are MRT systems.

Although the text of the report states that all three of the systems are rated equally on the criterion of aesthetics/urban design,[37] the numerical ratings give MRT a 3 and PRT and Busways each a 2. The basis for this evaluation is not discussed, and it may be inexplicable, since all three were to be underground.

Finally, an examination of the last criterion of importance, planning policy, reveals the biases of the consultants in terms of their ideas of the good city:

> . . . it is apparent that MRT provides the greatest potential for influencing urban growth in the centers of concentration desired by Los Angeles planners. At the other extreme is PRT, which, by virtue of its goal and design objective of providing nearly ubiquitous service, produces forces opposite from those that the planner desires for concentration development of activities and facilities. The busway lies somewhere in between MRT and PRT by virtue of its lower capacity and its relative difficulty of concentrating accessibility to activity centers.[38]

With five lines entering the downtown CBD, it is apparent where the concentration of development was to go. Downtown interests were to be the major potential beneficiaries of the system along with the construction interests and the SCRTD itself with its control of a larger program and more money.

Such a proposal ignores the needs of the transit dependent in favor of the needs of downtown business interests and those who work downtown, primarily middle-class workers in government, trade, and finance.[39] Whereas there would be a greater likelihood of concentrated development in the Los Angeles CBD and around some stations, this would not necessarily reduce urban sprawl. On the contrary, long-distance trips become more feasible with a train system, and such a system makes long trips more attractive than short trips. Therefore greater urban sprawl is likely to be encouraged, which has since been noted in relation to the BART system in San Francisco.[40]

In addition, the assumption regarding PRT is unrealistic, since it would be infeasible to make it a ubiquitous system. Its potential for covering a wider area would certainly make it conform more to the existing character of Los Angeles with its multiple centers of development, but the possibility for putting in a dense system in some areas with a more dispersed system in other areas could give planners a more flexible and effective tool for controlling urban growth.

The greater ridership it would attract would also ensure its effectiveness as a tool for urban design, whereas the low ridership projected for a train system would have effects limited to the development of downtown and certain outlying areas that had train service. The people with responsibility for regional planning at SCAG agreed that PRT would fit in with the planners' desire: "In general, the advanced technology framework as represented by Personal Rapid Transit supports regional development policies."[41]

Nonetheless, on the basis of the five criteria cited, "the study team recommended that study of transit in the Wilshire corridor be concentrated on the use of transit systems within the MRT generic category."[42] The thirty-one other criteria listed in table 11-1 were in effect ignored, and the questionable aspects of the criteria used were allowed to stand despite vigorous criticism from the Technical Advisory Committee.

Also omitted was any political analysis of who benefits and who pays for such a transit system. It seems essential that any transit plan should be examined to see how it affects particular groups and interests:

> . . . looking specifically at who benefits, among mass transit supplier interests, the "highway lobby," downtown business firms and real estate investors, land speculators and home builders, and technology-oriented engineering and consulting firms, as well as at who pay, among the poor, minority groups, the young, the elderly, the handicapped, and the "transportation deprived"—should be a regular part of any public consideration of transportation alternatives.[43]

Gruen Associates developed an evaluation process for SCAG, which suggested that any transportation plan should be evaluated from the perspective of four affected groups—the operator, the government, the community, and the travelers.[44] It was noted earlier that these groups may have interests that differ considerably in regards to public transportation, but such a suggestion was rejected by the SCRTD consultants:

> Evaluating alternatives from the viewpoint of four affected groups is not recommended. The impacts on the operator and government are really more properly considered as impacts on the community and travelers. In addition certain criteria are directed principally at either the traveler or community and so would be almost meaningless if directed at the other group. It therefore seems to unnecessarily complicate the process to attempt a complete evaluation for four separate impact groups.[45]

In discussing this issue with some of the participants in the process, the author found that most did not perceive a conflict of interest and even denied strongly that one could exist. To the contrary, the staff at the SCRTD and the consultants saw themselves as performing in the public interest. They were serving the "real" interests of the community, which still had to be "educated" to understand the need for public transit.

Therefore with their limited criteria the consultants followed their analysis of the Wilshire corridor with analyses of five other corridors, and always PRT and busways were summarily dismissed:

> From the standpoint of capital costs, there appears to be little to differentiate MRT from PRT and busway alternatives. While it is granted that MRT, as an alternative, would probably be of lower capital costs in the Wilshire and Hollywood area, *the opposite might be true* for the portions of the corridor in the San Fernando Valley, because low population densities in the valley would imply the need for extensive and potentially costly feeder systems.[46]

Such a finding did not deter the consultants from their train proposals, however. "In summary, the busway alternative ranked as being more attractive only with respect to the feeder and distribution and the special purposes criteria. Thus, MRT was recommended by the study team as the mode technology to be analyzed. . . ."[47] PRT was also summarily dismissed:

> Regarding availability, PRT was again judged considerably less attractive than other modes, and was not considered further as the corridor or line-haul system for San Fernando Valley service. This does not preclude use of PRT in other sectors of the valley or elsewhere in the District.[48]

In the San Gabriel corridor we have the following:

> Since the busway project being jointly developed by the California Division of Highways and SCRTD will shortly be placed into operation, and since reasons for not considering PRT further in this study have been discussed previously, the recommendation of further study of the MRT alternative was clear.[49]

In the discussion of the other three corridors, there is no mention of PRT at all. This analysis and the conclusions arrived at regarding PRT were not entirely satisfactory to the Technical Advisory Committee, so the SCRTD Board of Control decided to change some of the tasks of the consultants after the presentation of the Peat, Marwick, Mitchell & Co. report. Regarding PRT they determined:

> The analysis of PRT does not particularly lend itself to a corridor-by-corridor investigation. Rather, as has been presented by PRT proponents themselves, PRT must be examined as a region-wide, door-to-door service . . . It is therefore the decision of the Board of Control that consideration of PRT as an alternative, be carried along parallel to the corridor/mode study.[50]

Such a study was authorized on January 9, 1973, to be conducted by Kaiser Engineers/DMJM. The final report was submitted in March 1973. It apparently had no effect on the consultants' progress report, which was published at the same time and was virtually identical to the December report of Peat, Marwick, Mitchell & Co. regarding transit modes.

Since the Kaiser Engineers/DMJM report is frequently cited as proving that PRT is inappropriate for Los Angeles, it is important to see how the analysis was done and the basis for their conclusions. In the report the consultants distinguish between PRT, described as the Morgantown and Transpo systems, and APRT, advanced personal rapid transit, of the type suggested by Aerospace Corporation. Since PRT has now been defined as being the advanced system, this term will be used in this book except when quoting the Kaiser Engineers/DMJM report. The study done by the consultants was a limited one as they themselves state:

> This paper presents the results of a limited study of the application of APRT as the primary mass rapid transit system for the Los Angeles area. In this study, KE/DMJM has updated a continuing review of the literature on APRT and PRT; has had several conferences and detailed briefings from Aerospace Corporation . . . ; and has prepared several network concepts, operational concepts, purpose design layouts, service constraints and requirements, and sketches of guideway and station requirements, configurations and potential impacts within the Los Angeles CBD.[51]

The purpose of the report was to "present an objective evaluation of APRT." Because of the newness of the system, the consultants acknowledged there was no consensus on its proper role and function, and that many discussions of it quickly degenerated into biased reviews both pro and con. They also admitted "this leaves much confusion on *both* lay and professional" (emphasis mine) groups regarding the system. This confusion becomes evident in some of the analysis that followed.

Interestingly, the summary of conclusions at the beginning of the report is considerably more favorable toward PRT than the body of the report would suggest:

> The results of this review have reinforced the view that the APRT service concept could match the trip characteristics of the Southern California population more closely than other fixed-guideway transit systems (door-to-door travel; in a private vehicle when the traveller is ready to leave). The study team believes that APRT can play a meaningful role in the evolution of a transportation planning concept of a family of transit services, as a collection/distribution system in low-to-medium population density areas and as a feeder system to line-haul mass transit stations.[52]

They did, however, identify several problems that "must be resolved" before APRT could be recommended for Los Angeles. These included the need for further development and testing of actual hardware for reliability and accuracy of controls, as well as to resolve the questions of safety with close headway operations. They were also concerned about the aesthetics and environmental impact of aerial guideways and the reaction of travelers to such a different transit system. These are all concerns that proponents of PRT share and the reasons for their attempts to get a test facility operating in this country. The conclusions do not mention the excessive capital costs of such a system nor many of the other issues that have been raised by opponents of such systems.

Some of these are discussed, however, in the body of the report. The study team notes that other studies of PRT have been done in Minneapolis-St. Paul and Honolulu, and in each case the consultants have recommended against PRT as the primary transportation system. DMJM was involved in the Twin Cities study, and not surprisingly their conclusions there and for Los Angeles are similar. The reasons given in the Twin Cities were the high cost of the system, the dangers of close headway operations, which could not be developed and operational by 1982 when the mass transit system was to be operational, and the strong citizen opposition to aerial guideways. (See chapter 10 for a discussion of the problems with the Twin Cities studies.)

The Honolulu study was also done by DMJM in association with Alan M. Voorhees & Associates (another SCRTD consultant), and again the problems of high cost and environmental impact were cited as reasons for their conclusion that PRT would be inappropriate there. When these same people examined the Aerospace proposal for Los Angeles, similar problems were found.

The consultants examined the sample networks developed by Aerospace Corporation and "concluded that while the system would have little difficulty in the collection stage, its inability to handle the distribution end of the trip in the high density areas is of serious concern."[53] Although the conclusions assume PRT cannot handle line-haul trips, this is not discussed in the body of the report. Instead a detailed analysis of a Los Angeles CBD network is presented.

In doing this analysis the consultants used the inflated LARTS figures for downtown patronage estimates, but the greater attractiveness of a PRT network might make higher usage more probable even with a lower overall population density. The main problem with their analysis came in their assumptions, particularly the assumption regarding the size of PRT stations.

The Aerospace people had told them that the average-size station in the CBD area would allow six vehicles to load and unload at the same time.[54] Thus the Kaiser Engineers/DMJM people used this figure for all stations. Aerospace, however, calculated that in some highly dense areas around high-rise buildings, stations that could simultaneously handle up to twenty vehicles would be required, and other areas of the CBD would need only three vehicle stations.

One of the advantages of PRT cited by its proponents is the flexibility it allows in station size. Stations may vary according to passenger demand, producing considerable savings as compared to train systems that must have identical-size stations regardless of demand.

As the Kaiser Engineers/DMJM consultants quickly discerned, six vehicle stations would be inadequate in many areas of the CBD. Not only that, the higher modal split for PRT indicated that many more passengers would be using the system, and the number of stations recommended by Aerospace would be inadequate. Therefore they designed their own system for downtown, which required a guideway on almost every street and a station in almost every block.

To allow adequate space for slowing down and speeding up, virtually every street would have a double guideway to accommodate stations, and in some instances there was inadequate space to fit stations between intersecting guideways. In such a situation, the aesthetics of the system were terrible, and the extra lengths of guideway needed might have required the removal of some corner buildings.

Thus, through one mistaken assumption regarding station size, the size of the system needed for the Los Angeles CBD was effectively doubled. Based on this, they concluded: " . . . the Aerospace cost estimates do not properly reflect the higher costs associated with extensive construction in a downtown area, and are therefore undoubtedly optimistic and quite low."[55]

Interestingly they did not question the data supplied them by Aerospace Corporation regarding costs for a system of a given size, nor do these conclusions appear in the beginning summary of conclusions. What the report does show is the difficulty people can have when they attempt to analyze a system they do not fully understand and which they do not have time to think through. It may also indicate the dangers of seeking objective analysis from organizations that have already arrived at conclusions in published reports for other clients.

With the publication of the Phase I progress report, the SCRTD announced its intention to go to the people for another vote on rapid transit in 1974. Although no specific system was identified, a map was published showing first- and second-stage corridors. (See figure 6-13 for the first-stage corridors.)

Although this study deals with the way the issue of PRT was handled, there were many additional problems with the consultants reports. These did not go unnoticed, and the planners at SCAG raised a number of questions, which were addressed to the SCRTD and its consultants.[56] For the most part, the responses simply reiterated what was already in the reports or said that the questions would be answered in later phases of the study.[57]

Regarding PRT, Wallace, McHarg, Roberts & Todd (environmental consultants) replied, "See Kaiser Engineers/DMJM PRT Report."[58] Kaiser Engineers/ DMJM replied: "Advanced Personal Rapid Transit (APRT) was the only PRT concept to have the capacity capabilities to function as a regional system. The APRT was evaluated in this context and found unsuitable."[59] The proponents of PRT were not immediately deterred, however. In March 1973, an article by J. Edward Anderson on PRT was published in the Opinion Section of the Sunday *Los Angeles Times.*[60] Los Angeles City Councilman Joel Wachs continued to seek city support of the idea. He received some help in this in a letter from the past president, president, and president-elect of the College of Fellows of the Institute for the Advancement of Engineering. They advocated a full-scale test of PRT.[61]

In September 1973, the California Assembly Committee on Transportation requested that the Southern California Association of Governments conduct an independent study of PRT. For this purpose $50,000 was allocated, and Howard R. Ross Associates was hired as a consultant to SCAG. The results of these studies showed some blurring of the PRT concept, since vehicles carrying up to sixteen passengers were considered, but overall the reports were quite favorable toward PRT.[62]

Both the SCAG and the Ross reports suggested a staged development of PRT from small distributor systems (perhaps with larger or entrained vehicles) to an eventual linkup as a regionwide system. Although Aerospace Corporation advocated a similar approach, this was not widely understood due to their sample guideway network, which was regionwide. The most negative point made about PRT was its unavailability. Ross and the SCAG people both assumed such a system was at least a decade in the future.

This could easily become a self-fulfilling prophecy, but the positive aspects of the report encouraged proponents of PRT to take further action. In the spring and summer of 1974, the SCAG analysts put together a "Critical Decisions Plan for Regional Transportation," which essentially argued against the type of transportation advocated by the SCRTD consultants. This plan was approved by the representatives of the local and county governments who make up SCAG's decision-making body.[63]

This allowed people to support the tax-raising element of the SCRTD plan while preventing the SCRTD from spending such money until SCAG had approved their final plan. The Los Angeles City staff people had also been "extremely critical of SCRTD's work,"[64] and this holding action through SCAG allowed the mayor to support transit without specifically endorsing the SCRTD consultants' proposal. All this proved irrelevant, however, when the voters turned down the proposal.

While all this was going on, Councilman Wachs sought an analysis of PRT by the Ad Hoc Technical Advisory Committee on Rapid Transit (a staff group that advised both the mayor and City Council). This group concluded "That Personal Rapid Transit offers enough promise to justify further evaluation as both a regional and feeder-distribution system."[65]

Although the group felt that the construction of a test facility was beyond the capabilities of the city, they did suggest that the City Council support further studies of the system to be done by the state or by UMTA. They also suggested that their Ad Hoc Committee be asked to work with SCAG to evaluate the potential of PRT for Los Angeles.[66]

On February 21, 1974, the Ad Hoc Committee on Rapid Transit (City Council committee) passed a resolution encouraging the concurrent studies on the feasibility and application of PRT in the Los Angeles region and encouraging UMTA to develop a full-scale test facility for PRT. The entire Council adopted the Committee's recommendation on March 27, 1974. This received a brief report in the *Los Angeles Herald-Examiner,* but was not reported in the *Los Angeles Times.* It appears to have been unnoticed by everyone involved in transit planning at the local, state, and federal levels of government.

During this same period, a Los Angeles County Supervisor, Baxter Ward, began taking an interest in public transit. His initial concern was to use existing rail lines in the area to develop a commuter train system at a much lower cost than that proposed by the SCRTD and its consultants. In the fall of 1973, he saw the Aerospace Corporation proposal for PRT for the first time and was tremendously impressed with it. He published a general letter to his constituents commending PRT to their attention and included with it a comparison of a PRT network with the SCRTD consultants' bus/rail proposal.[57]

In a meeting between the County Board of Supervisors and the board of the SCRTD, he strongly suggested that they look at this new system and handed out the comparative summary. He also pushed for the use of railroad lines for commuter service. In reporting on this meeting, considerable detail about all aspects of the discussion was included in the *Los Angeles Times* report, but no mention was made of PRT.[68]

Later at public hearings held to discuss the SCRTD consultants' proposal, Ward noted the opposition to the rail proposals by cities such as Long Beach, Beverly Hills, and Torrance and said he would urge the Board of Supervisors to consider a substitute concept, that of PRT. He presented these ideas to another meeting between the Board of Supervisors and the board of the SCRTD.

Later in June, Ward won the authorization of the County Board of Supervisors to spend $1,750,000 to develop the idea of PRT for the county and to develop a preliminary design for a PRT test track. The amount was based on an estimate from Aerospace Corporation that they could do the first year's work for this amount of money.

The money was not allocated, merely set aside for the specified purpose, and Ward was to come back with a specific proposal for spending it. Aerospace Corporation could not receive a contract based on the board's allocation because of county requirements for competitive bidding and the legal restrictions against Aerospace entering such a competition. This was later resolved by suggesting that the SCRTD do the study under the direction of the county, since the SCRTD had no competitive bidding requirements.

During the summer, as Ward was prepared to bring in his resolution to use the allocated money for a PRT study, he became involved in some disputes with other supervisors regarding other issues. Therefore, it seemed likely that his PRT proposal would be defeated, and its introduction was delayed.

On July 16, the project received a severe setback (although this was not recognized at the time) from the proponents of PRT in the city of Los Angeles. Mayor Bradley sent a letter to each member of the Board of Supervisors forwarding an earlier letter he and Councilman Wachs had sent to the chairman of the State Assembly Transportation Committee. In it they suggested that a full-scale PRT test be conducted jointly with other cities in California under state auspices.[69] This proposal persuaded Supervisor Ward that the county of Los Angeles would be wasting its own money if it went ahead with such a project on its own, and he decided to delay his proposal to see what would come of the Bradley/Wachs idea.

He did not drop the idea and staff activities continued throughout the summer. Aerospace Corporation submitted a detailed proposal in July 1974 (revised in October 1974), and on August 8 a draft motion was prepared by Ward's staff. On August 21 Ward received a letter from Duncan MacKinnon, chief, Advanced Development Branch of UMTA, encouraging the Los Angeles project and suggesting the possibility of a colloborative effort with UMTA.[70]

All this effort came to a rapid halt, however, when Ward decided that he wanted the test track to be built from the Union train station in downtown Los Angeles into the central business district. He wanted a test facility that would be "useful" and visible, not a project in some isolated area. He even went so far as to seek a meeting with Mayor Bradley to obtain city approval of such a project.

The people from Aerospace Corporation had severe misgivings regarding such a proposal, since the requirements for a test facility were not compatible with construction in a congested urban area. They examined the Union Station site and discussed the possibility of such a facility with other potential contributors to the project. There was widespread agreement, however, that such a location was not only impractical, but that it might lead to premature "freezing" of design characteristics and premature usage of the system by the public. These were precisely the problems that had plagued the Morgantown, Dallas-Fort Worth Airport, and BART projects.

The Aerospace people tried to reach Ward with their conclusions but were unable to get an appointment until late in the afternoon the day before his scheduled meeting with Mayor Bradley. Their conclusion that a PRT test facility should not be built in a downtown area left Ward with nothing to talk about at that meeting and no time to cancel it.

This was most embarrassing to him. Later he would say that he thought the Aerospace rejection of the downtown site indicated their lack of confidence in their own system. He believed they wanted to hide it "out in the boondocks" so that any problems would be concealed. Such a "useless" test track could not be justified to the voters or the Board of Supervisors.[71]

From this point forward, Ward essentially dropped his interest in PRT and began developing his own plans for a commuter rail system based on existing rail lines. In January 1975, he did propose that the $1.75 million be earmarked for a PRT experiment at the Los Angeles International Airport.[72] This proposal passed the Board of Supervisors and was picked up by city proponents of PRT, but the airport staff was more interested in building a system that was already in existence—such as the SLT systems at other airports or a bus system.

Although there was considerable activity for several months to get a real PRT test, the proponents, especially Councilman Wachs, became busy with other issues and the airport staff continued to plan according to their own ideas. Gradually the idea of a PRT experiment petered out, and the money reverted back to the county, which had begun to find itself in financial trouble.

After the defeat of Proposition A (the SCRTD consultants' train proposal) in 1974, there was considerable criticism of the SCRTD and calls for its reorganization. Everyone agreed it should be reorganized, but there was no agreement regarding who should control transit planning and development, so none of the proposals was accepted by the state legislature.

Instead, in 1975, Baxter Ward suggested that a rapid transit/commuter rail department be established to make a concentrated effort to obtain "as much as $1 billion in state and federal funds for rapid transit development over the next five years."[73] This was done in February 1975: "The lack of a majority vote . . . was not interpreted as public opposition to rapid transit, but a vote against increased taxation during a period of economic recession combined with unparalleled inflation."[74]

More studies of train systems were initiated, culminating in another vote on a more elaborate train system proposed by Ward and called the Sunset Coast Line. This too met with defeat in June 1976. After three defeats of train proposals by the voters in a period of eight years, the transit planners then decided to plan for a "starter line"—a subway under Wilshire Boulevard—which could be financed without seeking voter approval. Through the Community Redevelopment Agency, there were also initiatives that led to the UMTA award of a Downtown People-mover project for Los Angeles.

PRT was no longer part of anyone's planning. No prominent public official was willing to push publicly for the concept of PRT, since it had seemingly been rejected in Minneapolis-St. Paul and Denver as well as by UMTA. There remains considerable concern to get "our share" of federal money, and the local officials (both bureaucratic and elected) are anxious to do whatever is necessary to comply with federal guidelines to obtain federal money.[75]

PRT may now be seen as an old idea that was long ago rejected: "If it were any good, someone would have built it by now."[76] The people at Aerospace Corporation took the idea as far as they could without outside support and have now moved on to other projects. They might still develop their idea if an agency of government were willing to pay for the next steps, but to this time no money or contracts have been forthcoming.

12 Local Politics and Federal Money

Whereas there are considerable differences among the four cities discussed in chapters 8-11, they all have common patterns, which may help to explain the difficulties encountered by restructuring or revolutionary technologies. Most obviously, their organizational networks are characterized by extreme fragmentation of power and authority. Even where a single regional agency has responsibility for planning, building, and operating a public transit system, such an agency requires agreements, concurrences, and, most importantly, money from a number of other governmental entities.

The domains of many of these governmental agencies are overlapping; they occupy parts of the same policy space. Local governmental jurisdictions, regional councils of governments, planning departments, engineering bureaus, finance officers, and competing highway interests all have some degree of influence regarding public transit. More importantly, many, or most of them, must agree and cooperate to put any plan into operation.

In this case, cooperation means agreeing to a regional plan that includes public transit as one element, and it also means that some entities must agree to contribute enough money to make up the 20 percent local share required to gain federal funding. If a tax or bond issue is to be put before the voters, there must also be agreement to generate public support for the issue.

With a multiplicity of values at stake, this means endless rounds of negotiation to get any plan devised and approved. It often takes years to get local plans together, get them integrated into regional plans, and then get the approvals of all the various elements that make up a regional plan. The transit element of the plans may have been agreed to many years earlier, and following the values of the planning profession, it usually called for a rail rapid transit system or at least express busways. Traditionally, planners' values called for more dense cities with more public transit, whereas the highway interests controlled the money and the action, which led to more dispersed cities and more highways.

Nonetheless, in many U.S. cities there is, in the plans, some idea of a public transit system to be built some day. Broad corridors, if not specific routes have been selected, and some local communities have begun orienting their local plans and zoning to accommodate a presumed transit system at some time in the future. When most of these plans were begun there were no alternatives to trains or buses. Therefore it is very difficult to insert a new type of transit system into the plan, even if one should become available, because existing agreements are based on a different idea, which is not compatible with the new system. The more revolutionary the system, the less likely it is to be compatible with existing plans and agreements. With concurrence so difficult to achieve, there is little, if any, inclination to consider a new technology that would disrupt hard-won achievements.

For the transit agency especially, there is considerable reluctance to consider a new technology. Beyond their knowledge of and commitment to the existing transit paradigm, their support is likely to be centered in the downtown business groups, which have long sought trains to serve their own particular interests. At the local level of government, transit interests have been fighting a losing battle with the much more powerful highway interests, and they are extremely reluctant to make any change in policy that might risk the support they already have.

Even in Denver, where a "new" type of system was proposed, it was still kept similar to the existing paradigm with corridors centered largely on downtown. The mass transit proposals for Minneapolis-St. Paul and Los Angeles have also centered on downtown, and those who have proposed PRT systems have been accused of acting in concert with the highway interests to prevent the construction of a real transit system.

With powerful vested interests on both sides of the highways-versus-transit debate, it is difficult to introduce a new element into their dispute. Elected officials and their staffs have difficulty understanding the new idea and want it analyzed by experts from the bureaucracy. Without alternative systems of appraisal, this is likely to be either transit planners or highway planners. To the transit planners, it is revolutionary and unworkable, whereas the highway departments generally do not approve of any system that does not use the highways.

Since the new program does not fit into existing organizational networks, it does not easily become part of the public agenda. As the experience in Los Angeles indicates, an idea does not become part of the public agenda until it is part of the agenda of the bureaucratic agency. Political officials can draw attention to an issue and put it on the public agenda temporarily, but continuing attention requires organizational efforts.

The Los Angeles City Council voted unanimously to ask for a study of PRT by either the State of California or UMTA, but the effects of this resolution were nil. Only when the City Planning Department, SCAG, and other staff agencies examined the idea did it really become part of the ongoing agenda. None of these agencies, however, had the authority to do anything regarding transit. They were staff agencies, without authority to act, and they could not force their views on a reluctant operating agency, the SCRTD.

Despite all these local forces, which mitigate against change, the structure of the transit subsystem network gives decisive power to UMTA through its concentrated control of resources. During all the local planning that was done in these cities, including Las Vegas, there was continuing concern regarding whether or not their plans would be acceptable to UMTA. To the author it appeared that very little local transit planning was being done simply to serve local needs; the planning was being done to gain the approval of UMTA, and with that approval, federal money to "do something."

Although the UMTA people claim to look at local plans and find no demand for new systems, the local people believe UMTA is unwilling to support new systems, frequently citing Denver and Las Vegas (perhaps mistakenly) as examples. It seems probable from the evidence of this study, that neither UMTA nor the local transit agencies want new systems, but it is also clear that if UMTA wished to demonstrate new systems, they could make the money available. It is unlikely that such money would go unused as shown with the DPM Program. The local agencies give every indication that their primary goal is to get federal money. The type of transit system is far less important.

Given this resource dominance, however, UMTA has done more to discourage than to encourage innovative systems. The difficulties at Morgantown and Dallas-Fort Worth Airport have made new systems suspect. In addition, the change in personnel that led to the abandonment of the Denver project and the apparent efforts of some UMTA officials to deter the private development of an innovative system in Las Vegas, have discouraged many local people who have hoped to promote more advanced systems.

The author has encountered a number of private citizens and local officials (in the local macropolitical system usually) who would like to plan for and develop innovative transit systems. They find it difficult to gain support for their perspective, however, as the local transit agency can report with assurance that UMTA will not support such proposals.

Thus the transit subsystem operates at all levels of government in a way that is mutually supportive. With dispersed authority and concentrated resources, the essential values of the transit paradigm are maintained. This may be due, in part, to the similar training and experience of the people who fill the key roles in the transit subsystem as well as the interchange among these people as they move into different career positions with the subsystem.

The scarcity of resources may also contribute to this situation. This subsystem is essentially resource short, whether one considers the costs to build and operate public transit systems, or compares the public transit subsystem with the highway subsystem. Therefore in seeking additional resources and authority to act, members of the subsystem must gain the support of powerful groups that often have narrower interests than those of the general public or the potential users of the system.

At the local level it becomes clear from all these cities that governmental organizations do have interests that are different from the people they serve. The extent to which this divergence of interests is recognized by transit planners is unclear. There is certainly a consistent denial that it exists, and in the case of

Los Angeles, a proposal to do an analysis based on such a divergence of interests was explicitly rejected.[1]

The special interests of the transit districts themselves are also denied, even though there is considerable evidence that indicates their interests (or the interests of their employees) are different from the interests of the traveling public. In Minneapolis-St. Paul and in Los Angeles, the people employed by the transit districts were hired because of their skills and knowledge in the area of bus and train systems. Their skills might be threatened by a different type of transit system. Also, their power and influence grow as their budget grows. Therefore, it is to their interest to get as large a project as possible started as quickly as possible.

Since others must pay for their projects, there is little or no incentive to build the most cost-effective system. Because they are part of government, they can even discuss (and perhaps implement) coercive measures to force people to use whatever systems they build. Parking restrictions, gasoline rationing or taxing, highway restrictions or tolls are all included in their arsenal, since they freely admit most people will not choose their systems without some sort of automobile disincentives.

In Denver, the transit planning group was brought in to develop one of the Transpo '72 systems. They were largely out of the aerospace industry but, like the train people, they needed to develop a system using their particular skills within the time frame set by the sales tax/bond election. The development of a PRT system would have left a time gap during which most of their jobs could not have been justified. A more simple bus system would not have required their expertise at all. The result of their analysis was a system (essentially GRT) that precisely fit their organizational and career needs.

What is interesting is how little concern is shown for the travel needs of potential riders. Although only 17 percent of all trips in the Los Angeles area are of the home-work type,[2] the transit consultants proposed spending between $8 and $10 billion for a system to serve essentially just those trips (and not even all of them at that). All other travel needs and the needs of most of the transit-dependent were virtually ignored.[3]

Even in Denver, where an extensive study of the travel needs of the community was done prior to planning a transit system, the study's conclusion that a vastly superior system was needed to attract ridership was largely discounted. Whereas the talk was clearly to build a system with superior service, and the characteristics of PRT were the basis for the 1973 vote, the system actually designed was essentially an automated bus system with no clear service superiority over other conventional systems.

In this situation, it is not surprising that a revolutionary system such as PRT received little analysis. Despite the widespread belief that objective analyses of PRT were done in all four cities and that on the basis of these analyses PRT was rejected, the evidence shows no real analysis at all. Part of this may be due to the state of the art in transit planning, which is limited at best. Almost all analyses of all transit systems over the past 20 years have been glaringly inaccurate.[4]

Therefore the application of the transit planners' primitive tools to a radically different technology was bound to be inadequate. Nonetheless, the use of highly questionable assumptions and stipulated conditions make the three studies done in Denver, Los Angeles, and the Twin Cities at best inadequate and, at worst, quite misleading.

Cost figures were either stipulated or generated by analogy—the cost to build and maintain a bus or the cost of a Cadillac were used to develop PRT costs. The cost estimates generated by Aerospace Corporation based on a real design priced by potential vendors were not used. They were widely criticized, but the author sought diligently for any detailed analysis of these figures or the figures generated by the operating test systems in other countries and found none.[5]

One analyst noted that people are not paid to evaluate the work of others, and another said the numbers were "too ridiculous" to be taken seriously. An analyst for the Denver project said he was told by a widely respected authority in the field that PRT was economically unfeasible.[6] This coincided with the views of the DRTD management, which did not want the subject pursued, and no analysis of the economic feasibility of PRT was done in Denver.

The author discussed the economic feasibility of PRT with the authority in question. He reported he had never studied the subject deeply because he "always had trouble taking the whole concept seriously." "Common sense" indicated it was "unworkable on its face." It was not worth the time to do a detailed analysis. "Even a half-mile grid would be ridiculous (too expensive)." He compared the Aerospace Corporation cost for a PRT vehicle to that of a Cadillac and the operating costs to those of a Pinto. In both cases, the analogy clearly showed the lack of reality of Aerospace figures.[7] This person may be correct, but his authority stems from the assumptions by others in the field that he has done thorough studies of the economics of PRT. When professionals begin to talk about what is realistic and substitute common sense for detailed analysis, their expertise is at least suspect, if not nullified.

Nonetheless, this type of assessment substituted for analysis not only in Denver, but in other cities as well. Everyone "knew" PRT was not feasible, so there was no need for further analysis. With the same consultants working for several cities, it is not surprising that their conclusions in one city remained compatible with their conclusions in other cities. The same judgments were simply plugged into new reports developed for their various clients. The authoritative weight given to these studies then becomes part of a circular process where judgments are called analyses and the analyses are later cited to confirm the initial judgments.

Although thorough cost analyses were not done, there were studies of the aesthetic acceptability of elevated guideways. The results indicated that citizens found such guideways unacceptable in most urban areas. Therefore the more miles of elevated guideway required, the less acceptable the system. If this were true, PRT with its extensive network of elevated guideways would be unacceptable. That was the conclusion of the studies done in Denver and the Twin Cities, but the conclusion was based on citizens' reactions to pictures of very large guideways, not to the much smaller guideways proposed for PRT. The people who did the studies apparently felt a smaller guideway would make little difference. It was also believed, according to a participant in the Denver study, that PRT could not have much smaller guideways than GRT, since the guideways had to exceed the width of the vehicle on any system. (See chapter 6, figures 6-1 through 6-3 for a clarification of this issue.)

Thus the people who did the studies believed they were conclusive, whereas the advocates of PRT felt there was little or no evidence relevant to PRT due to the difference in assumptions regarding guideway size. Such differences in assumptions continually plague studies of new technologies that do not fit the existing paradigm. There is lack of understanding, not necessarily an intention to distort.

One of the most common misunderstandings regarding PRT appears in the studies that attempted to compare it with other systems. PRT was forced into network configurations appropriate to group systems but not to a personal system. Its different service characteristics were used as deficiencies rather than being exploited as advantages. The analysts effectively proved it could not operate as a mass rapid transit train system, which is precisely its advantage to the rider. For the traditional transit analysts, however, the lack of single line-haul capacity was a severe barrier to the adoption of PRT systems.

Finally, the lack of available PRT systems confirmed and supported the position of the analysts. All their clients wished to take action immediately. During the period discussed in all these cities, the Arab oil boycott and the awareness of energy problems produced a crisis mentality that demanded quick action. For the transit districts, action meant starting construction as soon as possible. Again the action mentality worked against innovative systems.

Even though one can acknowledge the real difficulties for analysts attempting to grapple with a revolutionary technology, there appears to have been little desire to determine whether or not PRT was truly workable or desirable. In all these cases, analyses were used to justify conclusions that were based on political predilections not to determine which alternative would be most suitable. The framework of rational-analytical method was used, but it was a camouflage for politics by other means. Subjective assumptions and stipulations directed the analyses to predetermined conclusions.

There were other factors, of course, that helped to deter restructuring or revolutionary innovations. The claims and counterclaims of a myriad of manufacturers who tried to sell their products to the local communities and transit districts caused considerable confusion. All promised they could do better than their competitors—haul more people per hour at less cost, offer better service, reduce maintenance cost, and so forth. Their extravagant claims coupled with the denigration of competing systems made all new systems suspect.

The technical problems experienced with the BART system, Morgantown, and Dallas-Fort Worth Airport made local officials even more suspicious of large promises. They felt (often with good reason) that manufacturers were going to use their community as a testing ground, passing on development costs that should not be charged to any single customer.

Further, there was a widespread assumption within local communities that they could not and should not fund research-and-development programs. They have not viewed themselves as laboratories and do not believe local opinion would support their own research programs. Research was properly the domain of the federal government or private manufacturers. Consequently, they were not able to operate effectively as alternative systems of appraisal opening greater opportunities to potential innovators.

Even a cooperative arrangement with shared risks is not viable with existing concepts of local domains. Not only is research not a local function, a cooperative arrangement might smack of favoritism. It would almost certainly not be possible where there are legal requirements for competitive bidding and choosing the lowest cost offered. Local governments have neither the procedures nor the self-perceptions to get involved in experimental arrangements. Most also lack the financial resources as well.

All these barriers to innovation, however, apply primarily to the planning and design stages of innovation and reflect its revolutionary and restructuring character to the actors within the transit subsystem. There is evidence from the Las Vegas experience that different issues become important at later stages of innovative development.

In the planning, design, and testing phases, PRT was a revolutionary innovation to the transit political subsystem. In Las Vegas, however, the issue was whether or not to implement a new transit system. Even though a revolutionary innovation is also a restructuring innovation by definition, at the implementation stage it is the restructuring, not the revolutionary, characteristics that appear to activate the opposition.

In this case, the opposition included the privately owned bus company, a taxi company, and the regional planning agency. The bus operator also owned transportation interests connected with the airport and did not want a competitor that threatened that business and profits. The taxi company operated primarily from the airport along the Strip in direct competition with the new system. The regional planning agency (and apparently UMTA) did not want a (transit planning and building) competitor entering their policy space.

In this situation PRT was a restructuring innovation that threatened to take money, power, and influence from existing interests and redistribute it to other interests. This places the innovative technology in the traditional political arena of competing interests where the issue is not what is best for society as a whole, but who gets what.

The Las Vegas experience also gives warning that evading functional subsystems with alternative systems of appraisal will not be enough to ensure implementation of innovative ideas. Special interests that believe they will be harmed by the new technology will vigorously oppose it at the implementation stage. In the case of PRT, one can certainly expect opposition from taxi interests. If the system also carries freight, opposition from local trucking companies and the Teamsters' union might also be expected. One could also expect resistance from the existing transit planners and operator whether one attempted to work with them or to bypass them. Eventually, the impact of the new technology might threaten large national interests such as the automobile industry or the oil industry, which would bring them into opposition.

Small demonstration projects in large cities might mitigate much of this opposition, at least for the first limited networks. If these prove attractive, however, greater opposition is likely to be generated. Then the outcome may depend on the attractiveness of the new system to the general public plus the balance of the powerful interests that might be expected to favor or oppose the new system. How great will be the perceived level of threat or potential for benefits to small powerful groups is not entirely clear.

Certainly the Las Vegas circumstance of an extremely high degree of threat plus high levels of power within the two most threatened organizations is unlikely to be repeated often. In other localities, the level or threat may not be so obvious, and those threatened are unlikely to be as influential. Some powerful groups such as downtown business associations may see considerable benefits to their own interests and thus be unwilling to assist particular organizations, such as taxi firms, that are threatened.

Thus, the balance of power is likely to vary from community to community, and those implementing the new projects may be able to design their demonstration systems to maximize their support from powerful interests as well as minimize the strength of their opposition. As with the automobile, if the benefits they generate are widespread and obvious, present-day equivalents to buggy makers and horsewhip manufacturers may also be forced to capitulate to public demands.

External forces may also favor change as energy becomes more scarce and urban transportation problems continue to worsen. Even the most powerful vested interests collapse when faced with a major system failure or threat of failure. Some potential opponents such as the automobile manufacturers are likely to become producers of whatever new systems are adopted. Therefore implementation, while a difficult and delicate political task, is probably achievable despite the Las Vegas experience.

What the local experience in all these cities reveals are the complex political forces that must be dealt with to gain acceptance for innovative technologies, whether they are perceived as being restructuring or revolutionary. There are also indications that at different stages of development, different actors will become activated, and the issues that divide the adversaries will also differ. Therefore proponents of new technologies need to plan different strategies for each stage of the innovation process.

Whereas alternative systems of appraisal may facilitate the development stage, they cannot assure successful implementation. Such success will require demonstrations that do not threaten the most powerful interests that are likely to oppose the innovation while providing benefits to both the powerful interests that are likely to support the innovation and to the general public, which ultimately must be satisfied.

Part IV
A Larger Perspective

13 The International Experience

A complete survey of all the activities regarding personal rapid transit (PRT) around the world would go far beyond the scope of this book. Instead, this chapter's primary focus will be on the institutional arrangements in four countries that have led to the development of PRT systems. These institutional arrangements contrast sharply with those in the United States and give further evidence for the hypothesis that different systems of appraisal can be devised to give greater opportunity for innovations that are revolutionary to one organization-set, allowing them to be developed by other organization-sets.

It is also significant to note that much of the inspiration for these developments and much of the technology originated in the United States. Dr. Leslie Blake who conceived the Cabtrack system in England is reported to have been influenced by the early works on the StaRRcar, Urbmobile, and Teletrans.[1] The British as well as the French, the Germans, and the Japanese have all acknowledged the key role played by the Department of Housing and Urban Development (HUD) studies and *Tomorrow's Transportation,* which gave incentive to their own development programs.[2]

Of course, none of these countries would have been interested in developing a new type of transit if it had not been for their severe problems in urban transit. Even with their superior public transit systems, cities in these countries were faced with severe problems of automotive congestion. Their mass transit facilities were overcrowded during rush hours and underused at off-peak times. As had occurred earlier in the United States, people in Europe and Japan preferred the convenience and comfort of the private automobile as soon as they could afford one. The shift from public transit to the automobile began in the 1950s and accelerated during the 1960s.[3]

Despite reliable public transit service and good networks, the load factor dropped dramatically between 1960 and 1970. As in the United States, the automobile enabled more people to move to the fringe areas of the cities, where mass transit could not serve. The increasing auto congestion made bus systems slower and less reliable. The predictable result has been a decline in use, which has forced operators to cut back on services and to raise fares (or get larger subsidies).

There have also been difficulties in recruiting adequate staff for labor-intensive transit systems, and inflation has made the cost of personnel even more expensive.[4] The mass transit train and subway systems could not provide a fine-grain network to enable people to reach their multiplicity of destinations.

Thus, despite their more extensive public transit systems, European and Japanese cities were experiencing pressures similar to those of American cities. This led people in these countries to search for better transit alternatives, and among these alternatives were several PRT systems.

England–Cabtrack

The concept of Cabtrack was originally conceived in 1966 by Dr. Leslie R. Blake of the Brush Electrical Company, Ltd., now a subsidiary of Hawker Siddeley Aviation Company. Initial studies were sponsored by the National Research and Development Corporation (NRDC) in 1967.[5] These studies were continued using the name Cabtrack under the sponsorship of the Department of the Environment through its transportation division and its Transport Research Assessment Group (TRAG).[6]

TRAG was formed in 1967 by the then Ministries of Transport and Technology as the operating agency for their Joint Transport Research Committee. The work of TRAG involved operational research by a multidisciplinary team drawn from the Department of the Environment (DOE) and the Royal Aircraft Establishment (RAE), Farnborough. A number of government, industrial, and consultant groups worked under contract to TRAG on technical, economic, social, and environmental studies.[7]

The Cabtrack studies began with an analysis of urban transportation needs and problems.[8] They came to the conclusion that public transport systems would have to offer a high level of service with frequent points of access widely distributed throughout an urban area. Their answer to the needs and problems they identified was a PRT system called Cabtrack: (See figure 13-1.)

> . . . a system of driverless, electrically powered four-seater vehicles, routed automatically over a network of track which, in cities, would usually be placed on vertical supports to enable it to pass over existing roads and footways. Passengers are taken to their destination by the most appropriate route, determined by computer.[9]

The system included a fine-mesh network, demand activation, close headways, 24-hour service, and so forth—all the characteristics of true PRT. The vehicle was similar to a small automated automobile, using four rubber-tire wheels. Whereas this did not allow for a minimal-size guideway, it still allowed for a relatively small guideway.

One of the most significant elements of the Cabtrack development was the early inclusion of an architectural and planning firm to do an architectural and environmental impact study at the formative stage of technical development.

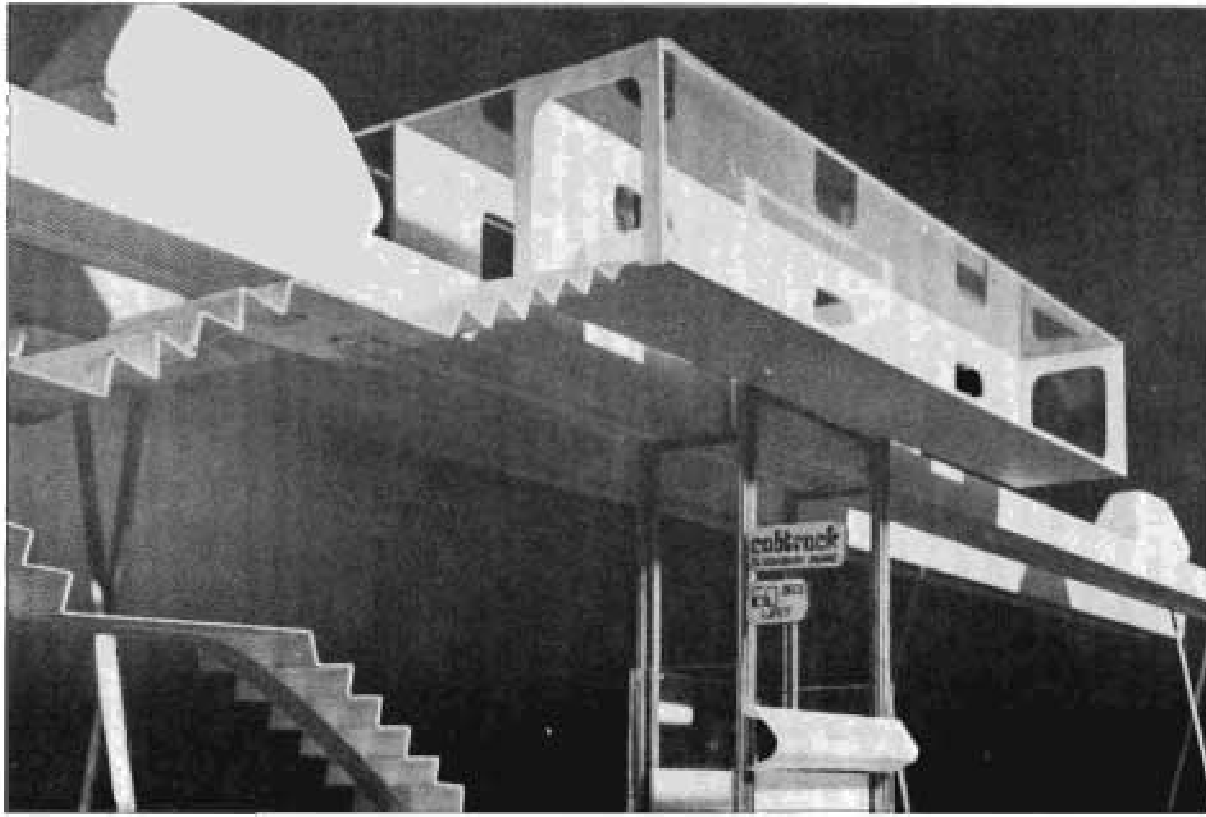

Figure 13-1. Cabtrack–England. Artist's Rendering.

Although it may have led to the demise of the project, the architectural study may be one of the most important outcomes of the entire project.

It was this study that led to the decision that a one-way network would be most aesthetically acceptable while providing greater accessibility to the system.[10] It also indicated that a PRT system was flexible enough to be acceptable even in an old traditional city like London. This did not mean a PRT system could be put anywhere in the city: "In some places the introduction of Cabtrack would be totally unacceptable, while in some it would be an acceptable intrusion or positive enhancement."[11]

Even in areas where there would be some visual intrusion, the benefits of reduced vehicle traffic or even closure to vehicle traffic along with tree planting and other aesthetic enhancements appeared to the study team to offer an opportunity for "improvements to a whole area (which) could be made at the expense perhaps of some less important streets."[12]

> It seems possible that if the system is carefully considered we may find that we have acquired not only a public transport system of a reliability, convenience and comfort greater than any which exists, but also a powerful tool for conservation which could help to restore to us those parts of our cities in which we most wish to linger and look.[13]

When the environmental and technical studies were published in 1971, there was a storm of criticism in the press as the most aesthetically unacceptable pictures of Cabtrack received the most publicity. Wallace Russell, an associate in Robert Matthew, Johnson-Marshall & Partners, which did the studies, felt the critics comments showed "in varying degrees . . . superficiality, irrelevance, seriousness and concern . . . "[14] One designer of the system felt the architectural study was totally mishandled and misused, and the positive characteristics of the system never received adequate attention.[15]

Certainly much of the criticism of the system was based on the aesthetics of the system, the difficulties of making turns through narrow streets, and the unacceptability of small vehicles "buzzing" in close proximity to building windows. There was also concern that it would duplicate existing bus and subway lines, perhaps diverting traffic from these already financially shaky enterprises.[16]

There was some questioning of cost figures and the technical data, but this was usually phrased as a need for more information. Sometimes this need indicated a misunderstanding of the characteristics of the new system, especially the differences between it and a linear system: "I would like to see further examples of Cabtrack operating as a line rather than an area system. . . ."

Others demanded more complete information regarding the capacity of the system, which was thought to be inadequate for rush-hour peaks. There was concern regarding the lack of data regarding the proportion of people who would transfer from other transportation modes and the economic costs of such transfer. There was also concern about the capital costs of duplicating the existing capital tied up in streets and underground lines.[17] Transit experts from the traditional modes criticized the ideas often using analogies as was done in the United States. One compared the cost of footbridges to the purported costs of a PRT network to prove that such a system was unfeasible.[18]

Thus, although it was easy to criticize the new proposal, as an *Architect's Journal* guest editor noted, none of the critics addressed themselves to the problems faced by British cities due to the reduced attractiveness of the public transit systems and the congestion caused by automobiles. There was an implicit assumption that the present system of transport was adequate.[19] Also missing was any consideration of the lack of equity in the existing system as documented more extensively only 2 years later.[20]

This press criticism of Cabtrack resulted in a reevaluation of the project. A change in administration in the Department of Environment then led to an abandonment of the Cabtrack project with efforts channeled into the technically less ambitious Minitram system.[21] The Minitram was a group system that used a similar but larger guideway than Cabtrack and also used a similar control system.[22]

It was thought that the Minitram might offer a means of beginning with a more familiar type of system so that public response and the likely interaction with existing modes could be assessed. The larger vehicles would be appropriate to more limited networks, which could later be expanded using smaller Cabtrack vehicles as more routes and more stations were added. One would lose the advantage of a smaller guideway (at least in the initial areas), but one might gain by having a system that was more readily acceptable to public authorities.[23]

There is some dispute therefore regarding why the Cabtrack project was abandoned. One report states the principal reasons for dropping Cabtrack were:

> 1. Technical goals appeared too ambitious relative to the development funds available and to the benefits to be realized. A one-second headway for cars was not regarded as a realistic objective at that time. Better benefit/cost values could be achieved, it was believed, with larger capacity vehicles operating at greater headways.
>
> 2. Fail-safe features were neither well enough analyzed nor shown to be feasible at reasonable cost. Risks to passengers had been too readily dismissed in earlier studies.
>
> 3. The addition of aerial structures within compact, older areas of London (and similar cities) could have serious adverse environmental impacts, far greater than originally envisioned. Tunneling became the only sensible approach, which would be excessively expensive.[24]

The *Architect's Journal* also reports that Cabtrack's "overly high degree of sophistication was probably the major reason for our not having heard much about it since (the stories published three years earlier)."[25] There was also a debate by some regarding the proper design of the vehicle/guideway interface and control system and their effects on emergency deceleration.[26]

Clearly there was considerable work to be done in terms of complete technical development and the construction of a test facility. There was a 1/5-scale model built at the Transport and Road Research Laboratory, but full-scale testing was needed. One participant reported that the primary problem appeared to him to be the question of money. England's economic troubles at the time simply precluded any investment in advanced technology. This economic problem is borne out in the abandonment of the Minitram project in Sheffield, again essentially for economic reasons.[27]

There were also serious questions regarding the visual intrusion of the larger Minitram guideways (16-feet wide) and its actual usefulness, since most people would have had to take the bus to get to it. Rather than being an intermediate step to a Cabtrack system, the Minitram was criticized as being excessively costly while adding little or nothing in convenience. It was perceived as being less convenient than taking the bus, and much of the criticism of it echoed the criticism of the UMTA downtown people-mover program.[28] Automating a bus may not be an acceptable way to avoid the paradigm challenge of PRT.

Whether the paradigm challenge influenced the abandonment of Cabtrack is unclear. Certainly it was no more acceptable to traditional transportation interests in England than it was in the United States. The attitude of the Greater London Council expressed the attitude well in their 1969 publication, *Tomorrow's London*:

> Some put their trust in electric city cars moving on computer controlled tracks . . . (But) there are a large number of reasons against all single and simple solutions. Those that are based on some advanced technological system are usually both unproven in their effectiveness and extremely costly to install . . . Monorails and travelators are virtually untried under urban conditions, at least under European conditions.[29]

As a result, the Greater London Council opted for a huge investment in motorways. As the *Architect's Journal* stated, "Developments such as Cabtrack form a direct challenge to such received wisdom on urban transportation." Thus, although there clearly was a paradigm challenge, the economic situation in England and press criticism prevented any new system from advancing past the earliest stages of development.

Japan–CVS (Computer-Controlled Vehicle System)

The first step toward development of a Japanese PRT system came in 1968 when a professor at the University of Tokyo developed a transportation game that was tested and displayed at the 1970 Osaka World Fair.[30] In this traffic game, several dozen electric vehicles were operated individually under computer control and ran on a checkerboard-like guideway network with intersections every 5 meters:

> Though primarily designed as an exhibition facility, it was aimed at a future transportation system from the technological viewpoint. In this game, a specially designed minicar for two persons ran on the guideway and communicated with the computer by radio through an underground communication channel. Grade crossing technology was also developed, as it was essential to the highly integrated network.[31]

When the planning for this system began in 1968, the concept was treated as something of a fantasy, but by 1970 the Japanese had begun to pay attention to the various problems of urban transportation. There was considerable concern regarding movement of freight, as well as the usual urban transportation problems of congestion, pollution, energy consumption, accidents, noise, and deteriorating efficiency of bus and freight transportation.[32]

The Japanese Society for the Promotion of Machine Industry, a quasi-public association, began to develop the computer-controlled vehicle system (CVS) based on the traffic game in 1970. This was done under the guidance of the Ministry of International Trade and Industry (MITI) and the University of Tokyo. They began with a miniature model of a system including vehicles and guideway. A total system with 1,000 vehicles was simulated using a large computer to complete technical specifications.[33]

Following this research, a 1/20-scale model of the Ginza area in Tokyo was operated under computer control with the results made public at the 18th Tokyo Motor Show in October and November 1971. The acceptance and attractiveness of the early research led to the construction of a full-scale test facility constructed with the assistance of a consortium of eight private firms (see figure 13.2)

The facility at Higashimurayama City, just outside Tokyo, was the largest PRT test operation in the world. It had 4.8 kilometers of guideway, two stations with berths for passengers and for automated freight-handling, three-tiered computer control, and over eighty vehicles—approximately two-thirds passenger and one-third freight.[34] The vehicles have rubber tires and ride on four wheels like an automobile.

The cost for all this from 1970 through late 1975 was roughly \$20 million—\$10 million of public money and approximately \$10 million from the eight private manufacturers. Testing operations continued on an almost daily basis with short-headway (1 to 3 seconds) operations begun in late 1975.[35]

Americans who have visited the project have been uniformly impressed with scope and attention to detail. The needs of the users have been carefully considered. The vehicle is to be air conditioned, have a spotlight, a radio

Figure 13-2. Computer-Controlled Vehicle System (CVS) Test Facility at Higashimurayama City – Japan.

receiver, and a telephone. There has also been careful design of stations, ticket vending and reading machines, and special ascent and descent mechanisms for the handicapped and blind. There has been much concern to design a total transportation system with the human users' needs and capacities fully considered rather than just to test a technical device. Special elevators have been designed to synchronize with the arrival and departure of CVS vehicles, and underground stops have only such elevators, no platforms, to reduce crime.[36]

There were some difficulties with the system, however. The Japanese acknowledge that the ride on the Phase I test facility was rather rough. They planned to correct this when constructing a Phase II test track by having the guideway built by a ship construction firm, which is accustomed to small tolerances, as opposed to the steel firm that built the original guideway.[37]

Some Americans have criticized the complicated three-tier computer system as being excessively complex and perhaps vulnerable to breakdown.[38] The Japanese claim this system was no more difficult to design and operate than a single computer system, but there are still some skeptics in this country. More importantly, there is concern that the emergency braking system which produces a 2-*G* deceleration might cause passenger injury. Some critics say there is a need for some kind of intermediate braking power between normal braking and a full emergency stop.[39] The Japanese seat people backward in the vehicles to avoid injury, but again, these steps have not silenced their critics.

Still the criticism seems to be of specific details, which could be changed in later designs if this seems necessary. The difficulty for the Japanese has been the reluctance of the Ministry of Transportation to support the MITI program and allow a demonstration project in an urban area. The Japanese who were at the Third International Conference on PRT at Denver in 1975 indicated their problems were more political than technical.

They were reluctant to discuss this subject in detail, but it seemed clear that again the transportation subsystem did not wish to face a paradigm challenge. They seemed much more ready to support the eight GRT systems that were also being developed in Japan. Beyond the paradigm challenge, however, there may also be some bureaucratic rivalry as MITI invaded the domain of the Ministry of Transportation.

To get over this political hurdle, there was some discussion of building a small network in conjunction with the Port Authority of Tokyo for freight-handling only. This agency had the authority to build such a system within their own area without the approval of the Ministry of Transportation as long as it did not carry passengers. This was a highly sensitive political issue at the time, but the idea was eventually abandoned. At least one port authority, Kobe/Osaka, has selected the Airtrans GRT system for larger freight operations, but the CVS system was not selected.

CVS still needed to go through a Phase II test phase to develop reliable and consistent 1-second headways as well as improving the guideways, collision avoidance, obstacle detection/avoidance, and a 0.5-*G* emergency braking system.[40] Although some manually operated and dual-mode vehicles were operated at the Okinawa International Ocean Exposition in 1975, the Phase II development that was to have begun in 1976 was abandoned.

One participant reported that the decision was largely political and was based in part on differences within and among the various organizations making up the development team as well as the difficulties encountered as they moved toward an urban demonstration or deployment.[41] Even though there was an alternative system of appraisal to develop the new system, there were few, if any, alternative systems to take the next step to deployment.

Germany – *Cabinentaxi*

German PRT development began in 1970 with a joint venture of DEMAG Fordertechnik and Messerschmitt-Bolkow-Blohm (MBB), a structural engineering firm and an aerospace firm. The concern was to develop a public transportation system that could attract a large number of people to relieve the automotive traffic problems in larger cities. These problems were similar to those of American cities described in chapter 4:

> Since 1945, the development of passenger transport within the Federal Republic of Germany has been coupled with a heavy increase in private transport. On the other hand, the structure of German towns and the amount of traffic space date back to premotoring days. This, therefore, led to severe traffic jams already during the 1950's. Nevertheless, the public transport companies lost more and more passengers to the private car, and that in spite of the fact that in almost every German town the public transport system offered a very good network and schedule compared with international standards. Due to this loss of passengers, the public transportation companies had to thin out their networks and schedules. In consequence, still more passengers turned to private cars, which led to a further reduction in public transport.[42]

This vicious circle was caused by the reduction in speed for buses and trolleys as the streets became more congested with autos, thus degrading service, and also from the move to more sparsely populated suburban regions, which could not be adequately served with conventional transit. Therefore there was a need to develop a transport system to include the following characteristics: high average speed; individual usage without unwanted fellow passengers, without intermediate stops, without changes en route; on-call operation and 24-hour service; short walking distance to and from station; nonpolluting and low-noise operation; independency from crude oil. These characteristics led to the ideas of: fully automatic operation; individual guideway separated from all other traffic (no dual-mode operations); small vehicles—two to three persons; short headways; and electric power supply.[43]

Although DEMAG and MBB began development in 1970, since 1972, the Federal Ministry for Research and Technology has supported the project with 80 percent funding of the development costs. Under the German system, no particular project is demanded by the Research Ministry. Instead an incentive was offered, which meant that private corporations would approach the government only with those systems that they thought attractive enough to be successful but too costly or risky for private investment alone.[44]

The percentage of government funding is open for negotiation, 80 percent is the maximum allowed. With such funding, the patent rights are still owned by the private firm, but the government maintains rights to collect royalties from successful projects in proportion to the amount of money invested in the system. Eighty percent funding confers more rights than 15 percent funding.

Complete responsibility for direction of development is left with the industry, as the Ministry does not give technical directives: "In this way, the expenses of governmental administration are minimized and the developing industry can react very flexibly to altered circumstances."[45] The government still controls the project through annual status seminars, where the private firms present their results and further planning in the presence of their competitors, analyses by independent experts, and a project monitor who controls cost, time, and work schedules. Sponsored developments also go through four phases:

1. study and conception phase, in which basic results on the suitability of the proposed system are obtained
2. component development phase, in which the critical components are developed and tested
3. test phase, in which a system built up out of pretested components is tested technically and operationally on a full-scale under simulated practical conditions
4. demonstration phase, in which—by building a public network—the system is tried out under real traffic conditions.[46]

A phased program of this type allows the Federal Ministry to cut off a program that does not appear promising at an early phase before major expenditures have been made. This occurred in the case of the Krauss-Maffei Transurban GRT system. The Federal Ministry decided its magnetic levitation system (mag-lev) was too heavy, too complicated, and too expensive. They thought mag-lev might be appropriate for high-speed intercity travel but not for local transportation. Seeing no apparent use for this system, funding was stopped in late 1974.[47]

Some Canadian officials still believe the money was cut off because the first urban deployment of the Krauss-Maffei system was to have been in Toronto,[48] but the former director of the Ministry for Research and Technology insists this is not true. He said the system was too costly and inappropriate for urban deployment. The gross weight of the vehicles was over 25,000 pounds with a carrying capacity of only thirty passengers.[49] This would necessitate very large and aesthetically unattractive guideways. Therefore the Federal Ministry for Research and Technology decided to fund the *Cabinentaxi* PRT system and a GRT system, the *H-Bahn,* as opposed to the Krauss-Maffei system.

The *Cabinentaxi* reached the third phase with a two-kilometer test facility in Hagen, West Germany completed in 1973. Five vehicles, three supported and two suspended, have undergone operational tests since that time (see figure 13-3). Headways down to 0.5 seconds have been achieved at speed ranging from 0-36 km./hr., but passengers were carried at only 1-second intervals under manual control.[50]

A similar system with a larger vehicle and a somewhat larger guideway was also developed. It offers a less attractive service to an urban area, but it can serve more limited markets such as airports, exhibitions, industrial complexes, and hospitals quite well. The first *Cabinenlift* (large-vehicle) system was installed in a hospital complex in Ziegenhain near Kassel, West Germany and has been operating successfully since late 1975.[51]

The *Cabinentaxi* system can also accommodate larger (up to twelve-passenger) vehicles, allowing deploying organizations to begin with a more familiar type of system while leaving open the option of converting to the small-vehicle system. Such a system was selected for a demonstration at the International Transportation Exposition in Hamburg in June 1979, using both large and small vehicles. This short loop will then be expanded to several kilometers for public use in Hamburg.[52]

Plans have also been developed in other cities to have an urban demonstration of the *Cabinentaxi,* but none of these have yet been implemented. The barriers seem to be more political than technical. As in the United States, a number of different governmental jurisdictions must be involved to have urban deployment, making the deployment problems very different from the development problems. Local authorities must be educated to understand the new system, and they must be compensated for the risks inherent in any innovative system. Originally the first deployment was to have been in Hagen, the city where the test facility is located, but a change in local administrations led to abandonment of the project.

The Ministry of Transportation has also been highly skeptical of this new system, and they are in a position to at least hinder, if not stop, deployment of a system developed by another ministry that has invaded their policy space. By law, the federal government shares the cost of the stationary parts of transit systems (not the vehicles) in a ratio of 60 percent from the Ministry of Transportation, 30 percent from the state, and 10 percent local funding. Only

Figure 13-3. *Cabinentaxi*—Germany.

proven systems are subject to this law, so PRT is precluded from this funding because it is new and has not been proven in urban operations. The funding of only the immobile parts of transportation systems also encourages the building of subways rather than other systems, which require more vehicles. The Ministry of Research and Technology tried to get this law changed. They also considered running a parallel effort to generate enough funds within their own ministry to give a town money to erect a system, thus bypassing the Ministry of Transportation, and this is essentially what is being done in Hamburg.

There were other problems as well. German law specifies strict safety requirements for subways, many of which are likely to apply to PRT, as for example rules regarding safe headways. The requirements for subway systems would make it impossible to run a PRT system, which appears to have very different requirements. Therefore the Ministry for Research and Technology had to seek a suspension of the rules for one demonstration to prove the new system is safe and reliable when operated according to rules appropriate for its particular technology.[53]

Unfortunately, as in most countries, planning and policy are often done with short time frames. The concern of local communities is with capital costs, which require only 10 percent local funding. There is little concern for later operating costs. Neither is there interest in the social and service benefits projected for PRT. The idea of endurable hardship is not unique to the United States.

The former director of the Ministry for Research and Technology also feels there is a normal resistance to anything new. Considering new ideas requires extra work and extra responsibility. Planners hide their resistance by saying people would not use the system, but studies done by the development team indicate that only 25 percent of the people express skepticism about the new system. Seventy-five percent indicate they would like to ride it. People can ride in the vehicles at the test facility, and this also indicates high levels of public acceptance.[54] Nonetheless, the public cannot demand PRT because most of them do not know about it. There is no inherent demand for something that does not yet exist. In years past there was no demand for electric refrigerators, but when they were made available to the public, they quickly proved to be more attractive than ice boxes.

There is also considerable opposition to PRT from the automobile industry. The recession they suffered in Germany in the early seventies made them lobby against any system that might threaten the many jobs produced by that industry. Still, the most formidable opposition has been generated by the Ministry of Transportation. They in turn were aided by the fragmented political system, which required many decisions at many different levels of government to get an urban demonstration project.

To overcome these difficulties, the Ministry of Research and Technology paid for a study that was commissioned by the government of Berlin (Senate) to prepare an AGT-feasibility report.[55] The study was to be done by a group of experts under the leadership of Studiengesellschaft Nahverkehr mbH (SNV), an organization that assists local transit operators. The former director of the Federal Ministry for Research and Technology had been made president of SNV, so a person from outside the existing transit paradigm could direct the analysis of AGT alternatives.

A number of German cities including Marl, Hamburg, Erlangen, Dortmund, Hannover, and Berlin-West have expressed interest in AGT systems, and they wanted more information regarding the costs at specific sites and potential service characteristics. The study published in March 1978 examined the *Cabinentaxi* (using the twelve-passenger vehicles), the *Cabinenlift,* and the *H-Bahn.* The authors of the report strongly supported the installation of an AGT system in Berlin. They found the specific operating costs of each of the AGT systems to be lower than the existing bus systems, and their effectiveness analysis indicated the AGT systems are much more attractive to passengers than conventional buses.[56] They did not, however, select between the group and personal systems examined. The choice of equipment would depend on the type of service which was desired.

With the selection of a *Cabinentaxi* system for Hamburg, it appears that the political barriers to change are being surmounted. This has been a long and difficult task, since the developers feel the system has been ready for an urban demonstration since 1975, and there will undoubtedly be future difficulties as the funding for new systems moves from the Ministry for Research and Technology to the Ministry of Transportation.

The German experience illustrates the effectiveness of an alternative system of appraisal in developing new systems, and it also indicates that such a system of appraisal will require considerable political as well as technical skill to get the first demonstrations of its systems. It is also important to note the key impact a particular individual may have on any human system. Dr. Hermann Zemlin was the director of the Ministry for Research and Technology when the *Cabinentaxi* was developed. He later became the president of SNV with responsibilities for the first implementation studies. His persistence, along with his political and technical skills, may have been crucial to the final outcomes. Even if better organizational systems are designed, having the right people managing those systems is essential for success.

France–*Aramis*

An inventor, Gerard Bardet, began the idea for the French PRT system in 1967 on a budget of 10,000 francs. He may have been inspired, in part, from ideas that originated in the United States.[57] Bardet's patents were purchased by Engins-Matra in 1970, which did design studies, site feasibility studies in the

Paris suburbs, and prototype development with the aid of a state agency, DATAR (Government Office for Territory Development).

The French metro authority (Régie Autonome des Transports Parisiens–RATP) had a minor involvement in this program. They participated in the technical group, which monitored the first year, and contributed roughly $100,000. They saw a need to collect people in the Parisian suburbs to take them to the metro stations, which led to a minor interest in the program.[58]

A prototype test track of 1 kilometer was built at Orly Airport in Paris for an exposition in 1973, and testing has been carried on since that time. Again, the vehicles resembled automated automobiles (see figure 13-4). The first phase of testing was completed in 1974, and the second phase of safety and reliability testing was begun under the direction of the RATP, which then began 70 percent funding of the project.[59]

The second phase was to proceed in three parts.

> Part I–Design Review, September 1974 to September 1975:
> Analyses of equipment, costs, reliability, safety and traffic management.
> Technical qualification of critical components.
> Redesign of the Aramis system incorporating features proven from RATP experience with the Paris Metro and from the design review.
>
> Part II–Qualification Tests, September 1975 to March 1977:
> Construct a new test track, 3 km. long with 3 stations, crossing switches, underground and elevated sections and 10 to 15 vehicles.
> Conduct qualification tests on the maintainability and automatic diagnostic equipment.
>
> Part III–Experimental system, March 1976 to May 1978:
> In parallel with Parts I and II, case studies will be made of possible Aramis installations in the Val de Marne district near Paris.[60]

Although the RATP is reported to have a strong research group headed by people who graduated from the *Ecole Polytechnique,*[61] parts II and III of the above program have not yet been implemented. One source suggests the RATP was considering using twelve-passenger vehicles for the second test facility, but that has not been done either.[62]

Again one is led to believe that traditional transportation experts have found a system that challenges their existing paradigm to be unacceptable. The suggestion that the *Aramis* system needed to be redesigned incorporating features proven in the Paris metro gives some indication of the transportation system's thinking.

The *Aramis* system is particularly interesting, since it was operated at 0.2-second intervals–roughly 12 inches between vehicles. French law requires

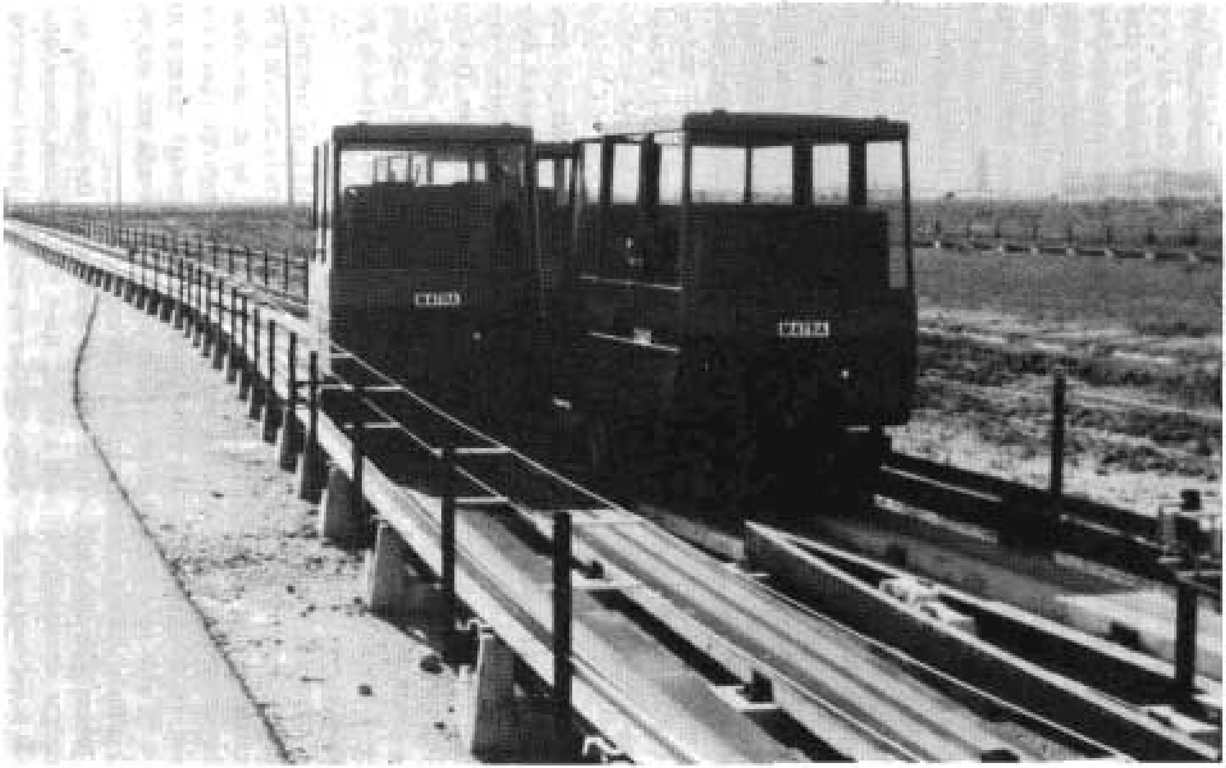

Figure 13-4. *Aramis* Vehicles–France.

60-second intervals between train systems, however, so the vehicles are said to be electronically coupled and run in platoons like trains, although individual vehicles can leave a platoon at any given exit. Such a platoon system allows capacities up to 20,000 people per hour per line, making merging easier, and lets the French PRT system meet train safety standards as required by law.

Thus the paradigm challenge was only partial in France. Perhaps the original idea sponsored by DATAR was a challenge to the existing transit paradigm, but the dominant position of the RATP prevented a full challenge. The requirement to meet train safety standards was achieved, and there was apparently no intention to run the French system as a full network as has been contemplated in other countries. The merging of vehicles in front of platoons precludes such a network feature: "We would never have a network in France as is planned in the U.S."[63]

Although it is still not entirely clear what the future of the French *Aramis* system may be, the project has been "napping" since 1976.[64] The takeover of the research by the traditional transit agency suggests that it will be changed to be more like conventional transit or abandoned altogether. For other PRT developments, however, the French have proved the feasibility of fractional-second headways, which they claim are safer than more distant headways.

Conclusions

It is significant to note that urban transportation problems similar to those found in the United States are also being experienced in other countries. Even with public transportation systems that have been considered far superior to our own, people still prefer the automobile as soon as they can afford one. This has caused even more severe problems in European cities, which were built long before the automobile existed. Therefore, there has been a felt need to develop new types of transit systems often influenced by ideas that originated in the United States.

These countries were able to go further with the testing of innovative systems that challenged the existing transit paradigm apparently because they had alternative systems of appraisal that were not threatened by the new ideas. In all four countries, initial research was sponsored by agencies that were independent of the existing transit subsystem. These alternative systems of appraisal were able to encourage much of the preliminary design and analysis work, and in three of the countries actually built test facilities.

Even where such test facilities were able to demonstrate the feasibility, and to a degree the desirability, of such systems, there has still been considerable difficulty in implementing urban demonstration systems. The transit subsystem, whatever its specific character in a particular country, is still in a position to claim its traditional policy space and deny either authority or money to build an operational system in the urban environment.

Thus if one were to design an alternative system of appraisal, some provision for deployment of a demonstration system should probably be made part of its domain. Even with such authority, there are still likely to be difficulties as the multiplicity of governmental jurisdictions creates complex requirements for approvals and concurrences. Such approvals may be easier to obtain if revolutionary innovations can be made to appear more familiar, as in the case of the twelve-passenger *Cabinentaxi* vehicle, which is compatible with the smaller PRT vehicles. This allows traditional transit interests to deal with change one step at a time and thus may reduce the level of threat implied by the small-vehicle system. Later, as the network expands, the desirability of small vehicles to serve a multiplicity of origins and destinations may become more apparent.

The German experience also points up the importance of key people in organizational systems. Even with the best of systems, the issue of personnel risk cannot be overlooked. Selecting the right people, with the right combination of technical and political skills, appears to be essential for successful development and deployment of technological innovations.

From a technical perspective, these systems from other countries give specific evidence of the relatively low costs that are involved in prototype development. Their estimates of the costs to build and operate PRT systems also confirm the analysis of Aerospace Corporation regarding these costs. There appears to be a clustering of values, which allows more confidence regarding the range of expenditures likely to be required to test and build a PRT system. (See table 13-1.)

Table 13-1
Cost Estimates for PRT Systems

	Costs of Early Design, Test Facility Construction and Use Through 1975	*Cost per Mile of System Including All Facilities (000,000)*	*Cost per Mile of Guideway (000,000)*	*Cost per Vehicle*	*Weight of Vehicle (pounds)*
England	no data	no data	$1.5	$ 3,500	1,320
Germany	$16,000,000[a]	$2.6	no data	$ 9,500	1,320
Japan	$20,000,000[b]	$3.32	$1.61	$17,000	1,700
France	$ 9,000,000[c]	$3.2	no data	$24,000	1,430
Aerospace Corporation	$25,000,000[d] estimate	$4.15	$1.3	$10,000	1,800

Sources: N.D. Lea Research Corporation, *The Lea Transit Compendium, Personal Rapid Transit,* Vol. II, No. 4, 1975.

Note: It should be noted that the English data are based on estimates made in 1968 without a test facility. All the other estimates are current as of 1975, but each is made with varying assumptions regarding the size of the system to be built ranging from a small demonstration up to a 280 mile system. There are also varying assumptions regarding the number of stations and number of vehicles required. Therefore these data are illustrative only. The actual costs of the test facilities are shown for Germany, Japan, and France, and their experiences with the test facilities may make their other data more credible. The Aerospace estimates for the cost of a test facility are highly tentative, while the costs of a 100 mile system, with 200 stations and 10,000 vehicles was costed out with potential vendors.

[a]Hermann Zemlin.

[b]Yoshio Tsukio.

[c]Gérard Levy.

[d]Jack Irving.

14 Technological Innovation and Public Policy

Initially, one of the purposes of this book was to present a theoretical framework to show how the processes of technological innovation were linked to political-administrative processes. Such a framework also illuminates some of the political-administrative relationships that may foster or deter such innovation. The events that have taken place in the case of personal rapid transit (PRT) help to give substance to the theory.

There is still a need, however, to draw from the specific examples a more generalized model of the political process as it relates to technological innovation. Although it is always dangerous to generalize too broadly from what is essentially a case study, some characteristics of technological innovation have been identified that appear to apply in areas beyond the specifics of a particular case.

It will be recalled that technology was defined as knowledge of the means for accomplishing a particular practical end. Tools, equipment, and machinery are the artifacts of technology. If we agree that technology involves practical knowledge and skills, such knowledge and skills must be held by human beings, who use their skills in social and organizational roles. These roles are based on the nature of the technology, so technology is clearly an essential component of social systems. It helps to define roles, skills, statuses, and power. It gives shape to jobs and careers as well as setting constraints on organizations and organizational networks.

This is not a crude technological determinism, since in most situations there are a variety of means to achieve human purposes. Technology remains a human choice, which humans evolve, change, and modify. Once the choice of technology is made, however, certain limits on further human choices become apparent. The choice of a train transit system implies one pattern of roles and skills, whereas the choice of bus transit or PRT implies other patterns of roles and skills.

The roles affected are not only those of the people who will build and operate the system, but also the roles of their political controllers and the roles of the public, which will use, or resist using, the system built. In the public arena, different technological choices offer different statuses and influence to both elective and appointed officials, as well as the special interests that support or oppose them.

Changes in technology therefore require changes in roles, role-sets, organizations, or organization-sets at both the administrative and political levels. These changes may be small or large, may involve minor behavioral changes or a major restructuring of power relationships, or even a change in the goals, objectives, and values of the individual role or the total organization-set. These two dimensions of change—its areal impact and its depth of penetration are illustrated in tables 2-2 and 6-3. These tables make clear the interactive effects of the characteristics of the innovation and the characteristics of the individual or organization to which the innovation is being introduced. What is deemed a revolutionary innovation by one role or role-set may be perceived by other roles and role-sets as a minor behavior or rule change. Thus one can ascribe characteristics to an innovation only in relation to particular roles or organizations.

It is not correct to say PRT is a revolutionary technology. It is revolutionary only to the organization set that makes up the public transit political subsystem. For other organization-sets and for the society as a whole, its adoption would involve only minor behavior and rule changes at least during the early years of its adoption (see table 6-3). Later there might be larger power shifts if it proves to be an equalizing rather than stratifying innovation. Over a very long period of time, it might affect the decline in power of the petroleum industry and the automobile industry, but this is highly problematical, since larger forces such as the depletion of earth resources will probably have a greater effect than any change precipitated by the widespread adoption of PRT.

Given this situation of penetrating change within the transit subsystem with relatively minor change in the larger society or macropolitical system, one would expect to find resistance to PRT within the subsystem most directly challenged by the new technology. For them, ". . . the adoption of new technologies reduces the value of present resources—whether physical or human—and introduces elements of uncertainty."[1]

The new technology would require new skills and new methods, which implies new people replacing the existing personnel. Jobs and careers would be threatened. The existing network of roles with their essentially stable relationships would be disrupted. There would also be a change in dependency relationships, which would in turn create new contingencies for roles, role-sets, organizations, and the total organization-set that make up the transit subsystem.

This is coupled in the public arena in the United States with a pattern of functional specialization, which places responsibility for particular programs or issues with a particular political subsystem (or organization-set). There are political subsystems for public transit, energy development, agricultural commodities, development of dams and waterways, and so forth. Any proposal regarding one of these functional subsystems is turned over to the subsystem for assessment and action.

Thus we have a situation where a functional subsystem must assess the merits of a new technology and determine what, if anything, is to be done with it. Restructuring or revolutionary technologies are, by definition, threats to the existing pattern of roles, statuses, powers, and/or values of the subsystem and are therefore unlikely to be acceptable. This leads to the hypothesis that restructuring or revolutionary innovations will have to gain the attention of the macropolitical system to be adopted.

The evidence from this study suggests a modification of the hypothesis, however. The New Technology Opportunities program in the United States, and the PRT development programs in England, Germany, and Japan suggest that different political subsystems can also offer alternative systems of appraisal and thus serve a function similar to that of the macropolitical system. The criteria used by these alternative systems of appraisal are likely to be different from that of the functional political subsystem, and the pattern of threats and opportunities may encourage rather than impede the innovation.

The New Technology Opportunities program in the Office of Science and Technology could be considered part of the macropolitical system because of their location in the Executive Office of the President. In another sense, however, their lack of public visibility made them an alternative subsystem with specific responsibility to assess new technologies. A new technology such as PRT presented them with an opportunity to fulfill their mission and to promote their values.

The NTO group did not, however, have the power to finance or manage the development of the new technology themselves. They had to work through the existing political subsystems. In the case of PRT, the existing subsystem was able to resist the changes proposed for them by the NTO group. Lacking the support of the macropolitical system, the NTO people could not force their will on a reluctant subsystem.

In England, the Department of Environment, in Germany, the Ministry for Research and Technology, and in Japan, the Ministry for International Trade and Industry were assigned a greater range of responsibility by their respective macropolitical systems. They could not only assess new technologies, they also had the authority to finance and to a degree manage their development. This gave innovators in those countries an alternative system of appraisal, which had the power and money to act and which was not threatened by an innovation that the functional political subsystem found to be restructuring or revolutionary.

The Hypothesis Restated

Political subsystems will reject innovations that are perceived to be restructuring or revolutionary to themselves. To gain support for such innovations, it is necessary to move to another system of appraisal, which may be either the macropolitical system or an alternative subsystem with responsibility for developing technological innovations.

The availability of an alternative subsystem may be a more effective way to develop new technologies for two reasons: (1) It is difficult to gain the attention of the macropolitical system, and (2) the macropolitical system is unable to maintain its attention on any one issue for very long and must turn over the program to an administrative agency for continuing attention and development. In the absence of an alternative subsystem, the program is likely to be returned to the political subsystem responsible for the area in question—the very subsystem most likely to resist the change and suppress the innovation.

Macropolitical attention may be gained through a major event or crisis. The media and the public become concerned and bring pressure on elected officials to "do something." This implies a need for immediate action, which may preclude the development of a new technology that cannot alleviate the problem quickly. A major shortage of gasoline could not be solved by beginning a 5-year development program for PRT or individual size fuel cells for household generation of energy.

In the area of domestic problems it is not possible to use the cry of defense and space officials, "The Russians are coming! The Russians are coming!" There are no Sputniks in public transit or housing or even energy development, although in the latter field "foreign oil interests" may serve as an effective substitute. Although it is not impossible to gain public attention for domestic issues such as public transit, it is difficult to gain such attention in a way that encourages the long-term development of alternative technologies.

Broad legislative interest may also require a major event or crisis, but even then, there is a well-defined division of labor among committees. This division of labor is reinforced by unwritten agreements to avoid interfering in each others domains. Where legislative committees (and more particularly committee chairmen) have maintained close and longstanding ties with their bureaucratic counterparts, it becomes virtually impossible to penetrate the macropolitical system through the legislature.

Where the relationships between the legislative committee and the bureaucratic agency are not so close, the committee controllers can offer access to the macropolitical system. As in Minnesota, they can lead the way to new technological appreciations. This approach seems to be most effective when the committee chairman is new to his job; when his role, powers, and status are not so closely intertwined with the existing technology. The approach also requires that the chairman and the committee view themselves as controllers rather than supporters or promoters of the executive agencies in question.

Penetration of the macropolitical system through the executive branch of government is also difficult. Presidents, governors, and mayors face severe pressures for alternative uses of their limited time and funds as well as conflicting views on the policy issue at hand: "Consequently, their responses are largely directed toward shifting responsibility to others and responding minimally to crises."[2]

Nonetheless, every aspect of executive branch activity is theoretically within the domain and legitimate concern of a chief executive. By gaining the attention of these executives through their staffs or through executive oversight agencies, some macropolitical attention may be achieved. The amount of attention and the quality of attention varies considerably with the perceived importance of the issue, but if some institutional arrangement for continuing attention to the issue can be gained, the transitory nature of the macropolitical attention can still achieve results.

This brings us back to the second problem, the availability of alternative subsystems. Without such alternatives, the only places available to give continuing attention to the issue are the existing subsystems with their preferences for the status quo. In a few instances of great public concern, an executive may appoint new people to the political positions within the existing executive agencies to develop the innovation, or new subsystems may be created to operate independently to develop the idea.

Both these latter options may be difficult to carry out without considerable public and legislative backing. They also carry certain risks. The new people may be coopted by the existing subsystem network and not carry out the development plans adequately. Creating new agencies for an untried idea may create a constituency for an idea that should (and would) be scrapped if a particular organization did not depend on it for its existence.

Therefore an alternative subsystem with a specific mission to assess and to develop new technologies such as the Ministry of Research and Technology in Germany, the Japanese Society for the Promotion of Machine Industry, the Ministry of International Trade and Industry, or even the more limited Department of Environment in England, may be more appropriate for governments which wish to encourage technological innovation. Such alternative subsystems may also have problems of ossification and a tendency toward excessive centralization of technological innovation, but these could perhaps be inhibited through policies regarding multiple alternatives for screening innovative ideas within the organization and by requiring rotation of people into and out of the organization on a regular basis. In the United States, state offices of research and technology might provide additional alternative systems of appraisal.

Excessive centralization might be avoided by limiting the domain of the alternative subsystem to the development of technologies that serve public purposes or perhaps purposes that are accomplished essentially by public agencies. Other policies might encourage the creation of venture capital for private firms, and changing the federal government's existing policy on patent rights and the funding of research could also encourage more private development.

Finally, these alternative systems of appraisal could be structured so that the direction is not simply toward the development of new technical gimmicks but toward technical systems that enhance human life. The measures for assessing any new technology would have to be enlarged from mere questions of technical feasibility to the larger questions of human desirability.

Humans must be used as the ultimate measure of desirability. The individual, social, and political effects on users, designers, builders, and operators of the new system will have to be assessed as will the effects on existing organizations. The effects on organizational domains, boundaries, and networks as well as the skills, roles, and power of members of the organizations will all have to be included.

This means that aggregate cost-benefit analyses will be inadequate. The gross estimates of costs and benefits ignore the specific political questions of who pays and how much do they pay, who benefits and how much do they benefit. How are particular groups and interests affected? Which values are enhanced, which are damaged? More explicitly, political considerations regarding the equalizing or stratifying consequences of a new technology will become more important, as will the new technology's potential effects on human diversity versus conformity, freedom versus regularity, government control versus individual control, independence versus interdependence, or the new technology's vulnerability to public violence, strikes, or other human failures: "Political and social analysis should become just as indispensable a part of making decisions on transportation policy as origin and destination studies. . . "[3]

Technology is not neutral. Its consequences have different effects on different segments of society, fostering some values while perhaps damaging others. This will be true not only in regard to public transportation, but also in the selection of other technologies that will be influenced by government actions, such as energy production, housing construction, ocean exploration and development, space exploration, and so forth. Each of these will have effects that not only are immediate but also will have consequences for future generations.

Whereas examining all these social and political factors will be a difficult task, one which obviously cannot be done with infallible accuracy, there is still a need to make the attempt—to make these types of considerations as much a part of technical assessment as the more traditional measures. Even with such analyses, unintended consequences for good or for ill are likely to occur. Our means for predicting future outcomes are limited. One need only consider the effects of the automobile on the economy and society in the United States or the effect of xerography on the idea of official secrecy to see some dimensions of the problem.

Nonetheless, there is a great deal that can be foreseen if political and social analyses are done. Such analyses are more likely to clarify the utility risk of a particular course of action and to assess its societal impact. Adversary reports with different positions rather than a single consensus report could help illuminate controversial issues. Such reports may also make technology assessment more understandable and accessible to nontechnical people. This may have the effect of intensifying resistance to particular changes as the distribution of costs and benefits reveals inequities or particular costs to special interests.

The benefits of such a debate, however, appear to the author to outweigh the costs. Today it is the specially affected interests who are most likely to have information regarding the real distribution of benefits and costs of a particular technology. It is the elected official and the general public who need better information to understand the potential effects of new technologies, and these are the people who are least likely to have such information now.

Technology and the Struggle for Power

Without alternative systems of appraisal, new technologies are evaluated by agencies of government that have established policies accompanied by a network of organized interests with preexisting conflicts and debates. The new technology may threaten these essentially stable relationships. As in the case of PRT, it may change the terms of the debate from highway versus transit to new transit versus old transit. Thus the new technology becomes part of the struggle for power, influence, status, authority, and budgets. One study suggests there are five significant attributes of innovations that influence whether or not they are adopted and the rate of adoption. These are: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability.[4] Each of these characteristics is significant only in the way it is perceived by potential adopters.

Relative Advantage

When government agencies act as adopters of new technologies for the society as a whole, their assessment of these characteristics may be skewed by explicitly political considerations. Relative advantage to the agency may mean a technology that will enhance its support within its organizational network. The questions of concern relate to whether or not the new technology will enlarge the budget of the agency or expand its domain. Whether it can enhance the agency's stature with its legislative or executive controllers, whether it will strengthen or weaken its support with its traditional allies, whether it solves the agency's immediate problems, making life less rather than more complicated, may all be more significant questions than questions of its benefits to the ultimate user.

Compatibility

Questions of compatibility are concerned with whether or not the new technology competes with existing programs. Agencies appear much more willing to add programs rather than replacing old programs with new ones. Replacement means disruption of careers and statuses, existing relationships with clientele, constituencies, and controllers. Addition means an expanded domain, larger budgets, more people, and more opportunities for promotion.

There are also questions regarding the compatibility of the new program with the organization's existing skills and competencies, its goals and values. By definition, a revolutionary technology will be incompatible with many of the organizations existing goals and values, and therefore less likely to be acceptable, as shown consistently in this study.

Complexity

Because a revolutionary technology requires considerable change in ways of thinking about a particular problem, it is likely to appear quite complex. It will be difficult to understand, and therefore difficult to explain. This is compounded by the many time demands on public officials, who find it difficult to spend the several hours it may take to explain the new idea. Therefore assessment is pushed to peripheral figures within the organization or given over to lower-level staffs, making it more difficult to gain the attention of the macropolitical system, which might find it more attractive than the organizational subsystem.

In the case of PRT, not only was the basic concept difficult to explain quickly, but there were many questions that could be raised regarding details of the system and its functioning. Often these questions would not be raised during a presentation of the ideas, but later, when no one who thoroughly understood the system was present. Then questions of reliability, line blockages, criminal violence, or vehicle sharing might be brought forward. If no knowledgeable person were present, it became easy to dismiss the new idea as interesting but impractical.

Later, as problems with the Morgantown system or the BART system in San Francisco surfaced, the most damning question became, "If we can't do a Morgantown (or BART), how can we possibly do this?" The appearance of complexity and the lack of understanding were thus effective barriers to a full consideration of the idea.

Trialability

Even though trialability might have been relatively simple and inexpensive (relative to costs of building transit systems and highways), the assumption of many officials both within and outside the transit subsystem was that such a trial (or test facility) would be very expensive and a high-risk venture. As the international experiences demonstrated, initial investments to test technical feasibility and consumer acceptability could be done for under \$25 million. Even the next step of building small networks in urban areas would not be prohibitive in cost (\$100-\$250 million),[5] but it was often assumed that one would have to build an areawide network costing billions to find out if it would really function effectively in technical, economic, and social terms.

Observability

Prior to the construction of test systems in other countries, there was no way to observe a PRT system in operation. Even with such test facilities, it was easy to raise questions regarding their practicality in an urban setting. It is often the nature of a revolutionary technology that it is not observable until the first demonstration is in place, thus making it more difficult for potential adopters to justify a decision to move ahead.

Domains

There were also questions regarding appropriate domains—who should do the project, who would pay for it, and so forth. In government the question of who will do the project may be more important than the question of what is to be done. Government agencies compete with each other for policy space, while private organizations compete with each other to determine which will get the contract. Any decision will involve a few winners and many losers, so there is continuing action to modify or reverse unfavorable decisions by those who did not win at an earlier decision stage.

Political Climate

Finally, there must be a consideration of the political climate and the amount and likely persistence of support for a particular project. The longer the time and the greater the amount of dollars to be committed, the more difficult it will be for an agency to sustain support from both its executive and legislative controllers.

Experimental systems tend to be viewed unfavorably by executive and legislative controllers, who want to see visible results from the expenditure of funds in a relatively short time. They want something "useful," meaning working to benefit their constituents, not a test facility in a remote location that will never be seen or used by the public. The UMTA moves away from research and toward demonstrations were essentially in response to this demand for useful action now.

Thus most of the political forces within and surrounding an established governmental agency act to discourage the development of restructuring or revolutionary technologies. The depth of penetration of such technologies creates more threats than opportunities for established political subsystems. As the new technology affects and constrains political roles, role-sets, organizations, and organization-sets, as it promotes some values while damaging others, it will become part of the political debate with political consequences.

Forces for the Status Quo

There are, of course, other forces for the status quo. Some of these can be termed institutional problems, whereas others are more analytical problems such as the myth of objectivity and the analytical reduction.

Institutional Problems

The functional division of labor, which turns transportation problems over to transportation experts, is only one among many difficulties that are frequently clustered under the term "institutional problems or constraints." When dealing with a social technology such as public transportation, there are other institutional problems that also tend to reinforce the status quo. One is the fragmented political-administrative network, which deals with issues of public transportation.

There are jurisdictional boundaries, which in large metropolitan areas include a multiplicity of city, county, and state governments as well as a variety of planning and modal agencies with varying and frequently overlapping domains and responsibilities. There are dozens of points where approvals, cooperation, and agreements must be reached before any affirmative action may be taken. In addition to the official bodies, there are many special interests who operate outside the formal structures of government to gain or prevent approvals of particular programs.

All these special interests have a stake in the existing debate and the existing technologies, and have established relationships, which are mutually reinforcing. The interests that support change and the new technology tend to be small, weak, and divided. The proponents of PRT may argue that their system will be good for transit users and the society as a whole, but they find it difficult, if not impossible, to organize the general public to support a complex idea with its inherent uncertainties due to its very innovativeness and newness. Small intensely organized interests with a clear stake in a particular issue can easily overcome more diffuse interests, which are supported apathetically if at all.

Furthermore, the public transit network is a maze of mutual dependencies, with no agency having full authority or sufficient resources to act without the agreement of others. Gaining the attention and support of one agency is not enough to move forward with an innovative proposal. The network, which includes organizations at the federal, state, and local levels of government, can be characterized as having considerable power dispersal. This allows more ideas to be presented and considered but makes implementing an idea more difficult.

Resources are also dispersed to a degree, but the federal government dominates the network because its resources are much greater than the resources that can be raised locally to build or to operate public transit systems. This resource dominance gives UMTA (the federal agency with responsibility) a preeminent position to veto local plans that require federal funding; it also gives UMTA the potential for instituting new systems, since local governments apparently devise their plans with an eye to what UMTA will approve.

This presents the private innovator with a small, oligopsonistic market with monopsonistic overtones. Even though an individual sale might be quite large, the number of potential buyers for any particular public transit system is quite small. (Although PRT shows potential for serving quite small communities if it can be marketed on a mass production basis, only a few of the 200 largest communities seem to be likely prospects for the initial installation of such systems due to start-up costs, the perceived local need for public transit, and the resources available to the communities.) To the extent that UMTA dominates technological choices through its capital grants program, the market for public transit is a monopsony. Such a situation provides poor economic incentives for private entrepreneurs and innovators.

This need not be the case, since UMTA could act as a market catalyst and encourage technological innovation either by sponsoring research-and-development efforts or by agreeing to fund a new system if it is selected by a local government. Even this might not be enough, however, since those who are dissatisfied with a decision in government can continue to try and change it. As administrations change and new people come into office, old commitments may be dropped making the market highly uncertain.

In the absence of federal support, the city and county market is essentially too splintered in location and product requirements to warrant expensive private development of revolutionary transit products. There are few single local governments that could afford a research-and-development program of their own, and even if they could, the governmental decision makers could be accused of promoting an expensive boondoggle to develop esoteric hardware.

Even within organizationally simple jurisdictions such as Las Vegas, there are severe political problems in instituting a new technology that threatens the existing political and economic power structure. Those who benefit from the status quo are in a position to delay and disrupt new developments, which make them economically unattractive to private developers.

Another aspect of the fragmentation problem occurs in the federal requirement that cities and counties have local and regional plans regarding land use. These interlocking plans are time consuming to prepare and difficult to agree on. They frequently include a transportation element that reflects ideas of the "ideal" city, which is usually more dense such as San Francisco or New York, rather than dispersed like Los Angeles. Such dense configurations require public transportation of the traditional sort—trains in the larger jurisdictions, streetcars (light rail systems) and buses in smaller jurisdictions.

Therefore, in local communities, a new technology such as PRT disrupts far more than the transportation subsystem. Planners and community groups which have been fighting for public transit to aid the implementation of their plans find the new technology threatening. It (the new technology) enters into an old debate between the planning/transit interests and the highway interests. When the people who favor PRT point out the inadequacy of train or bus systems, they immediately alienate the traditional supporters of transit while gaining only superficial support from the highway interests, which may view this new idea as a means of delaying or halting the traditional transit systems. In this situation, organized support for a new system is difficult to develop.

Beyond the fragmentation problem and the interlocking network of existing interests and plans, there are also questions of "prudent design" which may make it difficult for new technologies to be accepted. Engineers and designers are held liable by the courts for violating the canons of prudent design, and insurance companies enforce such standards as a requirement for insurance coverage. As was noted in chapter 6, prudent design is usually defined as doing that which was done before.

A fourth institutional barrier involves patent rights to technological artifacts that may be developed with public funds:

> UMTA's policy with respect to patent rights to inventions, improvements, and discoveries arising from UMTA-funded research and development, whether undertaken by direct contract or by grant, is to require the contractor or grantee to agree that the Administrator shall have the sole exclusive power to determine the disposition of all patent rights. As a general rule, title to any patent rights arising from UMTA projects is reserved for the Government, and licenses are made available to the public on a nonexclusive basis.[6]

In this situation, unusual but occasionally great projects may be neglected because individual firms would not risk innovating when rivals could freely imitate after most of the risks have been eliminated by the pioneering firm:

> Only about 15 percent of the inventions patented by the U.S. Department of Agriculture and the Tennessee Valley Authority are used by private industry (although they were developed for that purpose), while between 50 and 60% of inventions patented by private firms are used commercially.[7]

This would indicate that when the value of patent rights is reduced by making them available to all, such rights are not widely used, or else the more valuable patents are produced where private gain can be realized from them, that is, not with public money.

Nonetheless, there are some innovative ventures that need public financing because of the lack of venture capital or the size of the project. The approach adopted by the West German Ministry for Research and Technology provides some insight into a system that protects patent rights for those who develop a particular artifact while still protecting the public interest when public funds are used to develop the artifact.

The Ministry for Research and Technology is authorized to provide up to 80 percent funding for research and development projects it finds promising. Any inventions developed with such funding remain the exclusive property of the developer, but the government receives a royalty on any sales of the device, proportionate to the amount of money invested. Eighty percent public funding gives a 40 percent royalty, 50 percent funding gives a 25 percent royalty.[8]

Although this simplifies the actual operations of the German system, it does demonstrate one method of encouraging private innovation and also of holding public funding to a minimum through the reduction in profits that results from greater use of public resources. More speculative projects can still be encouraged by the 80 percent funding when it is required, and at every level of funding the public interest in public investments is protected by the payment of royalties in proportion to the public funding used.

A fifth institutional problem has to do with the role of government as adopter of a particular technological innovation. In the case of defense or the space program, government is not only the adopter but also the user of the technologies adopted. For most social technologies, government may be the adopter, but it is not the ultimate user of the technology. Such is the case in transportation where the users are the riders in the transportation systems selected.

In this situation, the benefits and costs to the users and the adopters may be different and to a degree antithetical. A high level of service may be very important to the user, but providing such a high level of service may bring few, if any, advantages to the transit operator. It may even bring disadvantages such as higher costs, which require greater dependency on outside sources of revenue.

On the other hand, building a high-cost, capital-intensive train system means more resources must be made available to the transit operator allowing the organization to expand, creating more opportunities for career advancement. It also places the burden of change on those outside the transit subsystem. For automobile users, the change to riding a train system would be at least a restructuring change, as they would lose the power to choose destinations at random and to operate on their own schedules and in privacy.

Such a change might also be revolutionary, since it would tend to cause greater stratification of society and would also require sharp changes in values regarding freedom from fixed schedules and the loss of independent travel. Since these systems have proven less attractive to the public over many years, there is an acknowledged need to coerce people into using the systems. Government has the power to create inducements for people to use their systems so there is little incentive to find a more attractive service. With 80 percent federal funding of capital costs plus the promise of operating subsidies there is little more incentive to build the most cost-effective systems either.

Thus there is a disjunction between user needs, operator needs, governments' needs, and societal needs, which may help to explain some of the difficulties noted in the introduction of new social/domestic technologies. When the adopter is not a single individual or organization but a whole network of individuals and organizations, the difficulties in reaching an agreement are magnified, and the needs of those not directly represented in the deliberation and bargaining—the users—are neglected.

As stated earlier, technological choices are not neutral. Any choice enhances some values while damaging others. Each change includes costs and benefits, opportunities and constraints, which fall unevenly on different actors in organizations, organization-sets, or whole societies. Technological choices can have the effect of equalizing or stratifying society; they may benefit a few or many; they may require authoritarian controls or democratic controls. Some technologies allow or encourage diversity as opposed to conformity, freedom as opposed to regularity, individual control as opposed to organizational or governmental control, independence or interdependence.

These are all explicitly political consequences that, in the public arena, cause particular interests to seek decisions which favor their own special values. Technological choices can determine "who gets what," which is why "for domestic/social agencies, the political environment pervades 'technical/business' decision-making to an extreme degree."[9] When the politics of technological choice are dominated by a particular political subsystem, one would expect that such choices would primarily reflect the needs of that subsystem.

To the extent the needs of the subsystem, the users, and society as a whole are consonant, such choices would serve the larger public interest. When they are not consonant, the narrower interests of the subsystem would be expected to prevail as long as they are not obviously and explicitly opposed to a clear public interest. Often, however, the larger and more general interests of society as a whole are not entirely clear, and the alternatives to the subsystem perspective are not widely known. In this situation, it is difficult to oppose the interests of the subsystem, which can be made to appear as if it were serving the public interest. The arguments made for train transit systems, and the difficulties encountered by the proponents of PRT illustrate how this occurs.

There is a sixth institutional problem regarding the idea of legitimized domains. In Las Vegas the feeling developed (with the assistance of the opponents of the new system) that public transit was a public problem that should not be exploited for private gain. Public transit was no longer to be a domain of private enterprise but was to be operated at public expense for public benefit. If this perception is widespread, it marks a distinct departure from earlier transit history, where public transit was clearly the proper domain for private enterprise. To be sure, such enterprise had to be regulated to prevent abuses such as those described in chapter 3, but private profit was still seen as legitimate in this area.

If public transit is to be a public enterprise, there is still the question of who should innovate to improve public transit systems. Local governments and local transit operators frequently note that technological innovation is not part of their domain. Development of innovation should be done by the federal government and/or private manufacturers.

At the federal level, there is apparently little agreement on the proper role of government in technological innovation regarding transit. There is the issue of private development versus public sponsorship of development. There is also the issue of responding to the demands for innovation from the transit industry–for improved brake shoes or less costly buses–as opposed to the demands for long-term system changes that may involve restructuring or revolutionary innovations.

It is argued that public organizations innovate to the extent they are authorized to innovate–to the extent innovation is a legitimate part of their organizational domain. They must also have financial support for this part of their domain and the freedom to make some mistakes. This latter element involves not only additional costs, but also requires, for want of a better term, psychological support.

Actors in executive agencies work hard to avoid mistakes that may come to the attention of their legislative controllers and create public criticism of their individual or organizational capabilities. Support for a variety of approaches at the earliest stages of innovation may encourage more bold and even revolutionary innovations. Allowing an examination of a variety of alternatives also removes the stigma of failure when one or another of the alternatives proves to be unacceptable. It removes the pressure to have every experiment a success in that it leads to a funded program. Success can also be defined as eliminating poor proposals.

As was discussed earlier, the decision to go ahead with the development of a major technological innovation is an important political decision for an agency. An agency can innovate only to the extent its innovations are acceptable to its controllers and constituents. Therefore, such a decision requires judgments regarding the technical, economic, and political feasibility of the project as well as the levels of support that can be anticipated throughout the life of the project. In such a situation, it is always easier to add a new project than it is to replace an old one.

Replacement involves explaining why the original idea was not so good in the first place as well as changing the jobs and perhaps career patterns of those who were working on the old project. Additional projects, on the other hand, imply that an agency is vigorous and growing, is trusted by its controllers with more resources, and can hire more people to enhance its position in the struggle for policy space.

PRT would not have been either restructuring or revolutionary for UMTA if they had been able to add it to their existing programs. Their small research-and-development budget did not allow such additions, however, and their lack of support in the Congress made them anxious to gain support from the transit operators, who largely favored the status quo. As suggested in chapter 2, government agencies may maintain their support by not changing their product or service.

This leads to the hypothesis that very weak agencies with small budgets will be unlikely to support restructuring or revolutionary innovations that might threaten their limited power base. One might also hypothesize that extremely strong and secure organizations would be unlikely to see the need for restructuring or revolutionary innovations, since their success would make change appear unnecessary.

These two hypotheses need further testing, but they imply a curvilinear relationship between organizational strength (defined as financial and political support from controllers and constituencies) and the propensity to innovate, as shown in figure 14-1.

Whereas resources are important to support the domains of particular organizations, there may also be a relationship between the overall resource abundance in an organizational network and the propensity to innovate. Assuming innovation involves costs in excess of daily operating and maintenance costs, some extra level of resources will be required to promote innovative activity.

Again the relationship may be curvilinear, since lack of resources may preclude innovative developments, while an excess of resources allows organizations to cover up mistakes and therefore reduces the necessity to innovate. (See figure 14-2.)

The transit subsystem seems to have suffered from both these problems. Overall public transit has suffered from a scarcity of resources since early in the twentieth century. As public transit technologies consistently failed the market test, the deficits required reduced service and eventually public takeover of the systems. These public systems were still under the constraints of operating at minimum cost and therefore had no means to encourage or pay for innovations.

In particular cities, however, through public bond issues and federal funding, huge dollar resources were made available to build traditional transit systems. As cost overruns mounted, the transit districts could demand more money to complete the systems, and, as long as this was forthcoming, there was

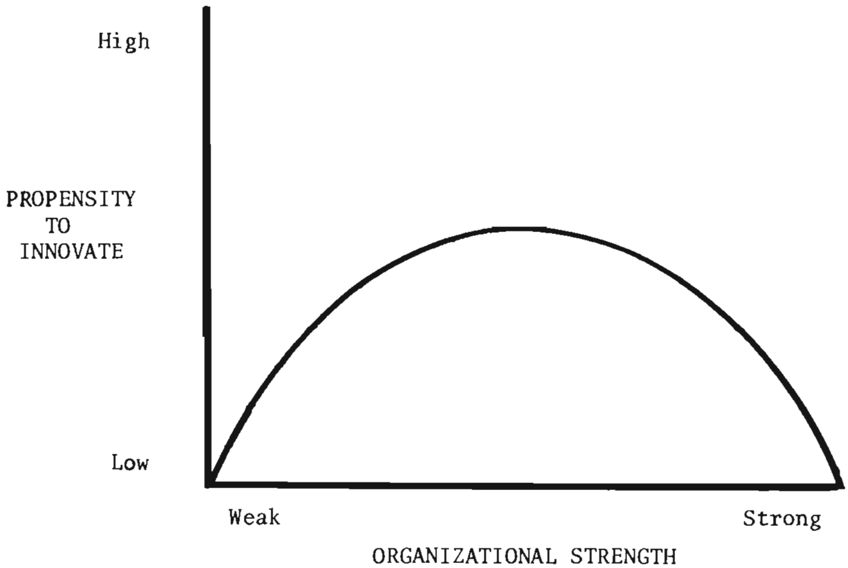

Figure 14-1. Relationship between Organizational Strength and Propensity to Innovate.

no need to seek more cost-effective systems. The artificial abundance created for particular jurisdictions made cost-effective innovation unnecessary while the overall resource scarcity made any innovation difficult, if not impossible.

The Analytical Reduction

These institutional problems create a turbulent environment.[10] In such an evnironment, network linkages become so interrelated and complex that overall understanding of key relationships becomes impossible. In the public transit subsystem, the turbulence of the environment can be measured in the number of people involved in transit issues, the number of governments, the number of organizations, the external linkages involving war and peace in the Middle East, OPEC and the price of gasoline, as well as media demands, citizens' demands, the number of alternatives generated for consideration, and the amount of data being generated. The situation is one of information overload, resulting in a desire to reduce the complexity of reality, to simplify in order to understand.

When a potentially revolutionary innovation is proposed in such a situation it adds to the complexity and turbulence of the environment as it is experienced by members of the political subsystem. It calls into question existing goals and objectives and the knowledge regarding possible outcomes. It also postulates new

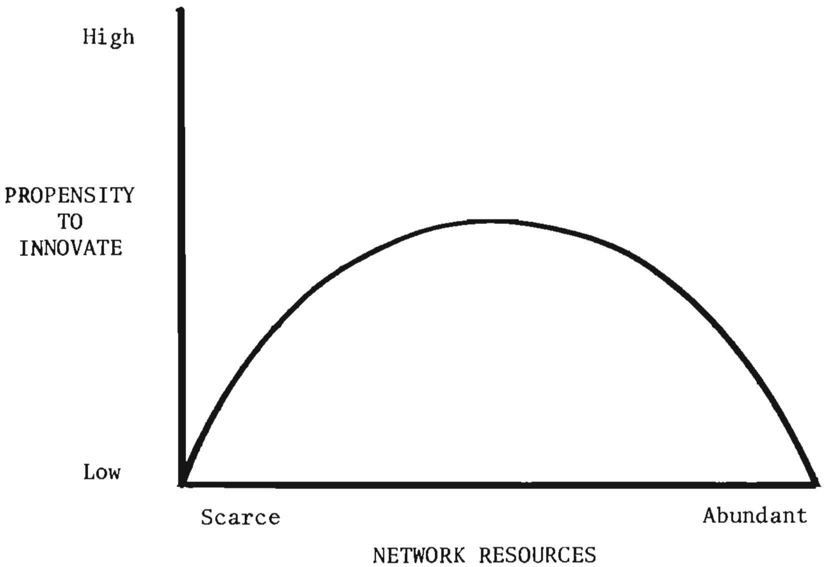

Figure 14-2. Relationship between Network Resources and Propensity to Innovate.

cause-effect relationships as it presents new means for achieving possible new outcomes. The decision problem tends to fall in cell D of figure 14-3.

To understand the analytical reduction, decisions can be viewed as having two major dimensions: (1) beliefs about cause-effect relationships, (2) preference regarding possible outcomes[11] The dimensions can be displayed as shown in figure 14-3.

Where goals (possible outcomes) are clear and agreed upon and the means to achieve the goals (knowledge about cause-effect relationships) are also clear, analysis or a computational decision strategy is appropriate. The issue here is the accuracy of the data. Where the goals are known but the cause-effect relationships are unclear (cell C), it is necessary to use judgment. Here the issue becomes the completeness or incompleteness of knowledge. Is there enough information to make an intelligent judgment? In cell B, the goals are uncertain, so a compromise strategy is required where the issues revolve around who gets what. In cell D, everything is uncertain, which calls for an inspirational strategy because the real question is, what is to be done?

When revolutionary innovations are proposed, they are most likely to fall into category D. By their very newness and revolutionary character, they must create uncertainty regarding cause-effect relationships. They also enter an ongoing situation, where they are likely to compete with existing goals and preferences. This creates uncertainty regarding preferred outcomes as new opportunities and new threats are revealed.

		Preferences Regarding Outcomes (Goals)	
		Known Certain	Unknown Uncertain
Beliefs About Cause/Effect Relationships (Means)	Certain	ANALYSIS COMPUTATION Issue: Accuracy of Data A	B COMPROMISE Issue: Who Gets What
	Uncertain	C JUDGMENT Issue: Incomplete Knowledge	D INSPIRATIONAL Issue: What is to Be Done

Source: Adapted from J.D. Thompson, *Organizations in Action* (New York: McGraw-Hill, 1967), p. 134.

Figure 14-3. The Analytical Reduction.

The work of this study indicates, however, that even when decisions fall into category D, the political actors try to push the decisions into category A. There seems to be a prevalent impression that if only enough "hard," "objective" data are gathered, if only enough studies and analyses can be performed, "the answer" to complicated questions of values and fact will become apparent.

This is, in part, a protective device for elected officials who are aware that any decision they make will create some opposition. If it can be shown that the decision is based on objective data and requirements, the official can evade responsibility for it and thus deflect opponents. Key value judgments can be justified by being reduced to computations where the issue becomes the accuracy of the data rather than the validity of the assumptions that directed the search for data and its organization.

This reduction also pushes decisions out of the public political realm of city council and legislative debates into the more private political realm of administrative agencies with their technical experts, where basic value questions are assumed not to exist and where analysis can take place unencumbered by political considerations. Their purpose is to obtain "objective" data, "hard" data, and to avoid debating or thinking about fundamental questions even when vague, implicit, and half-formulated views are obviously governing choices.

The analytical reduction as a further consequence leads to the limitation and often the rejection of restructuring or revolutionary innovations. First, the analysis is done by so-called experts who are usually part of the subsystem that benefits from the existing paradigm. Secondly, the analytical methods used by the experts are likely to be appropriate to the existing paradigm and prevent a proper analysis of the new proposal. The efforts to study PRT in terms of corridors appropriate for rail mass transit systems is one example of this problem.

Finally, there will be little hard data regarding a truly revolutionary innovation. By definition such an innovation challenges the existing paradigm, including its conceptual framework, theories, instruments, and methods. In such a situation, there may be little quantitative data or proof that the innovation has any value whatsoever. Since the purpose of the analytical reduction is to increase certainty, or at least the appearance of certainty, to the extent it is practiced, to that extent will restructuring and revolutionary innovations be suppressed.

The Myth of Objectivity

The myth of objectivity is closely related to the analytical reduction, for behind both is the assumption that there is some existential truth regarding the feasibility, value, benefits, and costs of a new idea—that it is possible to gather facts, weigh the data, and determine what is the best course of action. "All advocates of ideas make them sound so good. How do you know? How do you evaluate them? If only we could get a *really objective* study."[12]

This plaintive cry and variations on the theme were expressed over and over by elected officials during the course of this study. Congress established the Office of Technology Assessment in 1972 "to provide assessments for Congressional committees of the beneficial and adverse impacts of technologies, together with an analysis of alternatives."[13]

The problem with these assumptions regarding objectivity begins with the nature of expert knowledge, which tends to be oversold. As has been shown earlier, experts have their own biases related to their experiences, career patterns, and future career expectations. They also have their own organizational domains to promote, and if they are hired as outside consultants, they want to do work that pleases their client.

In addition, the analytical methods of experts are based on an existing paradigm. In the case of revolutionary innovations, which challenge the existing paradigm, new methods may be required to evaluate the new paradigm. Forcing PRT into the old corridor analysis of the traditional transit paradigm distorted its potential costs and potential value.

Finally, all studies are done under constraints of time, money, and uncertainty. They are also based on specified assumptions, which set limits or boundaries to the study. These assumptions are essentially subjective judgments that are likely to reflect the biases of those who make them, whether they are "experts" or other interested parties. Even though the analysis that follows may be excellent, if the boundaries are set incorrectly, one arrives at the wrong conclusions no matter how elaborate and "objective" the analytical means.

In the case of public transportation analyses, the assumptions are sometimes termed "heroic," indicating there may be more assumption than analysis in the final results. Certainly the analyses of recent rail transit proposals must make all such studies suspect.[14] In these cases, once the assumptions were specified, the analysis was foreordained to particular outcomes. In other words, analysis was simply a continuation of politics by other means.

Nonetheless, many elected officials appear to have a distaste for grappling with technological issues. They assume discussions of such issues must be left to the experts, and they appear to tune out when technological issues are raised. There is apparently no acute awareness of the social and political consequences of technological choices. Even when awareness of the larger consequences was at least vaguely felt and expressed, there was still a tendency to leave technological assessments to experts from the subsystem, which was to use or reject the new technology.

The inadequacy of this arrangement is recognized, but most jurisdictions have no alternative systems of appraisal. Congress did try to deal with this issue by creating the Office of Technology Assessment, based on the assumption that objective appraisals of new technologies were possible and desirable. The idea was that such assessments could help to determine the most desirable lines of technological development, potential external effects of such development, and in essence report on how various technologies would likely affect the public interest.

Office of Technology Assessment Report

The difficulties in generating such an objective analysis are illustrated by the Office of Technology Assessment report, *Automated Guideway Transit.*[15] The study began with a request from the Senate Transportation Appropriations Subcommittee to assess "the question of the degree of automation which is technically feasible, economically justifiable or otherwise appropriate to rail rapid transit." Later the scope of the study was broadened to include an assessment of PRT (actually referring to any automated guideway system). The major purpose was to identify policy alternatives and quantify the probable effects of such alternatives.[16] Because this study was done at the request of an appropriations subcommittee, these alternatives were specified in terms of budgetary alternatives for UMTA.

People. The first problem regarding objectivity in doing an assessment of this type is to find the people to do the work. An objective study requires knowledgeable but objective people. The Office of Technology Assessment employs a minimal number of people who then go outside the organization to tap experts for their assessment panels. There is an awareness that many of the issues they assess are controversial, so an effort is made to assure that all sides are heard. The problem is that the people in OTA may not be aware of the various facets of the issue, and their choice of participants may favor one view over another. The presence of one devil's advocate may allow the appearance of objectivity without its substance.

Dr. Gretchen Kolsrud was the manager of the OTA's transportation assessment program. Her background was in psychology, not transportation, and by her own acknowledgement she did not know who was who in the area of automated guideway transit. She and the director of OTA, Emilio Daddario (a former congressman who wrote the legislation establishing the office), had become acquainted with Frederick A.F. Cooke, a vice-president of Bendix Corporation and marketing manager of their Dashaveyor (GRT) system. They met him prior to the time the AGT report was contemplated, and they believed he was a good organizer.[17]

Later when they were looking for someone to head up the AGT study, an acquaintance of Cooke's who had known him in the Navy dropped by the OTA office and told Daddario and Kolsrud that Cooke had left Bendix when the Dashaveyor program had been abandoned. He was going to go to work for the Environmental Protection Agency in a few months leaving the AGT area entirely, and he was looking for something short-term in the meantime.[18]

To Kolsrud and Daddario, this made him appear to be the ideal candidate to head their study, since he would be knowledgeable in the field but a disinterested party, because his future employment would take him into other fields. (This turned out not to be the case since the visibility he gained with the report kept him in the AGT area.) Nonetheless, Cooke was selected to be project director, and he brought in H. William Merritt to be his deputy project director. Merritt had been with the Urban Transportation Administration in HUD and was technical editor of *Tomorrow's Transportation.* He had also worked as assistant director of Research and Development in UMTA and on their tracked air cushion vehicle before becoming a private consultant.

"Between them they knew everyone in the field."[19] It was Cooke, Merritt, Kolsrud, and Daddario, as a group, who chose the five panel chairmen, identifying what Merritt termed objective but knowledgeable people. "Someone knows someone who knows someone. . ." was the way Kolsrud expressed it.

Douglas Kelm and John Jamieson of the Minneapolis-St. Paul Metropolitan Transit Commission (two vociferous opponents of PRT) identified Jacqueline Ingersoll who chaired the panel on social acceptability.[20] The other panel chairmen were all well-known authorities in the field. Clark Henderson of the Stanford Research Institute chaired the panel on current developments in the United States; Lyle C. Fitch, Institute of Public Administration, headed the panel on economics; Robert A. Makofski, Applied Physics Laboratory, chaired the panel on operations and technology; and Merritt headed the panel on International Developments.[21]

Each of the chairmen then selected members to serve on the panel trying to balance those who favored and those who opposed PRT. They also tried to include a few so-called extremists such as Ed Anderson from the University of Minnesota, who served on the economics panel.[22] What is interesting about these choices is that they all had taken public stands in regards to various aspects of PRT—many of them negative to true PRT. In the world of objective assessment, however, a negative position does not imply bias or lack of objectivity. As Merritt put it, "I feel now that no one can seriously question the objectivity of the panels."

Conversely, it is also true that people who study a problem for several years and come to a conclusion that favors one solution over another are said to be partial or advocates. A positive position implies bias while a negative position does not. Even worse is to become a strong advocate, because this implies an extreme position. This takes one beyond the pale of ideas in good currency,[23] and makes one appear unreasonable. It is very important for objective analysts to appear reasonable, and reasonable is defined as being moderate—taking no advocacy positions.

It is perhaps for these reasons that no one from Aerospace Corporation was included on any of the panels. They were invited to make a presentation to the operations and technology panel, but they were not allowed to sit in on the debates and discussions that determined the final shape of the report. This effectively removed the very people who had done the most detailed analysis in the United States of true PRT systems.

As was reported by many members of the panel, this was a very emotional study. This is not entirely surprising considering the strong differences regarding the appropriate direction for public transit in the United States. On one end of the spectrum were those who felt conventional systems could adequately fulfill the transit needs of the United States. Others believed only the simplest automated systems would work, whereas still others wanted to move toward more sophisticated GRT systems. Finally, at the opposite end of the spectrum, were the few proponents of true PRT. Overall, the group was dominated by the traditional transit paradigm with the old guard favoring existing systems while the "moderns" favored automated group systems. The challenging paradigm had only minimal support, and as will be shown, almost no impact on the final report.

Given the extreme differences within the total panel, it might have been more effective for each group to make their best case and then subject it to challenge from other members of the panels. In this way, the underlying assumptions as well as the pros and cons of each choice could have been made explicit, and mistaken beliefs about one or another system might have been corrected. As it was, the final report was a consensus document. Each panel chairman wrote his or her own report, which was then gone over by the OTA staff and reviewed by two editorial panels. Cooke himself put together the general report, which was supposed to summarize the positions of the individual panels.

Those who took part in the study, especially the panel chairmen with whom the author discussed the subject, all felt the outcome of the report was a moderate position–somewhere between the conventional systems advocates and the PRT advocates. The search for moderation, for a middle ground, allowed everyone to maintain their objective, reasonable posture, and such a posture effectively precludes a real challenge to the existing paradigms.

The fallacy of this approach lies in its confusion of moderation, middle-ground compromise, and skepticism with the idea of objectivity. The moderate position can be just as subjective as an extreme position, skepticism as subjective as advocacy. It is also true that an advocacy position can be based on objective analysis of data as can be true of the moderate position or a negative position.

When objective data are so closely intertwined with deeply held values, it may be impossible to give a wholly objective report. Separate reports prepared by advocates, criticized by opponents, listing the benefits and the costs, the assets and the liabilities of each approach would give the policy decision makers more and better information. It would also force both advocates and opponents of particular systems to confront specific issues and assumptions thus clarifying rather than obscuring the issues. One need not go so far as Oscar Wilde in questioning the value of objectivity, but one can maintain a healthy skepticism regarding consensus reports discussing controversial issues: "A critic cannot be fair in the ordinary sense of the word. It is only about things that do not interest one that one can give a really unbiased opinion, which is, no doubt, the reason why an unbiased opinion is absolutely valueless."[24]

This is not to say the OTA report did no good. Its standardization of the language of automated guideway transit has been extremely helpful to all who labor in the area. Its identification of the problems between the Capital Grants Office and the Research and Development Office within UMTA was also useful. They pointed out that Capital Grants rules required a cost-benefit analysis based on existing systems. If no system existed, a new system could not meet UMTA requirements for a Capital Grant. Thus manufacturers of new systems were shut out of the market even if a city might prefer their product.

The Study. The primary weakness of the study was its avoidance of the issues raised by the PRT paradigm challenge. It also avoided the questions of which type of service would be most desirable from the user point of view. Instead the panelists attempted to assess the state of the art among several different technologies with the prime criterion of what is available now rather than what would best serve societal and user needs.

In assessing the potential for high-capacity PRT, the primary concerns were technical feasibility and costs. Where there were differences noted on these subjects, both points of view were presented without any analysis of the basis for each. Data were offered with no apparent analytical base:

> Automobiles cost in the order of $1 to $2 per pound. Aerospace system hardware costs much more—for example, the 747 averages about $65 per pound. PRT vehicles can be expected to cost somewhere between, probably in the range of $10 to $20 per pound . . .[25]

This was followed by mentioning an Aerospace Corporation study which indicates that PRT vehicles can be produced in volume for $10,000 each. They do not say what volume, but mention the total number proposed for an extensive system in Los Angeles, 64,000 vehicles. In actual fact, the $10,000 figure was based on the purchase of 10,000 vehicles, each weighing 1,800 pounds.[26]

A De Leuw, Cather study for the Twin Cities Metropolitan Transit Commission was also quoted. It stated that the manufacturers they had contacted indicated the on-board control equipment alone would cost well in excess of the amount suggested by Aerospace Corporation. The implication was that figures from manufacturers were more reliable and that the Aerospace figures were not based on manufacturers' data. According to Dr. Jack Irving, the Aerospace data were based on a precise design with all the components priced by vendors who produced such items.[27] As later parts of the OTA study indicated, the Twin Cities data were based on the experience of one manufacturer of a different kind of system in a research-and-development situation.

Rather than including this explanation, the differences are simply left hanging as if there were no possible resolution between them "because no PRT systems have been built, aside from overseas test tracks." The assumptions for the Aerospace and De Leuw, Cather studies are not examined; the depth of each analysis is not considered; and the data from the foreign test facilities are not scrutinized. The reader of the report is left with the impression that there are contending forces of *equal value* that each say something very different. It also appears there is no way to analyze these differences to see where the weight of the evidence lies.

Table 14-2 taken from the OTA study indicates some of the problems in comparison when the assumptions of the study are not examined. In the first column, the Aerospace Corporation study is site specific. In other words, it has considered the particular problems of the community (hills, weather conditions, earthquakes, and so forth) in developing its cost figures. The Twin Cities figures could also be site specific but are, in fact, based on the figures from the Morgantown research-and-development experience. Research-and-development prototypes of much larger vehicles are compared to mass production costs of very small vehicles. Plastictown is a hypothetical city with characteristics unlike most American cities.

Once this background is known, the data presented offer the basis for an interesting analysis—an analysis that does not appear in the final OTA report. Some examples may clarify the point.

The per-station costs offer significant contrast. The Los Angeles numbers reflect the fact that different stations will be different sizes depending on the

Table 14-1
Comparison of HCPRT Cost Estimates

	Los Angeles	*Plastictown (hypothetical 1990 city)*	*Twin Cities*
Analyst	a	b	c
System length (miles)	638	825	–
Number of stations	1,084	1,600	–
Per station cost (thousands)[d]	\$170-\$225	\$600	\$120-\$2,200[e]
Guideway width (feet)	2½	10	–
Guideway costs (millions per mile elevated)	1.1	1.1	2.3-3.7
Vehicle weight (pounds)	1,800	3,000	–
Per vehicle cost (thousands)	\$9.8	\$10	\$100-\$120
Modal split (percent)	10	20	14
Patronage (passengers per day, thousands)	1,000	2,000	700
Average trip length (miles)	10	10	6
Cost per passenger-trip	\$1.04[f]	\$0.78[f]	\$2.60[f]
Cost per occupied car mile	.156	.117	.65
Cost per passenger-trip mile	.104	.078	.43

Source: U.S. Congress, Office of Technology Assessment, *Automated Guideway Transit* (Washington, D.C.: U.S. Government Printing Office, 1975), p. 310.

[a]Aerospace.

[b]DOT-TSC.

[c]De Leuw, Cather.

[d]Costs of first 2 columns are in 1973 dollars; last column, January 1975 dollars.

[e]Depending on type and location of station.

[f]All costs are based on full recovery of investment as well as operating expenses.

demand pattern in the area. Unlike trains, which must have uniform station lengths even if only ten people are using the station, PRT stations can serve one vehicle at a time or twenty. The Plastictown study does not take this variation into account, whereas the Twin Cities study does (even though they are using GRT vehicles). The basis for their difference is the "type and location" of the station.

All three analyses estimate per-mile guideway costs, but the Twin Cities study does not indicate anything about the size or construction of the guideway. Both the Aerospace analysis and the Plastictown analysis have identical per-mile guideway costs, but the guideway for Los Angeles is only 2.5-feet wide, whereas the Plastictown guideway is 10-feet wide. Since the primary cost of the guideway depends on its size, this discrepancy indicates that the cost figures are based on different assumptions and different analyses.

A similar discrepancy occurs between vehicle weight and vehicle cost. The Los Angeles vehicle weighs 1,800 pounds and is estimated to cost \$9,800. The Plastictown vehicle weighs 3,000 pounds and is estimated to cost \$10,000. There is no weight given for the Twin Cities vehicle, but there are still costs of $100,000 to $120,000 each. (Actual weight of the Morgantown vehicle is 8,600 pounds.)[28]

These differences are explicable, but the OTA study does not do so. They do offer some explanation but they do not discuss the data just presented, and the remaining analysis is, in part, based on false premises:

> Even allowing for the fact that the cost data are on somewhat different bases, the respective projections differ greatly; vehicle cost estimates, for example, are an order of magnitude apart. It may be pointed out, however, that the $10,000 per vehicle cost estimates for PRT systems are in the cost range of high-performance automobiles, although the performance reliability for PRT vehicles would need to be much higher than for private automobiles, in addition to which PRT systems would require highly complex control systems.[29]

The false premise is the comparison to high-performance automobiles. High performance in automobiles refers to weight and speed. High performance in PRT refers to reliability. Thus the highly complex control systems are not in addition to the performance reliability of PRT vehicles, they are the essence of that reliability. Secondly, a PRT vehicle is estimated to weigh 1,800 pounds as compared to a large automobile, which can weigh from 4,500 to 6,000 pounds. The cost of the materials and fabricating that make up that extra weight could be applied to the cost for the controls in a PRT vehicle.

This type of noninterpretation or even faulty interpretation of data continues in many places in the report. Another example:

> The Twin Cities study vehicle cost projection is in the range of the actual cost of the considerably larger Morgantown vehicles. There is *no apparent reason* for the great difference between the vehicle cost estimates; if anything, the more complex pure PRT vehicles should be more costly.[30] (emphasis mine)

As was pointed out in chapter 5, the Morgantown vehicles were research prototypes, and the GAO study of the Morgantown project gives ample reasons for the excessive costs—the normally higher costs of research and development, the rush to get something operational before the November 1972 elections, the small number of vehicles purchased, and so forth.

In addition, the size and weight of the vehicles create important differences in costs. The degree of complexity of PRT versus GRT (Morgantown) systems is hotly debated, but the onboard vehicle controls for a small vehicle are believed by proponents to be much simpler than the controls for a large vehicle. Even if one assumes greater complexity for PRT, one still cannot account for the differences in cost that the OTA report suggests are meaningful.

There seems little reason to assume PRT vehicles will be much more expensive than their analysts indicate, judging from international test facilities. Actual experience may prove these analysts wrong, but more is required of an objective report than vaguely justified assumptions that run counter to detailed analytic studies. Merritt suggested that the Aerospace data might be accurate for mass production, but there was no evidence of a market large enough to support mass production.[31]

In the area of operating costs, the Aerospace estimates are simply stated to be "unrealistically low." No data are offered to support this assessment. ". . . [M]ore realistic, but still conservative" costs are suggested, but again with no data to show the basis for these "realistic" costs. The only assumption given in the report indicates the operating costs are based on the number of maintenance people needed for such a system, and this is based on the experience from existing systems. Which systems is not made clear, but one can assume they mean the Morgantown and the Dallas Airport systems, since the simple SLT systems at airports have a low number of maintenance personnel.

The high number of maintenance people, thus projected, is used to show that maintenance cost per vehicle alone would be $2,000 per year. The problem is that both the Morgantown and the Dallas systems were, in 1975, still largely experimental, and the number of maintenance people may yet be reduced. More importantly, even the smallest system will have a certain irreducible minimum of maintenance people to have all the skills available that might be needed. One can expand the system considerably without having to expand the maintenance force correspondingly.

The larger the system, the smaller the maintenance force is likely to be, proportional to the overall size of the system. Even a one-vehicle system might have to hire an electronics engineer to take care of certain problems as they occurred. This person is likely to be unoccupied in such a system most of the time, but essential for the particular times he is needed. It might be possible to expand the vehicle fleet to 500 before another electronics engineer would be needed to handle the increased load.

One final example should be enough to indicate the problem of technological assessment based on different and unexamined assumptions. The conflict is basic to the viability of PRT systems and has been widely debated.[32] It is exemplified in a conflict between the panel on economics and the panel on operations and technology. In each case, the assumption is made that a PRT network would be spaced approximately at 1/2-mile intervals. The panel on operations and technology correctly noted that this would mean a maximum walk of 1/4 miles from the furthest point to a station.[33]

The panel on economics stated that a PRT grid with lines spaced 0.5 miles apart would require trips of up to 1/2 miles to reach a PRT station. In a footnote this is explained:

> A person located in the center of a square of a grid 1/2 mile on a side is $[2(.25)^2]^{.5}$ or .35 mile, as the crow flies, from the *intersections* of the

> grid, where PRT stations *would be located.* If he has to travel along streets laid out parallel angles to the grid, he would have to travel 1/2 mile to reach an intersection.[34] (emphasis mine)

Therefore a quarter-mile network grid would be required to ensure a maximum quarter-mile walk for a passenger. As was shown in chapter 6, the quarter-mile grid is unnecessary, but much of the debate about the real costs of PRT systems is based on this particular difference in assumptions. Running a quarter-mile network doubles the number of guideways and the number of stations needed and makes costs unacceptably high. It also affects the assessment of social acceptability of aerial guideways, since a quarter-mile grid would have to intrude on residential streets, whereas a half-mile grid could be essentially confined to major arterials.

When one considers the influence of the "devil's advocate" in a study of this sort, it is interesting to note that Ed Anderson, who clearly understands this point, sat on the economics panel that produced these erroneous assumptions. It seems clear that Anderson did not have a great deal of influence if such an error was allowed to stand.

It is not clear how much influence this portion of the economic panel report had on the overall assessment of the feasibility of PRT, but whatever its influence, these details are not the significant problem with the report. They merely illustrate the problem that results when there is a felt need to arrive at a single point of view in a final report. Such a necessity must preclude the "extreme" or the "different" point of view. Differences must be suppressed in the interests of unity and compromise.

The desire to achieve compromise and avoid controversy may cause the convenors of study panels to exclude knowledgeable people who have taken contentious positions. This has the further consequence that the areas in which they are expert may be neglected or misunderstood, leading to false assumptions and inaccurate conclusions.

The difficulties noted here were probably inevitable given the charge of the Office of Technology Assessment to produce a single objective report. The people involved in this study labored long and diligently, but they could not achieve consensus without also including distortion. There was, in reality, a lack of consensus in the larger community, and the attempt to give the appearance of agreement resulted in a Procrustean report.

The Action Mentality

The action mentality was discussed more fully in chapter 5, but it deserves further mention here because it is normally assumed that the politician who seeks action is a force for change. In the case of restructuring or revolutionary innovations, however, such a political actor is more likely to be a force for the status quo. The action mentality is often triggered by a crisis, an upcoming election, or a severe problem. Action becomes essential to prevent even more severe difficulties. Therefore the pressures are to build something now, create jobs, do something about the energy crisis.

A revolutionary technology, on the other hand, may need time for testing and development. Although it may offer a long-term solution to the existing problem, it cannot have much effect immediately. Therefore, it is neglected in times of crisis as being impractical and ignored at other times when macro-political attention is directed elsewhere. It is as if the action-oriented actor is too busy putting out fires to build a fireproof house.

The action mentality also tends to oppose research and development in general. Such research and development may be necessary for defense, space, and atomic energy, but there is no such understanding regarding other domestic issues. The assumption of the political actor is that we know what to do; what is required is simply more money to do it.

Finally, the action mentality realizes that studies and research lead to delays. Such delays give advantages to those who did not like the original decision and who are seeking to reverse it. Once one has the votes to start a project, it is better to have it visible and in some senses irreversible. The desire of rail rapid transit advocates for a "starter line" is a very practical means of getting what they want. It appears to be an incremental step, but once started it will be very difficult to stop. Research and development, on the other hand, is difficult to maintain and easy to cut off. Thus, the action mentality favors the short-term visible project over the long-term development of restructuring or revolutionary technologies. In that sense the action mentality is a force for the status quo.

The Power of a Bad Example

There may be nothing so damaging to the cause of innovation than a demonstration gone sour. It is almost impossible to overstate the influence of the Morgantown project as a deterrent to further innovation in automated transit. This, coupled with the difficulties experienced with the BART system and the system at Dallas-Fort Worth Airport, combined to have a chilling effect on transit innovation.

The environmental support, which had been weak at best, turned into open hostility. The people who had pushed for greater innovation were forced to retreat to projects that were less innovative and more certain of at least technical success to regain the confidence of their political controllers in Congress. Without such confidence, support for further innovation vanished.

Finally, the term personal rapid transit fell into disrepute. It mattered not that Morgantown was a GRT system. It had been called PRT from its inception, and its failure tainted the very different proposals that used the same term. It may be true that there is nothing more powerful in deterring innovation than an unsuccessful demonstration.

Forces for Change

Although the balance of power seems to be heavily in favor of the status quo, there are still some forces for change. Most importantly in government may be the turnover of elected officials and their appointees, which occurs with some regularity due to the election process. There have been instances, illustrated here, where such turnover has halted or deterred an innovative project that required a long-term commitment to come to fruition. For the most part, however, turnover allows a reexamination of old commitments, which are more likely to be compatible with the traditional paradigm.

The new person may also be caught up in the traditional paradigm rather rapidly as pressures from the existing organizational network take effect. Nonetheless, new administrations offer new opportunities—a chance to abandon old programs and begin anew. Such turnover does not assure innovation, but it creates at least one condition that may contribute to it.

In the case of the transit area, there is also a growing realization that the present methods are not working, that existing solutions within the existing paradigm are inadequate to the existing problems. In the case of transportation, Webber's report on BART and Hamer's report on rail rapid transit in several cities may affect perceptions regarding the viability of rail transit systems.[35] The difficulties being experienced by older established public transit systems in the United States and other countries must also lead eventually to a reassessment regarding what is required for effective public transportation.

Most crucially, the rapidly escalating costs to construct and to operate public transit systems may preclude their use in the future. These rising costs are coupled with the increasing dispersion of cities all over the world. This means the more and more expensive systems are able to serve fewer and fewer people.

Whereas these changes may not have a great effect on the perspectives of the actors who operate within the existing paradigm, they do have impact on the larger population. In the case of public transit, UMTA may have created the seed of the destruction of its operating paradigm in its requirement that local transit planning agencies receive information and advice from citizens in the community.

This requirement has led to the formation of citizens' advisory panels, which actively question and deliberate regarding transit issues. Often the effort is made to have these panels operate as rubber stamps for the sponsoring agency, even act as the agency's emissaries to the community to help persuade the populace to approve what the agency proposes. There is evidence, however, that this does not always happen. A citizens' advisory panel to the Los Angeles downtown people-mover (DPM) program brought out a report condemning the whole project.[36] They noted the DPM does not encourage a balanced use of land and that it favors certain large property holders over the rest of the community. They also observed that it does not serve the people most in need of transit service. Because the DPM is a group system, the size of the guideway is seen as being aesthetically unacceptable.[37]: "[Therefore] the risk of negative impacts is potentially too great to justify using Los Angeles CBD as a test area for demonstrating the appropriateness of an AGT/SLT in a Central City setting."[38] This report was not enough to deter the project, as the political decision makers decided to go ahead anyway. The action mentality led them to believe, "We have to get something started." The lure of federal money may also have influenced their decision.[39] The federal officials believed the citizen's panel was biased and not representative of the community.[40]

Nonetheless, citizens' groups may become a greater force for change than has been true in the past. Even in Los Angeles, a number of officials are expressing doubts about the project, and it may yet be stopped before construction starts.[41] Such citizens' panels offer an opportunity for potential users of a transit system to act as an alternative system of appraisal. Since the existing systems do not serve user interests well, the impact of citizens' advisory panels may well be a strong force for change.

There may be other governmental arrangements and practices as well that will encourage innovation. Clearly alternative systems of appraisal with power to develop and to implement early demonstration systems offer a great opportunity for promoting innovation. Such alternative systems will need to have adequate money, however, especially at the early stages of development, where relative costs are low and much can be gained by pursuing parallel developments until one method proves superior to the others.

This approach would also reduce the pressure that many public officials feel to always have a "success." A recognition that research money is to learn with, not to produce, could have a salutary effect on innovation. Of course, too much money with too little concern for production could lead to a lot of tinkering in the shop, but this danger is so far removed from present practice that it seems unnecessary to be concerned about it now.

Even without alternative systems of appraisal, the authority to innovate, to do research, can be made part of the domains of existing systems. At the federal level, there might be some consideration of funding local experiments when they are well conceived. By dispersing the places where innovation is authorized and financially feasible, more creative approaches might become possible.

Local and state governments that are large enough and wealthy enough might also expand their domains to include more research and development. Rather than abdicating this responsibility to the federal government or private entrepreneurs, they might promote projects of particular interest to their own locale.

Another promising approach is Public Technology, Inc., a nonprofit Washington-based organization set up by the major organizations of city and county governments: "Through committees of local officials, PTI tries to identify unmet technology needs common to many localities, to encourage private or federally financed research on the problem and then to get private industry to manufacture the appropriate new products."[42] Acting alone, these cities would not offer a large enough market to encourage private innovation, and none could afford to do their own research-and-development work. Acting in concert, however, they can articulate demands with common criteria, thus creating a significant market for private ventures.

All governments could also make the rewards for innovation more attractive and the penalities for occasional difficulties less severe. There must be room for learning and experimentation, and there can be no learning or experimentation without mistakes. The magnitude of the mistakes can be reduced by putting more money into the planning and design end of the experiment before concrete is poured.

Controls can also be maintained by resurrecting the decision rule of calculated risk. There is a decision area between pure incrementalism and comprehensive rational planning. It is possible to examine the real costs to fund 1 year of experimentation. It is possible to weigh the utility risk and to consider the personnel risk of not having enough of the right people to bring the project to fruition.

In the case of new technologies, it is rarely the "cussedness" of the technology which is the problem. Technical difficulties can usually be worked out if there is enough reason to do so. Therefore, technical risk need not be the great concern it is today, while other risks deserve far greater attention. Adversary reports regarding potential social, political, economic, environmental, and other human effects could help contain the risks inherent in any new technology.

Beyond all the human activities to bring about or restrain change, however, there are larger environmental forces, which may require change. The threat of reduced availability of petroleum is pushing governments toward public transit systems. Usually these are traditional systems, but the costs of the traditional systems plus their short-term high consumption of energy during construction make them less attractive when there is a real need to conserve. Even their operating consumption of energy may be unacceptable, since present public transit systems are only energy-conserving when an adequate number of people are on board.

Thus while the key forces for change may come from the conditions of society and the environment of governmental and organizational networks, such forces will not lead to innovation until better alternatives to existing methods are developed. The better idea or alternative is likely to be produced, however, as problem-solving people have their attention directed to imminent problems or opportunities by environmental forces. Organizations in several countries turned to the problem of improving transit as it became clear that present trends in both public and private transit were creating unacceptable conditions.

Gaining public attention and recognition may require alternative systems of appraisal, which can also act as forces for change. In a market economy many organizations and individual consumers act as systems of appraisal offering many potential buyers. Even when governments are the buyers of the product, there are enough local and state governments to offer some hope for alternative systems of appraisal.

Although state and local governments may be somewhat limited in their roles as laboratories for change due to their dependence on the federal government for funding, they may still be in a position to influence federal policy. The more the market for a product or service resembles a monopsony or even an oligopsony, the weaker will be the forces for change. Whereas the greater the number of potential purchasers, the stronger will be the forces for change.

Summary

Technology is a means to achieve human ends. It conditions and constrains (but does not determine) the roles, role-sets, organizations, and organization-sets of which it is part. When the organizations and organization-sets are also part of a political subsystem, the whole complex of relationships is embedded in a political milieu. Thus technological change that penetrates to the restructuring or revolutionary levels of any subsystem will have political as well as social and technical consequences.

Although it may appear obvious that those who feel themselves adversely affected by change will resist such change, it has not been so obviously understood in our allocation of public policy decision powers and our assessment of new technologies. We have turned transportation problems over to the transit subsystem, energy problems to the energy production and regulation subsystem, housing to the housing construction subsystem, and so forth.

We have asked these subsystems to be innovative without, perhaps, realizing the limits on their innovative capacities. There is little evidence that we have thought through the human and political effects of technical innovation—the changes it may inflict upon individual's roles, careers, statuses, and power. Nor have we considered the effects on organizations' abilities to maintain their domains, deal with their environments, maintain support for their policy space, or even to survive. We have not recognized that political subsystems can inflict change on the society as a whole to maintain their own stability.

We have demanded innovativeness without fully understanding the different types of innovation and the extent to which various types impinge differentially on particular groups and society as a whole. We have not recognized that restructuring or revolutionary innovations are more difficult to bring to public attention and acceptance and that therefore to encourage such developments we may have to create alternative systems of appraisal.

The case of PRT illustrates that the needs of the users of a technology may be different from the needs of individual organizations and organization-sets, government, and society as a whole. The lesson to be drawn may be that all these needs must be included in the assessment process. It also seems clear that we need to have an ongoing system of assessment that is an alternative to the functional subsystems that now dominate government decisions regarding technology.

Whether the issue is energy or transit, housing or ocean exploration, when government acts as a purchasing agent for society, the decisions cannot be effectively made by those who have a vested interest in maintaining the present technologies. The political implications of such choices are too important to allow them to be dominated by any narrow political perspective.

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57. GAO, *Personal Rapid Transit Systems,* p. 25.

58. See, for example, House Committee on Appropriations, *Department of Transportation Hearings,* for 1974, 1975, or 1976.

59. Interviews, 1976.

60. "Escalating Cost," *Business Week,* p. 50.

61. See, for example, House Committee on Appropriations, *Department of Transportation Hearings,* for 1975, pp. 477-492.

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63. J. Harlowe, president, University of West Virginia, ibid., p. 490.

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94. Reported in GAO, *Personal Rapid Transit Systems*; U.S. Congress, Office of Technology Assessment, *Automated Guideway Transit* (Washington, D.C.: U.S. Government Printing Office, 1975); as well as reported by numerous respondents.

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96. Ibid., pp. 196-201.

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98. R. Hemmes, interview, 1976.

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Chapter 6: The Challenge of Personal Rapid Transit

1. This section reflects a series of discussions with Dr. Jack Irving, a former vice-president of Aerospace Corporation who headed the PRT development project. Much of the discussion of what Aerospace Corporation did was learned from Dr. Irving and members of his research team.

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11. C. Freeman, "A Study of Success and Failure in Industrial Innovation," in B.R. Williams, ed., *Science and Technology in Economic Growth* (New York: John Wiley and Sons, 1973), p. 242.

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13. W. Keller, "A Method for Development of a Mass Transit Evaluation Model Based on Social System Values" (Paper presented to National Research Council, 52nd Annual Meeting, Highway Research Board, Washington, D.C., 1973); L.A. Hoel, *Latent Demand for Urban Transportation* (Pittsburgh: Transportation Research Institute, Carnegie-Mellon University, 1968), p. 58; M. Webber, "The BART Experience--What Have We Learned?" Berkeley, University of California Institute of Urban and Regional Development and Institute of Transportation Studies, 1976; R. Pozdena, "The Interaction of Transit Design Characteristics and Urban Travel Demand: The Case of BART," Berkeley, University of California Institute of Transportation and Traffic Engineering, n.d.

14. Hoel, *Latent Demand,* p. 58.

15. K.H. Schaeffer and E. Sclar, *Access for All: Transportation and Urban Growth* (Middlesex, Engl.:Penguin Books, 1975).

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51. As it turned out, the AGTT program had little or nothing to do with PRT. The studies undertaken looked at all types of AGT systems "to determine the operational characteristics of automated guideway transit systems in various network configurations." There were also studies of components of AGT systems and subsystems as well as various wayside technologies. These were separate from social and economic studies, thus preventing an iterative examination of service needs and technical requirements. From fiscal year 1976 to fiscal year 1979 there has been a steady reduction in AGTT program appropriations. See Senate Committee on Appropriations, *Department of Transportation Hearings for FY 1979.*

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26. "People Mover Desires to Be Named Streetcar?" Editorial, *The Dispatch,* St. Paul, 19 July 1978, p. 10.

Chapter 10: Las Vegas

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9. "Trouble in Mass Transit: Why Can't the People Who Put a Man on the Moon Get You Downtown?" *Consumer Reports* 40 (1975): 195.

10. R. Hebert, "LA Transit Officials Misusing New Funds, Senator Mills Charges," *Los Angeles Times,* 7 February 1973, p. II-1.

11. U.S. Congress, House, Committee on Appropriations, *Department of Transportation and Related Agencies Appropriations for 1975, Hearings before a Subcommittee on Appropriations,* 93d Congress, 2d Session, 1974, p. 653.

12. Committee for Central City Planning, Inc., *Preliminary General Development Plan, 1972/1990* (Los Angeles: 1972), p. 58.

13. Southern California Rapid Transit District, *Consultants Summary Report* (Los Angeles: July 1973), p. i; The employment figure was reported in a survey of Los Angeles central business district employment, by W. Smith and Associates, "Central Business District Travel Survey" (Draft prepared for Southern California Rapid Transit District, April 1975), p. 67.

14. Southern California Rapid Transit District (SCRTD) Consultants, *Phase I Progress Report,* appendix A.

15. Peat, Marwick, Mitchell & Co., "Analysis and Recommendations of System Alternatives for Phase I Analysis in the Technical Study of Alternative Transit Corridors and Systems," Work Package 1A12P2, prepared for the Southern California Rapid Transit District, 1972, p. 2.

16. Marcuse, "Mass Transit for the Few," pp. 11-14.

17. Task IA8 of the Transit Development Program.

18. SCRTD Consultants, *Phase I Progress Report,* p. I-7 (emphasis mine).

19. A.M. Voorhees Associates, Inc., "Summary Report of Consultant's Recommendations," July 1973, p. 30; Kaiser Engineers/DMJM, "Plan Refinement Report, Task 8.5.2," April 1974, p. III-27; see also A. Hamer, *The Selling of Rail Rapid Transit* (Lexington, Mass.: Lexington Books, D.C. Heath, 1976), on the manipulation of patronage estimates.

20. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 3.

21. SCRTD Consultants, *Phase I Progress Report,* p. VI-1.

22. Voorhees, "Summary Report," p. 5.

23. Ibid., p. 7.

24. Ibid., p. 9.

25. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 5.

26. Ibid., p. 7.
27. SCRTD Consultants *Phase I Progress Report*, p. VI-4.
28. Marcuse, "Mass Transit for the Few," p. 11.
29. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," pp. 5, 6; see also SCRTD Consultants, *Phase I Progress Report*, p. VI-2.
30. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 6.
31. Ibid., p. 2; see also SCRTD Consultants, *Phase I Progress Report*, p. VI-1.
32. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 6; SCRTD Consultants, *Phase I Progress Report* p. VI-2.
33. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 6; SCRTD Consultants, *Phase I Progress Report*, p. VI-2.
34. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 6; SCRTD Consultants, *Phase I Progress Report*, p. VI-2.
35. SCRTD Consultants, *Phase I Progress Report*, pp. VI-2, VI-4.
36. Ibid., p. VI-4.
37. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 7.
38. Ibid., p. 7; SCRTD Consultants, *Phase I Progress Report*, p. VI-4.
39. Marcuse, "Mass Transit for the Few," pp. 16-18.
40. M. Webber, "The BART Experience—What Have We Learned?" Berkeley, University of California Institute of Urban and Regional Development and Institute of Transportation Studies, 1976.
41. Southern California Association of Governments, "Framework 5. Personal Rapid Transit," *Regional Transportation Frameworks* (Los Angeles: 30 January 1974).
42. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 8; SCRTD Consultants, *Phase I Progress Report*, p. VI-4.
43. Marcuse, "Mass Transit for the Few," p. 32.
44. Gruen Associates, "Transportation Plan Evaluation Process," prepared for Southern California Association of Governments, (Los Angeles: July 1973).
45. Voorhees, "Summary Report," pp. 9, 10.
46. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 8; SCRTD Consultants, *Phase I Progress Report*, pp. VI-4, 5.
47. Peat, Marwick, Mitchell & Co., "Analysis of Systems Alternatives," p. 9; SCRTD Consultants, *Phase I Progress Report*, p. VI-5.
48. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 9; SCRTD Consultants, *Phase I Progress Report*, p. VI-5.
49. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," p. 10; SCRTD Consultants, *Phase I Progress Report*, p. VI-5.
50. Peat, Marwick, Mitchell & Co., "Analysis of System Alternatives," pp. 15, 16.
51. Kaiser Engineers/DMJM, "Analysis of Advanced Personal Rapid Transit (APRT) Concepts for the Los Angeles Area," Special Work Task Authorized by

the Southern California Rapid Transit District Board of Control (Los Angeles: March 1973), p. 1.

52. Ibid., p. 2.

53. Ibid., p. 8.

54. J. Irving, interview, 1975.

55. Kaiser Engineers/DMJM, "Analysis of Personal Rapid Transit," p. 11.

56. W.O. Ackerman, letter to G.L. McDonald, June 27, 1973; W.O. Ackerman, letter to J.R. Gilstrap, November 1, 1973.

57. G.L. McDonald, letter to W.O. Ackerman, February 12, 1974.

58. Ibid.

59. Ibid.

60. J.E. Anderson, "Rapid Transit for the Cities–On a Personal Level," *Los Angeles Times,* 11 March 1973, pp. VI-1, VI-6.

61. B.P. Bayliss, M. Stitch, A.C. Ingersoll, letter to J. Wachs,

62. Southern California Association of Governments, "Framework 5"; H.R. Ross Associates, "Transit Alternatives for the Los Angeles Region: A Review of Bus, Commuter Rail, Light Rail Vehicle, PRT, and Rapid Transit Alternatives," prepared for the Southern California Association of Governments, Los Angeles: 1974; H.R. Ross Associates, "Energy Consumption by Transit Mode," prepared for Southern California Association of Governments, Los Angeles: March 10, 1974.

63. Southern California Association of Governments, *Critical Decisions Plan for Regional Transportation,* April 19, 1974; *Critical Decisions Plan for Regional Transportation* adopted by the Executive Committee Los Angeles: June 13, 1974; *Southern California Regional Transit System Plan,* an element of the SCAG Critical Decisions Program recommendations adopted Los Angeles: July 11, 1974.

64. Marcuse, "Mass Transit for the Few," p. 27.

65. C. Hamilton, Los Angeles City Planning director, memo to J. Ferraro, Los Angeles City councilman, November 11, 1973, p. 7.

66. Ibid., pp. 7, 8.

67. B. Ward, supervisor, Fifth District, letter to constituents, February 22, 1974.

68. R. Hebert, "Supervisors May OK Annual RTD Subsidy," *Los Angeles Times,* 19 January 1974, p. II-1, 6.

69. T. Bradley and J. Wachs, letter to K. Meade and A. Sieroty, June 28, 1974; T. Bradley, letter to K. Hahn, July 16, 1974.

70. D. MacKinnon, letter to B. Ward, August 19, 1974.

71. This was made clear in private conversations with Ward as well as in a published statement by him, "Proposed Plan to Contribute $1.75 Million in County Funds Earmarked for PRT," Los Angeles, Office of the Fifth District Supervisor.

72. Ibid.

73. R. Hebert, "Rail Unit Formed by RTD Officials," *Los Angeles Times,* 20 February 1975, p. II-1.

74. Southern California Rapid Transit District, Office of Manager Rapid Transit Department, *Summary Report on Rapid Transit Starter Line Corridor as of July 15, 1975* (Los Angeles: 1975) p. 1.

75. This was made clear in public statements and private conversations during the years 1976 through 1978.

76. Comment of a transportation planner in Los Angeles.

Chapter 12: Local Politics and Federal Money

1. A.M. Voorhees, "Partial Statement on Phase III Evaluation Procedures, Task 8.5.1" (Draft for initial discussion only, November 30, 1973). Los Angeles, prepared for the Southern California Rapid Transit District.

2. Southern California Association of Governments, *Critical Decisions Plan for Regional Transportation* (Los Angeles: April 19, 1974), p. 36.

3. P. Marcuse, "Mass Transit for the Few: Lessons from Los Angeles," School of Architecture and Urban Planning, University of California, Los Angeles, Departmental Paper 56, 1975.

4. This was pointed out by M. Wohl in a lecture delivered at a transportation conference at the University of Southern California in 1976.

5. It was only in 1977 that UMTA participated in a joint study with SNV Studiengesellschaft Nahverkehr mbH to do an investigation of the Cabinentaxi/Cabinenlift system. See "Development/Deployment Investigation of Cabintaxi/Cabinlift System," U.S. Department of Transportation, Transportation Systems Center (Cambridge, Mass.: Dec. 1977), Report No. UMTA-MA-06-0067-77-02. This report found that the first installation of the Cabinenlift-type vehicle with suspended vehicle guideway came in 1976 less than 10 percent over the contracted price in 1975. The 578 meter long guideway was installed in three months at a cost of $880,000. The original contract had called for a price of $822,400.

In 1977, Aerospace Corporation conducted a study for UMTA, summarizing the work they had done over the years. This study, "Independent Study of Personal Rapid Transit," UMTA-CA-06-0090-77-1, does not seem to have had any impact upon UMTA programs.

6. These analysts were participants in one or more of the studies done in the four cities.

7. These comments were made during an interview in 1976.

Chapter 13: The International Experience

1. U.S. Congress, Office of Technology Assessment, *Automated Guideway Transit* (Washington, D.C.: U.S. Government Printing Office, 1975), p. 203.

2. Ibid., p. 203; these studies were also mentioned in many interviews conducted both in 1975 and 1978.

3. B.E. Grant and W.J. Russell, *Opportunities in Automated Transit* (Hatfield, England: Stellar Press, 1973); T. Ishii, M. Iguchi, M. Koshi, Y. Tsukio, "CVS–Computer Controlled Vehicle System," (mimeo), n.d.; H. Zemlin, "Research and Development in the Field of Urban Transportation in the Federal Republic of Germany: A Governmental Viewpoint" in D.A. Gary, ed., *Personal Rapid Transit III* (Minneapolis, Minn.: University of Minnesota, 1976), pp. 109-116; Office of Technology Assessment, *Automated Guideway Transit*, p. 206.

4. "Cabtrack," *Architects' Journal* 153, no. 20 (19 May 1971):1104, 1112-1123.

5. Office of Technology Assessment, *Automated Guideway Transit*, p. 235.

6. W.J. Russell, "Architectural and Environmental Studies of the PRT System," in J.E. Anderson et al., eds., *Personal Rapid Transit* (Minneapolis, Minn.: University of Minnesota Press, 1972), p. 61.

7. Ibid., p. 61; see also "Cabtrack," *Architects' Journal.*

8. Ibid.; Grant and Russell, *Opportunities in Automated Transit.*

9. Russell, "Architectural Studies," p. 61.

10. "Cabtrack," *Architects' Journal*, p. 1116.

11. Ibid., p. 1115.

12. Ibid., p. 1118.

13. Russell, *"Architectural Studies,"* p. 106.

14. "Cabtrack," *Architects' Journal,* p. 1123.

15. Interview, Roy C. Baker, 1978.

16. "Cabtrack," *Architects' Journal,* pp. 1118-1122.

17. Ibid.

18. R. Gillie, "Computer Automated Reserved Track Systems (CARTS) Track Costs," University of Warwick, Lanchester Polytechnic, Urban Transport Research Group, Working Paper No. 16, August 1973.

19. C. McKean in "Cabtrack," *Architects' Journal*, p. 1123.

20. M. Hillman, I. Henderson, and A. Whally, *Personal Mobility and Transport Policy,* Political and Economic Planning Broadsheet 542, London, Research Publications Services, Ltd., 1973.

21. Office of Technology Assessment, *Automated Guideway Transit,* p. 235.

22. Grant and Russell, *Opportunities in Automated Transit.*

23. Ibid.

24. Office of Technology Assessment, *Automated Guideway Transit,* p. 236.

25. "Sheffield Minitram," *Architects' Journal,* reprint, 23 October 1974, p. 952.

26. Lea Transit Compendium, *Personal Rapid Transit,* vol. 2, no. 4 (Huntsville, Ala.: N.D. Lea Transportation Research Corp, 1975), p. 24.

27. This was disputed by another participant, who blamed the poor handling of the architectural report with the press for the demise of both projects.

28. "Planning: Minitrams in Sheffield," *Architects' Journal,* 12 February 1975, pp. 345-346.

29. Quoted in "Cabtrack," *Architects' Journal,* p. 1112. Reprinted with permission.

30. Y. Tsukio, "The Present Urban Transportation," *Digest of Japanese Industry,* no. 95 (1975):16-18.

31. Ishii et al., "CVS System."

32. Ibid.

33. Ibid., p. 2.

34. Ibid.; Tsukio, "Present Urban Transportation."

35. Interview, Y. Tsukio, 1975.

36. Ishii et al., "CVS System," pp. 10, 11.

37. Y. Tsukio, interview, 1975.

38. Office of Technology Assessment, *Automated Guideway Transit,* p. 254; this was also noted in a number of interviews conducted in 1975 and 1976.

39. Again, this was mentioned in several interviews with U.S. observers.

40. Office of Technology Assessment, *Automated Guideway Transit,* pp. 253-254.

41. This was discussed with a participant in the process during an interview conducted in 1978.

42. Zemlin, "Research and Development in Germany," p. 1.

43. Ibid., pp. 2, 3.

44. Ibid., p. 4; this was also discussed with him directly in 1975 and 1978.

45. Ibid., p. 4.

46. Ibid., p. 5.

47. H. Zemlin, interview, 1975.

48. This belief was expressed by several officials from the Ontario Urban Transit Development Corporation in conversations at the Third International Conference on Personal Rapid Transit in Denver, Colorado, 1975.

49. Lea Transit Compendium, *Light Guideway Transit,* vol. 2, no. 3 (Huntsville, Ala.: N.D. Lea Transportation Research Corp., 1975), p. 86.

50. Office of Technology Assessment, *Automated Guideway Transit,* p. 244.

51. J.E. Anderson, "Cabinentaxi: Urban Transport of the Future," Raytheon Co. Paper, 1976, p. 26; H. Zemlin, interview, 1978.

52. Reported at the International Conference on Advanced Transit, Indianapolis, Indiana, April 1978.

The initial loop was not built in 1978-1979, apparently due to some opposition from the existing transit interests (both local and national). The argument was made that the Cabinentaxi was not a train or a streetcar or an elevator, and therefore there were no standards to regulate it. Without standards it could not be certified as safe for public use. The "Catch-22" was that in order to develop standards, one had to have a system in operation. This difficulty was overcome with special legislation, and an initial segment of a few kilometers is scheduled to begin construction in autumn 1979. This system is to carry 12-passenger vehicles initially, but it is designed to use small 3-passenger vehicles if the system is expanded.

53. H. Zemlin, interview, 1975.

54. Ibid.

55. H. Waschin, "AGT Feasibility Study for Berlin West," *Advanced Transit News* 2, no. 3 (May-June 1978):7.

56. Ibid.

57. Lea Transit Compendium, *Personal Rapid Transit*, p. 16.

58. Reported by Gerard Levy of Engins Matra in an interview in 1975.

59. Ibid.

60. Office of Technology Assessment, *Automated Guideway Transit*, pp. 238-239.

61. G. Levy, interview, 1975; it was the presence of this technically strong research group that may have led to the initial interest in PRT on the part of the RATP. Such an interest was not sustained over time, however.

62. Office of Technology Assessment, *Automated Guideway Transit*, p. 225.

63. G. Levy, interview, 1975.

64. This is the phrase that H. W. Merritt reported the French were using in 1976.

Chapter 14: Technological Innovation and Public Policy

1. J.D. Thompson, *Organizations in Action* (New York: McGraw-Hill, 1967), p. 146.

2. J.W. Doig, *Metropolitan Transportation Politics and the New York Region* (New York: Columbia University Press, 1966), pp. 240-241.

3. P. Marcuse, "Mass Transit for the Few: Lessons from Los Angeles," School of Architecture and Urban Planning, University of California, Los Angeles, Departmental Paper 56, 1975, p. 32.

4. E.M. Rogers and F.F. Shoemaker, *Communication of Innovations* (New York: The Free Press, 1971).

5. These costs reflect prices in the early and mid-1970s. In the late 1970s and early 1980s, the cost of a test facility and early development work could be doubled.

6. U.S. Congress, House, Committee on Appropriations, *Department of*

Transportation and Related Agencies Appropriations for 1976, Hearings before a Subcommittee of the Committee on Appropriations, 94th Congress, 1st Session, 1975, p. 202.

7. J. Schmookler, "Industrial Research and Development," *International Encyclopedia of the Social Sciences,* 2d ed., vol. 13, 1968, p. 485.

8. H. Zemlin and R. Gotz of the Ministry for Research and Technology, interviews, 1978.

9. W.H. Lambright, *Governing Science and Technology* (New York: New Oxford University Press, 1976), p. 85.

10. E.L. Trist and F.E. Emery, "The Causal Texture of Organizational Environments," *Human Relations,* 18, (1965):21-32.

11. Thompson, *Organizations in Action,* p. 134.

12. This was expressed to me by a Los Angeles City councilman.

13. U.S. Office of the Federal Register, National Archives and Records Service, *U.S. Government Organization Manual 1974/75,* (Washington, D.C.: U.S. Government Printing Office, 1974), p. 58.

14. M. Webber, "The BART Experience– What Have We Learned?" Berkeley, University of California Institute of Urban and Regional Development and Institute of Transportation Studies, 1976; A. Hamer, *Selling of Rail Rapid Transit* (Lexington, Mass.: Lexington Books, 1976); S. Zwerling, *Mass Transit and the Politics of Technology* (New York: Praeger, 1975).

15. U.S. Congress, Office of Technology Assessment, *Automated Guideway Transit: An Assessment of PRT and Other New Systems Including Supporting Panel Reports* (Washington, D.C.: U.S. Government Printing Office, 1975). Although the author criticizes various aspects of this study, the criticism is not done to attack the efforts, integrity, or sincerity of the people who organized and participated in the development of this report. The purpose of the critique is to demonstrate that their assignment was incorrectly defined, due in part to the myth of objectivity. Theirs was an impossible assignment, which they attempted to carry out diligently and conscientiously as far as the author could determine.

Since this report was issued, OTA has changed its assessment procedures. More work is done internally, and advisory panels simply give advice; they do not write the reports.

16. Ibid., pp. vi, vii.

17. G. Kolsrud, interview, 1975.

18. Ibid.

19. Ibid.

20. H.W. Merritt, interview, 1976.

21. Office of Technology Assessment, *Automated Guideway Transit,* p. xi.

22. In discussions with participants Anderson was often referred to as an extremist, since he had taken a firm position supporting development of PRT. Others who strongly opposed that position were not referred to as extremists.

23. D. Schon, "The Organization as an Arena for Learning," Transcript from lecture given at Seminar in Organizational Frontiers, Los Angeles, University of California, Graduate School of Management, 1970.

24. Oscar Wilde quoted in the *Los Angeles Times*, 8 April 1975. Reprinted by permission.

25. Office of Technology Assessment, *Automated Guideway Transit*, p. 53.

26. Ibid., p. 310.

27. J. Irving, interview, 1976.

28. Lea Transit Compendium, *Light Guideway Transit*, vol. 2, no. 3 (Huntsville, Ala.: N.D. Lea Transportation Research Corp., 1975), p. 53.

29. Office of Technology Assessment, *Automated Guideway Transit*, p. 311.

30. Ibid., p. 311.

31. H.W. Merritt mentioned this during an interview in 1976.

32. R.K. Lay, "A Rationale for Automated Personal and Group Transit Development" in D.A. Gary, ed., *Personal Rapid Transit III* (Minneapolis, Minn.: University of Minnesota, 1976), pp. 183-193 in J.E. Anderson, J.L. Dais, W.L. Garrard, and A.L. Kornhauser, eds., *Personal Rapid Transit* (Minneapolis, Minn.: University of Minnesota, 1972).

33. Office of Technology Assessment, *Automated Guideway Transit*, p. 378.

34. Ibid., p. 312.

35. Webber, "The BART Experience"; Hamer, *Selling Rail Rapid Transit*.

36. Los Angeles Citizens Advisory Panel, *Report*, prepared for the Los Angeles Community Redevelopment Agency, July 1976.

37. Ibid., pp. 4-6.

38. Ibid., p. 6.

39. The desire for federal money was expressed both publicly and privately by a number of public officials in Los Angeles. Federal money is "free" to such officials, since they can spend it on visible projects without taking responsibility for raising local taxes. They can even join with the general public in their complaints regarding excess federal taxation.

40. This came out in discussions with some UMTA officials at the International Conference on Advanced Transit, Indianapolis, Indiana, 1978.

41. Interviews, J. Ferraro, Los Angeles City Council president, 1977; R. Eckert, member State Transportation Board, 1977.

42. N.R. Peirce, "Horse and Buggy Cities Look to the Space Age for Help," *Los Angeles Times*, 14 October 1976, p. II-7.

Glossary

ACIR Advisory Commission on Intergovernmental Relations
AGRT Advanced group rapid transit (see Group Rapid Transit)
AGT Automated guideway transit
APTA American Public Transit Association
ATA American Transit Association (Now combined with the Institute for Rapid Transit to form APTA)
ATRA Advanced Transit Association
Access Time The time required to walk or drive from the origin of the trip to a (boarding) transit stop, plus the waiting time, the transfer time, and the walking or driving time from the (deboarding) transit stop to the destination
Air Cushion Vehicle (See tracked air cushion vehicle)
Arterial Roadway A roadway with partial control of access, with some intersections at-grade and intended to move high volumes of traffic over long distances at high speed
Automated Guideway Transit A generic term that includes all advanced systems with automated, driverless vehicles traveling on exclusive guideways or roadways
BART Bay Area Rapid Transit
BARTD Bay Area Rapid Transit District
Brick-Wall Stop Assumes the lead vehicle stops instantaneously and that a following vehicle is capable of stopping without colliding with the lead vehicle
Capital Costs The nonrecurring costs that are required to build a transit system. These include right-of-way (row), facilities, rolling stock, power distribution, and the associated administrative and design costs. Sometimes also includes financing costs for construction
Central Business District (CBD) The single business and commercial region, which dominates the financial life of an urban region and may also contain a very substantial portion of the specialty commercial activity. (Traditional area of this type of activity, which may have been supplanted by other outlying areas in recent years.)
Collection The process of picking up passengers at a number of different locations
CVS Computer-controlled vehicle system—Japanese PRT system
Demand-Activated or **Demand-Responsive** Transportation responsive to a request for service. (An elevator or taxi for example)
Demonstration The fabrication, construction, and operation of a small system that is used by the public under conditions that test its public serviceability and acceptance
Density The number of people per square mile in an urban area

Distribution The process of letting passengers off at a number of different locations

DOT Department of Transportation

DPM Downtown People-mover Program—A special program of UMTA to put SLT systems into downtown areas

DRTD Denver Regional Transportation District

Dual-Mode A transportation system where, in one mode the vehicle operates under its own power and control, usually on city streets; and in the second mode it operates under automatic control and/or external power. Usually suggested for automobiles or buses

FAA Federal Aviation Administration

Feeder Service Local transit service, which feeds some other (usually faster and at higher capacity) transit service

FHWA Federal Highway Administration

Fixed Route An invariant path over which a transit vehicle is assigned and operated

FRA Federal Railroad Administration

Grade Separated Crossing lines of traffic are vertically separated from each other and do not share a common intersection

Group Rapid Transit A GRT System that serves groups of people with similar origins and destinations. Stations are on sidings off the main guideway, permitting through traffic to bypass. There is extensive use of switching, and guideways may merge or divide into branch lines to provide service on a variety of routes. Vehicles have a capacity of ten to sixty passengers. Headways range from 60 seconds down to 3 seconds. [A 3-second headway system is referred to as advanced group rapid transit (AGRT) or high-performance personal rapid transit (HPPRT). More recent usage based on the OTA study, 1975, prefers AGRT] (See also AGT, PRT, SLT)

GRT Group rapid transit

Guideway Specifically designed way traversed by transit vehicles constrained to the way

HCPRT High-Capacity Personal Rapid Transit (see Personal Rapid Transit)

Headway The time interval between identical points on successive vehicles passing the same point along the way

Heavy Rail Transit A train service with large vehicles usually greater than 45 feet in length with line haul service and on-line stations with level platform passenger boarding in stations. It moves on an exclusive guideway grade separated from other traffic. (Examples include most subway systems and the BART system in San Francisco.)

HEW Department of Health, Education and Welfare

HPPRT High-performance personal rapid transit (Obsolete term, see Group Rapid Transit)

HUD Department of Housing and Urban Development

IRT Institute for Rapid Transit [now merged with the ATA to form the American Public Transit Association (APTA)]

Jitney A loosely regulated roadway transit system where vehicles operate similar to taxis except passengers do not command exclusive use of the vehicle and vehicles generally follow a specific route but are not scheduled

Labor Intensive Operational costs of the transit system are dominated by wages

Light Rail Transit Generally a duo-rail electric traction service which runs at street level (with or without auto segregation). Passengers board from the street, there is overhead collection of power, and train operations during rush hours do not exceed three vehicles. (Example is the basic streetcar)

Line Haul A transit system that offers service along a line or corridor

Loop A guideway layout where the way forms a loop that closes on itself

Magnetic Levitation A form of vehicle suspension that uses the attractive or repulsive forces of magnets

Major Activity Center A defined urban area where pedestrian traffic is dense—shopping area, school, industrial park, sports complex

Merge Point A guideway or roadway section where two lines converge into one

Modal Split The proportioning of trips between travel modes

Mode A particular form or method of travel

Monorail A guideway where vertical vehicle support and lateral guidance is provided by a single track or rail

Mph Miles per hour

Moving Way A way over which vehicles, passengers, or goods are propelled passively and controlled via a moving belt, cable, or mechanical means while being transported

MTC Metropolitan Transit Commission (Minneapolis-St. Paul)

MVMA Motor Vehicle Manufacturers Association

NASA National Aeronautics and Space Administration

Network A system of real or hypothetical interconnecting links that form the configuration of transit routes and stops that constitute the total system

NTO New Technology Opportunities Program

Off-line Station A transit station whereby the vehicle is removed from the main line for loading or unloading and the flow of traffic on the main line is not impeded

Off-Peak Those periods of the day where demand for transit is not at a maximum

OMB Office of Management and Budget

On-Demand Transit service is rendered on the specific demand of a passenger

On-Line Station A transit station located on the main transit line requiring sufficient spacing between vehicles that one can load and unload before the next vehicle arrives

Operating Costs Recurring costs incurred in operating transit systems. Wages and salaries, maintenance of facilities and equipment, fuel, supplies, employee benefits, insurance, taxes, administrative costs. Amortization of facilities and equipment is not included.

Operating Revenue The gross income from operation of the transit system including fares, charter income, concessions, advertising. Does not include subsidies, interest from securities, nonrecurring income from the sale of equipment.

Operational A transit system or component that is placed into normal revenue service

OTA Office of Technology Assessment

Patronage The number of person-trips carried by a transit system over a specified time period

Peak Hour The hour(s) of the day when maximum demand for service is experienced. Sometimes referred to as peak period.

People-mover Becoming a generic term for any slow-moving AGT system which is placed in dense urban areas or activity centers. Also a trademark of the WEDway People Mover System at Disneyland.

Personal Rapid Transit A term restricted to systems with small vehicles carrying one person or one person with related party (up to six people maximum) traveling together by choice. System requires a network with off-line stations and extensive switching. Under computer control, vehicles switch at guideway intersections to follow the shortest uncongested path from origin to destination without intermediate stops. Vehicle headways are usually less than 3 seconds, approaching fractional second headways for high capacity service. (Sometimes also called high-capacity personal rapid transit)

Person-Trip A trip made by a person by any travel mode

Preliminary Design Initial engineering design but not detailed

Prototype A working system or component designed to demonstrate technical operation only

PRT Personal rapid transit

Public Transit Service provided for the carriage of passengers and their incidental baggage within cities and metropolitan areas, usually on a fare-paying basis. The term is not applied to intercity transportation.

Radial Network A guideway layout where most lines converge into and diverge from a central hub as do the spokes of a wheel

RATP Régie Autonome Des Transports Parisiens, the regional transport authority for Paris

SCAG Southern California Association of Governments

SCRTD Southern California Rapid Transit District

Shuttle Loop Transit The simplest type of AGT system. Vehicles move along fixed paths with few or no switches. The vehicles may operate as a simple back and forth shuttle (like a horizontal elevator), or they may travel in a closed loop. The number of stops is usually quite limited. The vehicles may vary in size and may travel singly or in trains. Vehicles are comparable to an automated bus. The Downtown People-mover Program of UMTA is supposed to demonstrate SLT systems in urban areas.

SLT Shuttle loop transit

Suspension Method by which a transit vehicle is supported (wheels, air levitated, magnetic levitation)

TAA Transportation Association of America

TACV Tracked air cushion vehicle

Tracked Air Cushion Vehicle Vehicle suspended from exclusive guideway by air cushion

Transit A transportation system principally for moving people in an urban area and made available to the public usually through paying a fare

Transit Dependent Those people who are unable or unwilling to drive an automobile

TRB Transportation Research Board (formerly Highway Research Board)

Trip The one-way movement of one person between his or her origin and destination, including the walk to and from the means of transportation

UMTA Urban Mass Transportation Administration

Vehicles Supported Below The vehicles ride over the top of the guideway

Vehicles Supported from Side Vehicles ride along the side of the guideway

Vehicles Suspended The vehicles hang from the guideway

Note

1. Excerpted and adapted with permission from Lea Transit Compendium, *Reference Guide,* vol 2, no. 4, (Huntsville, Ala.: N.D. Lea Transportation Research Corporation) and the U.S. Congress, Office of Technology Assessment, *Automated Guideway Transit* (Washington, D.C.: U.S. Government Printing Office, 1975).

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