TRANSIT COOPERATIVE RESEARCH PROGRAM

SPONSORED BY

The Federal Transit Administration

TCRP Report 42

Consequences of the Interstate Highway System for Transit: Summary of Findings

Transportation Research Board
National Research Council

TRANSIT COOPERATIVE RESEARCH PROGRAM

Report 42

Consequences of the Interstate Highway System for Transit: Summary of Findings

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.
Portland, OR

with

JOHN PUCHER
Rutgers University
New Brunswick, NJ

Subject Areas

Public Transit

Research Sponsored by the Federal Transit Administration in Cooperation with the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY PRESS
Washington, D.C. 1998

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academy of Sciences, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP REPORT 42

Project H-13A FY'96
ISSN 1073-4872
ISBN 0-309-06309-4
Library of Congress Catalog Card No. 98-61203

Price $25.00

NOTICE

The project that is the subject of this report was a part of the Transit Cooperative Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the project concerned is appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, the Transit Development Corporation, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

To save time and money in disseminating the research findings, the report is essentially the original text as submitted by the research agency. This report has not been edited by TRB.

Special Notice

The Transportation Research Board, the National Research Council, the Transit Development Corporation, and the Federal Transit Administration (sponsor of the Transit Cooperative Research Program) do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the clarity and completeness of the project reporting.

Published reports of the

TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

and can be ordered through the Internet at
http://www.nas.edu/trb/index.html

Printed in the United States of America

FOREWORD

By Staff
Transportation Research Board

TCRP Report 42, "Consequences of the Interstate Highway System for Transit: Summary of Findings" will be of interest to transportation and urban planners, local decisionmakers, and historians. The research project examined the consequences of the interstate highway system for transit. A literature review and case studies of urbanized areas were done, with each of the case studies representing a different relationship between highways, transit, and urban development.

TCRP Project H-13A, *Consequences of the Interstate Highway System for Transit,* researched the intended and unintended consequences of the development of the urban interstate highways (or their equivalent) for transit by examining four metropolitan areas in the United States, four cities in Germany, and one city in Canada. The U.S. case study areas were selected based on their levels of highway availability and levels of transit use. The selected locations represent three different categories: high interstate emphasis and low transit use; high interstate emphasis and high transit use; and low interstate emphasis and high transit use. The fourth category of low interstate emphasis and low transit use was not included.

The U.S. case studies were then compared with international case studies in Canada, which has no federal highway program, and Germany, which has the autobahn system—the second largest limited access highway system in the world. German autobahns, however, largely connect cities rather than provide mobility within cities. Canada and Germany are comparable to the United States in their high standards of living and auto ownership rates, but differ significantly in their building of limited-access highways, especially within urban areas and their investments in transit services.

The case studies tested two major hypotheses. First, that the interstate highway program in the United States biased transportation investments in favor of high-speed, limited-access highways, which helped make travel by automobile much more attractive than using transit. Second, interstate highways facilitated the suburbanization of households and firms, producing a pattern of development that is a challenge for transit to serve.

TCRP Report 42 presents a summary of findings from the literature review and case studies. The complete case studies are contained in a separate report, available for loan from TCRP.

CONTENTS

AUTHOR ACKNOWLEDGMENTS

Dr. Judy Davis, Ross Roberts, and Samuel Seskin of Parsons Brinckerhoff and Dr. John Pucher of Rutgers University contributed to this report.

1.0 INTRODUCTION

In 1956, Congress passed the Interstate Highway Act, authorizing the largest public works project in the history of the country. The act authorized 40,650 mi (later expanded to 42,796 mi) of Interstate and National Defense Highways to be built by 1972 and provided $24.8 billion in funds for the period from 1957 to 1969.

One innovation of this act was the method of funding. The Highway Trust Fund Act, passed simultaneously with the Interstate Highway Act, designated all federal gas and other vehicle-related taxes to highway construction and maintenance. Previously, these funds had been deposited in the general fund and highway federal-aid dollars were proportioned from the general fund. The federal designation of funds followed the practices of many states that had designated gas taxes exclusively for highway use. Highway advocates were thus able to argue that users paid for the construction of these projects (Federal Highway Administration 1977, Dunn 1981).

In the 1950s, the public and elected officials considered highway congestion the main urban transportation problem. Rapid growth of automobile ownership and the suburbanization of the population produced congestion in central business districts (CBDs) and on the routes to and from them during peak periods. Cities and counties tried to reduce this congestion by expanding arterial streets and building expressways and parkways. The new and expanded facilities, however, were rapidly becoming congested. As a result, limited-access, high-speed freeways were proposed as a solution to congestion.

Highways were regarded as a public good that should be built and maintained by government to serve the most "democratic" of transportation choices - the automobile (Foster 1992). Federal funds for highway construction were first authorized in 1916. However, prior to the interstate highway era, most federal and state transportation funds were spent on rural roads. Urban highways were regarded as local routes that should be funded locally. The first federal funding for urban roads was approved as public works projects during the Depression more to provide jobs than to deal with urban transportation issues.

Prior to 1956, there was long debate about whether interstate highways should go around or through urban areas. The Automobile Manufacturers Association (AMA) was a major supporter of interstate highways within cities. The AMA commissioned a report by Wilbur Smith and Associates (1961) on cities and highways, *Future Highways and Urban Growth.* This report laid out the reasons for building interstate highways in cities.

The Wilbur Smith report pointed out that the largest future market for automobiles was in cities. Not only were urban areas the most rapidly growing parts of the country, but many urban households did not yet own automobiles. The report contended that CBDs needed radial freeways to survive and that express buses on these freeways were the transit of the future. The AMA also argued freeways were needed in cities for civil defense purposes. The civil defense argument that freeways would help people leave the city in

the event of a nuclear attack helped convince Congress that federal dollars should be spent on "local" projects like urban highways (Schwartz 1962, St. Clair 1986, Flink 1988).

At the beginning of the interstate highway era, highway planning was largely done by engineers seeking low-cost routes. Interstate highways were built to rural standards so that high speeds could be safely maintained at all times although this required more land than other types of highway design. Urban interstate highways were often planned by state highway agencies with little consideration for broader metropolitan area plans.

When selecting routes, transportation agencies consulted with mayors, other public officials and major institutions, but rarely with the public. Social and environmental concerns played almost no role in decision-making. Lower-cost routes often went though poor neighborhoods and city parks. The disruptions were greatest in the inner cities where many homes and businesses were displaced by these projects. In the suburbs, interstate highways could often be built on undeveloped or partially developed land, causing less disruption to established patterns of living (Altshuler et al. 1981, Flink 1988, Rose 1990). Later critics questioned both the way costs were measured and the policy of using highway building to demolish many inner city neighborhoods in the name of urban renewal.

Congestion continued to be an issue in the 1960s and 1970s. However, attention was also given to the decline of transit, the disruptions of urban freeway building, and automobile safety. Later, concerns about environmental and energy issues increased as the nation celebrated Earth Day and responded to the Organization of Petroleum Exporting Countries (OPEC) oil embargoes. Transit financing became an issue as more and more systems became publicly owned, and state and local governments sought funds to maintain and expand service. As automobile use increased, concern about the mobility of people without cars became more significant (Altshuler et al. 1981, Smerk 1991).

The environmental movement emerged in the late 1960s and early 1970s. The National Environmental Policy Act of 1969 required environmental impact statements for federally funded projects with major impacts. This changed the rules for planning interstate highways. The Clean Air Act Amendments of 1970 required that states develop state implementation plans (SIPs) for nonattainment areas. As a result, air-quality agencies became involved in transportation issues (Weiner 1992).

Freeway revolts had erupted in 12 cities by 1970. What began as reactions of the people directly affected by the disruption of massive highway projects on neighborhoods and communities, snowballed and became a rallying cry for civil rights activists, environmentalists, urban neighborhood preservationists, and downtown business groups. Many groups feared that interstate highways aided growth in the suburbs and fostered downtown and urban neighborhood decline (Jones 1985, Kemp and Cheslow 1976, Dunn 1981). Eventually, the freeway revolts resulted in the withdrawal of some interstate projects and the substitution of other transportation projects. In 1973, the rules were changed to allow transit projects to be substituted for interstate highway projects that were not considered essential for the system. In 1976, the rules became more flexible, allowing some interstate funds to be expended on other highway projects (Weiner 1992, Edner and Arrington 1985).

As the number of federal programs addressing urban issues expanded to include urban interstate highways, transit projects, urban renewal, and model cities, the federal government saw a need for coordination at the metropolitan level to avoid duplication of effort or contradictory programs. The federal government promoted regional cooperative efforts such as clearinghouses for federal grants and metropolitan planning organizations (MPOs) for transportation planning. Federal legislation required joint planning of highways and transit after 1973 (Smerk 1991, Weiner 1992). However, throughout the interstate highway building era, there remained a focus on planning and building the interstate segments that often downplayed examination of other possible solutions to congestion. The federal funds available exclusively for the construction of interstate highways encouraged their construction as the way to meet urban transportation needs. Similarly, the provision of federal capital assistance without operating assistance for transit encouraged bus purchases and construction of rail systems, but not changes in scheduling, routing, or transit management (Kemp and Cheslow 1976, Altshuler et al. 1981, Jones 1985).

Many cities used the designated federal funds to build extensive radial and beltway interstate highways. These large-scale projects created massive disruptions in developed areas. In the late 1960s and early 1970s, increased activism supporting neighborhood preservation, downtown revitalization, social and economic development for minorities, and environmental concerns combined with the disruptions of interstate highway building to change attitudes and laws affecting the interstate highway system. At the same time, public opinion changed from viewing transit as a private enterprise to seeing it as a solution to various other urban problems, including congestion. Public agencies acquired failing private transit companies, and the federal government became involved in subsidizing transit through the newly created Urban Mass Transit Administration. Changes in public attitude led to changes in federal policy, including the following:

- Halting the construction of urban interstate highway segments and delaying the completion of others for years;
- Substituting transit and other highway projects for interstate highway projects;
- Shifting urban highway decisionmaking from state highway departments to newly created MPOs;
- Using an interdisciplinary approach to transportation planning that considered the social, economic, and environmental impacts of transportation investments;
- Establishing public ownership and operation of most transit systems;
- Granting new federal, state, and local subsidies for transit; and
- Giving transit and highways separate federal agencies and rules.

These changes - in transit financing, transportation planning rules, environmental legislation and public perceptions of transportation problems - occurred after a generation of highway development (approximately 1956 through 1976). They did not, of course, mark the end of federal involvement in transportation planning, financing and development. Further evolution in transportation policy culminated in the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1990. This legislation, among other things,

- Unified the transportation planning process across modes;
- Reduced modal bias in funding formulas;

- Required consideration of the land use impacts of transportation investments and policies; and
- Strengthened citizen involvement at all levels of government.

Today, as legislators consider the re-authorization of ISTEA, it is appropriate to review some of the consequences of the development of the Federal Interstate Highway System. The purpose of this TCRP Project is to undertake this evaluation, with the added benefit of the passage of an additional generation of time since the interstate highway system was effectively completed in the 1970s.

The principal focus of this project is the system's effects on public transit. This analysis requires, however, an examination of the effects of the interstate highway system on the spatial form and evolution of metropolitan areas, since the efficiency and effectiveness of public transit has been shown to be linked to urban form (Parsons Brinckerhoff, 1996a).

These relationships are not simple ones, because the political, social and economic context in which they were operating steadily changed. Further, any broad analysis of the effects of the interstate highway system on transit requires the collection and examination of an extremely complex set of data, measuring multiple factors in attempting to control for them in a way that isolates the role of highways. An econometric analysis would require data that is not readily available and would likely be inconsistent and unreliable if collected from individual regions, and would require proxy variables to represent some key aspects that are not easily measured. The research team, therefore, determined that this approach would not be possible within the constraints of this project. The project's approach involves the use of a small set of carefully selected case studies, both domestic and international. The full set of case studies is contained in a separate report.

The comparisons show that while U.S. cities were building interstate highways, governments and citizens in other countries were making decisions about urban highway and transit investments that diverged from the American point of view. Their investments reflect different attitudes and policies toward transit, highways and urban development.

Among the U.S. cities, the comparisons show important local policy, institutional, financial and other differences in transportation infrastructure development which help explain variations in the consequences of the interstate highway system for transit.

Before turning to the case studies, it is appropriate to finish a review of the literature on these issues and to summarize its findings relative to interstate highways and transit. (TCRP Research Results Digest 21 presents the literature review for TCRP Project H-13A.) Then, in Sections 3.0, the reader will find summaries of six case studies conducted on American, Canadian and German metropolitan areas, focusing on the relationship between highways, transit and urban development.

Section 4.0 contains a set of findings, or lessons learned, relevant to metropolitan and national transportation policy from the cases which may be relevant in the context of the reauthorization of ISTEA underway.

2.0 LITERATURE REVIEW

During the interstate era, urban areas in the United States became more spread out, multicentered, and dependent on the automobile. The question of interest here is the role of the interstate highway system in fostering or supporting these trends. The interstate highway system was not the only force at work. For example, cities like Phoenix and Orlando became fully motorized cities without extensive networks of interstate highways or even other freeways. Many other factors are involved in the way cities have developed, including individual preferences for living in suburbs, higher incomes, widespread automobile ownership, and few limits on suburban development (Altshuler et al. 1981, Jackson 1985, Linneman and Summers 1993).

However, a review of the literature makes clear the interstate highway system put transit at a competitive disadvantage in two ways. First, it biased transportation investments in favor of high-speed, limited-access highways. This enhanced automobile travel at a time when transit service was already declining, further encouraging the use of the automobile and reductions in the use of transit. Second, it facilitated the suburbanization of households and firms. The resulting dispersed, low-density pattern of development is difficult to serve efficiently with transit.

Interstate highways, and the legislation that created them, had these effects for the following reasons.

Interstate Highway Funding Biased Transportation Investments

One effect of the interstate highway system was to bias transportation investments in favor of building urban limited-access highways rather than pursuing other solutions to urban transportation problems. Dunn (1981) analyzed U.S. and European transportation policies and concluded that the U.S. emphasis on highways was largely a result of designating motor vehicle taxes exclusively for highway construction. The earmarking must be considered part of the interstate highway system because it occurred simultaneously with authorizing the interstate highways. Dunn argues that this earmarking of funds allowed the United States to build the best highway system in the world and created the powerful argument that car users pay their own way. It meant, however, that little was invested in other modes until the freeway revolts of the 1960s and 1970s focused attention on the environmental and social consequences of automobile use, including the decline in transit services and use.

Congress set the funding formula for interstate highways at 90 percent federal and 10 percent state and local funds compared to 50 percent federal and 50 percent state and local funds for other federally aided highways. Meyer and Gomez-Ibanez (1981) point out that this made interstate highways a more attractive investment to local areas, despite their higher costs, than construction or improvements in other projects eligible for federal aid. This funding formula created incentives to build interstate highways rather than invest in other highways, develop transit service, improve existing facilities, or consider other transportation alternatives. It is interesting to note that since the funding formulas changed with ISTEA, the balance of modal investment has also begun to change.

Interstate Highways Improved Automobile Travel Times and Costs

The interstate highway system was intended to link cities with high-speed travel routes and to improve traffic flows in and around cities. Beltways were originally designed as part of the through traffic system, but they became the carriers of enormous amounts of local traffic as well (Payne-Maxie and Blayney-Dyett 1980). In city after city, as networks were completed, interstate highways became the most highly used urban routes. In 1991, the 131 federal aid urbanized areas with populations of 200,000 or more had 8,505 miles of interstate highways. These urban interstate highways carried 26 percent of daily vehicle miles of travel within the urbanized areas although they made up only 1.8 percent of total road mileage (Federal Highway Administration 1992).

In an assessment of the economic impacts of the interstate highway system, Louis Berger International (1995) reports that three of the primary impacts of the interstate highway system have been to reduce travel costs, improve safety, and increase connectivity of regions. The interstate highway system has increased traffic capacity and travel speeds. A 365-mile trip that took 10 hours in 1956 took only 8 hours on the interstate highway system in 1970, a 20 percent reduction in travel time. The travel cost reductions had widespread effects on the economy, lowering the cost of consumer goods and improving the competitiveness of businesses. Furthermore, the interstate highway system has half the accidents per mile compared with travel on other types of highways. Interstate highways are safer because of limited access and wide lanes designed for high-speed travel. Improved safety is one of the reasons that trucking has become reliable. In addition, the interstate highway system increased connectivity of regions and metropolitan areas spurring a growth in trucking and shift in logistics, such as to just-in-time deliveries.

Garrison and Souleyrette (1996) argue that transportation innovations that lower travel costs and increase connectivity, which the interstate highway system does, spur companion innovations. Transportation is essential for moving goods and people. Improved highways, for example, allowed the use of the larger trucks. This changed the nature of the warehousing industry by supporting the replacement of dispersed locations that served multiple clients with consolidated locations operated by individual retailers.

But Kemp and Cheslow (1976) notes that improvements in travel conditions were often short-lived. Interstate highways created the expectation that there would be free-flowing traffic at high speeds at all times. The benefits to travelers were often less than expected because of latent demand. Some interstate highways rapidly became congested during peak periods because the improved travel conditions encouraged more travel or caused shifts in travel from other routes, times, or modes.

Interstate Highways Disadvantaged Transit Operations

As noted previously, the improvements in automobile travel that interstate highways provided occurred at a time when few investments were being made in transit. Ridership was declining. Few private transit companies had the resources to invest in new equipment or expand services as urban areas grew. The improvements made in automobile travel only compounded transit's problems (Pucher 1995).

Vuchic (1981) argues that this created a cycle of worsening transit conditions. Improved automobile travel led to fewer transit riders. Fewer riders produced less revenue and resulted in service reductions. This in turn caused further defections to the automobile. One way to avoid the downward slide of transit was to simultaneously invest in both modes to maintain a balance between them, as some Canadian and European cities did, but most U.S. cities in the 1950s and early 1960s only invested in highway improvements.

Direct competition between interstate highways and transit occurred on only a few long-haul commuter rail or rapid transit routes in larger cities. This reduced peak and especially off-peak travel. Fares in the peak period could not be raised to compensate for fewer riders because of the competition with interstate highways, which also lacked peak-period pricing. For bus operations, the primary effect of interstate highways was increased congestion within the CBD because of the larger number of cars arriving there. This lowered the speeds of buses, making them less attractive to their main market: short-haul trips. If parking was available, short distance riders began driving to work because of the time advantage (Jones 1985, St. Clair 1986).

Interstate Highways Facilitated Suburbanization of Households and Jobs

Interstate highways supported dispersion of population and employment to lower density suburban areas, which further eroded transit's market share. In 1990, the most common type of commuting trip (44 percent of all metropolitan commutes) began and ended in the suburbs. Only 20 percent of metropolitan commutes were from suburbs to the central city (Pisarski 1996). Meanwhile, transit has focused on bringing people to the CBD, where a smaller and smaller proportion of a region's workforce is employed.

Some researchers reach sweeping conclusions about the impact of the interstates on urban development and travel patterns. In his history of suburban development in the United States, Jackson (1985) says,

> ...the interstate system helped continue the downward spiral of public transportation and virtually guaranteed that future urban growth would perpetuate a centerless sprawl (p. 249).

Muller (1995) states,

> The maturing freeway system was the primary force that turned the metropolis inside out after 1970, because it eliminated the regionwide centrality advantage of the central city's CBD. Now *any* location on that expressway network could easily be reached by motor vehicle, and intraurban accessibility swiftly became an all-but-ubiquitous spatial good (pp. 43-43).

Other authors are more cautious. Louis Berger International's (1995) analysis of the economic impacts of interstate highways reported that no studies have conclusively shown that the interstate highway system has changed the way cities develop. Rather, studies such as the Payne-Maxie and Blayney-Dyett (1980) study on beltways (see below) have found that interstates supported dispersed development only when other factors like regional economic growth, favorable tax rates, and zoning for higher levels of development

were also present. Altshuler et al. (1981) believed that the Interstate Highway Act was one of many public policies that "accommodate(d) and reinforce(d) the majority taste for low-density and for automobility (p 24)." It points out that postwar patterns of location and travel were laid down between 1945 and 1960, before any significant amount of urban interstate highway was built.

A recent review of the impacts of highways on land use by the Transportation Research Board (1995) takes the middle ground. It concludes that highway expansion did influence urban form, but only in conjunction with other societal forces and public policies supporting suburbanization. The study drew the following conclusions about the effects of highways on urban land use:

- Early highway capacity expansions, such as construction of interstate highways, dramatically reduced travel costs and increased access to undeveloped land. Lower land costs enticed households and firms to move to areas on the urban fringe that had improved accessibility.
- Highway capacity expansions interacted with population growth, rising personal income, increased automobile ownership, decreased cost of transportation, and land use policies to channel the location of growth within metropolitan areas.
- Additions to the highway system made at the same time a metropolitan area was growing influenced the location of residential and employment development because the corridor where the investments were made became more attractive for development.
- Additions to highway capacity that reduced the cost of travel supported sprawl when other conditions also supported dispersed development. The effect was greatest when access to large tracts of rural land on the urban fringe was improved.

In sum, the study finds that building highways, including the interstate network, in urban areas improved accessibility to suburban and exurban locations, facilitating the development of housing and employment at the urban fringe and encouraging the expansion of metropolitan areas. The highways did this by interacting with a variety of other factors that supported dispersed development.

The Federal Highway Administration and U.S. Department of Housing and Urban Development jointly sponsored a study of beltways in the 1970s to test the widespread assumption that beltway construction was undermining other federal efforts to support central cities. The beltway study used a statistical comparison of 27 cities with beltways and 27 cities without them and detailed case studies of eight beltway regions. The study found little support for the hypothesis of suburban gains at the expense of central cities. The study found no statistically significant differences between beltway and non-beltway cities in regional economic growth, rate of suburbanization, CBD retail sales, and residential development locations. Some differences between the two types of regions were detected, but the differences were small.

Hughes and Sternlieb (1988) Muller (1995) and Leinberger (1996) suggest that it took a whole generation of living with interstate highways before developers realized that the intersections of beltways and radial interstate highways afforded the same accessibility advantages as the CBD. Thus, it was not until the 1980s, when most interstate highways were complete, that high-rise office development along the beltways took off. In the 1980s, the circumferential highway corridors and, to a lesser extent, the radial corridors

became the preferred locations for office development. In many cities, including Houston, Boston, Dallas, Denver, San Diego, St. Louis, and Kansas City, the majority of regional office space is now outside the CBD (Garreau 1991).

Carlino and Mills (1987) found that interstate highways supported metropolitan growth in the 1970s but their analysis does not support the idea that suburbs grew at the expense of central cities. They did a simultaneous equation analysis of population and employment change in all U.S. counties in the 1970s and found that people and jobs moved to counties with more intense interstate highway networks. The largest impact was on total and manufacturing employment. Counties with double the interstate miles per square mile of land had about a 6.0 percent increase in total and manufacturing employment during the decade. Population grew somewhat less. A doubling of interstate density increased population density on average by 2.8 percent. Interstate highways are densest in central counties, followed by suburban, adjacent nonmetropolitan, and non-adjacent nonmetropolitan counties. The growth effects of interstate highways therefore, declined with distance from the central city. The authors view the growth in population and jobs in areas with more interstate highways as an unintended consequence of the interstate highway system.

Other studies by Humphrey and Sell (1975), Lichter and Fuguitt (1980), and Rephann and Isserman (1994) have also found that interstate highways helped expand metropolitan areas. They studied the effects of interstate highways on population and employment growth in non-metropolitan areas and found that interstate highway effects were greater the closer the area was to a metropolitan area. Some of this population growth in counties adjacent to metropolitan areas was due to increased commuting to the metropolitan area and some to expanding service jobs within the nonmetropolitan county. Rephann and Isserman (1994) reports that adjacent nonmetropolitan counties began having higher population and retail growth immediately after interstate highway construction compared with similar counties without interstate highways. The counties retained this advantage for the period of the study (at least a decade) and also began attracting more manufacturing as the population grew. All of these studies leave open the question whether interstate highways caused new development or were built in the path of new development (Forkenbrock et al. 1990), although the Rephann and Isserman time series matched pair study provides more conclusive evidence that interstates directed development than other studies.

The case studies that follow document facts and trends in four U.S. metropolitan areas which are consistent with the conclusions offered here - that Interstate highways biased transportation investments, improved automobile travel times and costs, disadvantaged transit operations and facilitated suburbanization. In the chapter that follows, we present these cases, as well as several from other countries. The cases bring into focus local and national policies which caused these impacts, and others which helped to mitigate them.

This page left intentionally blank.

3.0 CASE STUDIES

The principal research hypothesis of this project is that development of the Interstate Highway System adversely affected public transit, both directly and indirectly. The direct effects were the result of the comparative advantages in travel time and cost afforded to motorists who travel on the interstates in comparison to travelers who use public transportation. Consequences of this included declining ridership for transit, increasing difficulty in maintaining transit service levels, and neglect of transit capital investments at a key stage in the evolution of American transportation technology.

The indirect effects included the dispersion of households and businesses into a pattern of development which is difficult to serve efficiently with transit, further compounding the difficulties faced by transit in established travel corridors. Automobile oriented development patterns since the 1950s reduced the cost-effectiveness of transit and increased the difficulty of providing attractive levels of service.

Researchers for this project chose the comparative case study method for testing this hypothesis. From the universe of US metropolitan areas, researchers identified subsets of regions that fit the matrix shown in Table 1. Metropolitan areas were sorted into groups with high and low levels of highways, based on a composite measure which included consideration of

- Percentage of all metropolitan roadway miles in interstate highways;
- Percentage of daily vehicle miles of travel on interstate highways,
- Number of interstate highway road miles per 100,000 persons; and
- Number of interstate highway road miles per 100 square miles of metropolitan area.

Metropolitan areas in the top and bottom half of the sample with respect to interstates were further sorted based on the composite measure of transit use consisting of the following:

- Transit trips per person;
- Metropolitan work trip transit mode share; and
- Change in metropolitan transit mode share, 1960 to 1990.

The most promising candidate regions are shown in Table 1. Only eleven cities are classified as high transit use cities because of the sharp difference in current transit use between this group of eleven and the remainder of the cities. The eleven high transit cities have more than 12 percent of central city residents commuting on transit while the remainder of the cities, with the exception of Louisville with an 8.5 percent mode share, have less than 6 percent of work trips by transit.

Table 1. Candidate U.S. Case Study Cities by Interstate Emphasis and Transit Usage

	Low Transit	High Transit
High Interstate	Birmingham ***Columbus*** Indianapolis ***Kansas City*** Louisville Nashville-Davidson Oklahoma City Salt Lake City San Antonio Springfield-Chicopee-Holyoke	***Atlanta*** Cincinnati Cleveland Hartford St. Louis
Low Interstate	Chattanooga El Paso Fort Lauderdale-Hollywood Norfolk-Portsmouth Orlando Phoenix Sacramento San Jose St. Petersburg Tacoma	Austin Miami New Orleans New York-NE New Jersey Philadelphia ***Pittsburgh***

Bold italic indicates a city selected for study

From this group researchers selected four cities. Among the many cities with high levels of interstate highway and low transit, Kansas City, Missouri and Columbus, Ohio stood out because of their extensive interstate networks.

Columbus, Ohio has 1.3 million residents and 112 miles of interstates, including a suburban beltway. Transit use in Columbus has declined sharply since 1960 and only 4.7 percent of work trips originating in the central city are on transit today. Both the city and the metropolitan area have had moderate growth throughout the period from 1960 to 1990.

Kansas City, Missouri-Kansas (population 1.6 million) is an example of a region where the central city has declined as the metropolitan areas has grown and spread out. Kansas City has both extensive interstates (180 miles) and other freeways (137 miles). Transit use in the region has declined sharply during the freeway era. The residents of Kansas City's transit service area make about 15 transit trips per year and about 5.8 percent of work trips of central city residents are made on transit.

The researchers selected two cities, rather than one, from this cell because they constitute base case conditions against which other case study regions would be compared. They exemplify regions with extensive commitments to interstate highways that have also had particularly rapid declines in transit patronage.

From the set of cities with low levels of interstate development and high levels of transit use, Pittsburgh was selected. ***Pittsburgh, Pennsylvania*** is a region with 2.2 million residents and

only 138 miles of urban interstates and 67 miles of other freeways. Pittsburgh has invested in light rail and busways. Residents of the region make on average 60 transit trips per year.

As a complement to these, one city was selected where high levels of interstate investments have been accompanied by high levels of transit investment. ***Atlanta, Georgia*** has invested in both transit and interstate highways, retaining high transit use in its core as the region has spread out into 18 counties. The region has built a 38 mile rapid rail system, 221 miles of urban interstates, and 47 miles of other freeways. Atlanta is a large region with nearly three million residents, most of whom live in suburbs where there is little or no transit service. Selection of this community affords the researchers a chance to observe the consequences of commitment to high levels of accessibility by both transit and highways, an approach which, while costly, is common in a number of prominent American cities.

The researchers did not select a case study region where low levels of interstate investment coincided with rapid declines in transit patronage, since the low levels of investment in either mode precluded a meaningful testing of the research hypothesis.

Supplementing this set of American cities, the researchers added two international case studies. Canada has no federal highway program while Germany has built the autobahn system, the second largest limited access highway system in the world. German autobahns, however, largely connect cities rather than provide mobility within cities.

Calgary, Alberta is a moderately sized metropolitan area (about 750,000 residents) with a strong, vibrant downtown. Calgary has grown rapidly during the interstate era and has few geographic constraints to growth, making it comparable to several of the United States case study regions. Calgary has built few freeways, and even the Trans Canada Highway passes through the city as an arterial street. The region has an 18 mile light rail system with additional routes planned and a bus system integrated with light rail. Transit trips per person in Calgary are about four times those in Columbus.

Muenster, Freiburg, and Munich, Germany are cities of different sizes that have increased transit ridership and bicycle use and decreased automobile mode shares despite the extensive system of autobahns (high speed, limited access highways) and high standard of living in Germany. Munich, for example, is a 2.4 million person region where residents average 223 transit trips per year. In addition, these regions are contrasted (in the case study report) with the large polycentric Rhein-Ruhr region where autobahns connect 24 cities with a total of 7.5 million residents. Even in this more auto-oriented region, 20 percent of all non-pedestrian urban trips are made on transit.

The researchers chose to include international examples in order to evaluate the ways in which national policy differences can explain differences in the impacts of freeways on transit. Case studies proved particularly effective in illuminating these differences in both public policy and its consequences for public transit use.

The researchers also reviewed a set of case studies prepared for TCRP Project H-1, "Transit and Urban Form," before synthesizing lessons learned about the consequences of the Interstate highway system. Three United States and two Canadian regions were studied to understand the factors and conditions required in order to induce development

near transit. Documented fully in Volume II of TCRP Report 16 (Parsons Brinckerhoff, 1996b), these cases focused on the following places:

In ***Vancouver, BC, Canada,*** a regional government developed a vision of regional town centers connected by rapid transit. The provincial government built a rail system linking these regional centers. Land use plans implemented by local governments have guided development near stations and produced a pattern of settlement in the urban core highly supportive of transit. No freeways were built in or through the city of Vancouver.

In ***Ottawa, Ontario, Canada,*** where transit is a service of the regional municipality, a system of regional busways provide a high level of service to activity centers and the strong central business district. Parking constraints and other policies encourage transit use.

In ***Portland, Oregon*** a citizen-based "freeway revolt" led to the substitution of a light rail line for a segment of the interstate highway system. Interstate highway development and freeway expansion have been accompanied by investments in light rail. Downtown growth in a highly transit accessible urban core, coupled with aggressive land use planning, has led to recent increases in transit patronage.

In ***Washington, DC,*** the regional transit agency has participated successfully in the joint development of suburban station areas. The downtown core has only limited freeway accessibility and attracts most employees on public transit.

Houston, Texas's freeway expansion program, partially funded and implemented by the region's transit provider, includes the nation's largest system of high occupancy vehicle lanes. Express buses share these lanes with carpools. Transit serves the downtown adequately, but has been unable to compete successfully in suburban activities centers. Elsewhere, the disbursed development pattern and high levels of freeway accessibility have precluded effective transit service.

We have used information contained in the H-1 case studies to test and substantiate the conclusions reached in the subsequent sections of this report. Together with the six case studies named above, they offer a diverse set of experiences from which to draw conclusions about the effects of the interstate highway system.

Table 2 and Table 3 summarize information on each case study region including its size, the extent of the interstate highway system (or equivalent roadways), and transit use. The information is limited for the international case studies because of the difficulty of obtaining comparable data. The tables indicate the diversity of regions in terms of size, interstate highways, and transit use as well as highlighting the higher level of transit use in the international regions.

Table 2. Summary of Characteristics of United States Case Study Regions

	Interstate Case Study Regions				Transit and Urban Form (TCRP H-1) Case Study Regions		
	Kansas City	**Columbus**	**Pittsburgh**	**Atlanta**	**Portland**	**Houston**	**Washington**
Characteristics of Federal Aid Urbanized Area							
Population (1000s)	1,282	951	1,679	2,158	1,220	2,902	3,282
Land Area (sq mi)	608	305	1,033	1,198	416	1,549	926
Persons per acre	3.3	4.9	2.5	2.8	4.6	2.9	5.5
Metropolitan Area Growth Rate, 1960-1990	41%	63%	-7%	142%	80%	136%	85%
Median Household Income (MSA)	$31,948	$30,668	$26,501	$36,051	$31,070	$31,488	$46,856
Characteristics of Urban Interstates							
Miles of interstate	180	112	138	221	85	140	163
Miles interstate/100 square miles	30	37	13	18	20	9	18
Miles interstate/100,000 persons	14	12	8	10	7	5	5
% of roadway in interstates	4.0%	5.0%	1.8%	2.3%	1.7%	0.8%	1.9%
% of travel on interstates	34%	37%	18%	36%	30%	25%	31%
Characteristics of All Urban Freeways							
Miles of All Freeways	317	141	205	268	128	336	289
Proportion of freeways that are interstates	57%	79%	67%	82%	66%	42%	56%
Travel Conditions							
Daily VMT/Capita	22	22	20	29	19	24	20
TTI Congestion Index - 1990	0.74	0.83	0.82	1.11	1.07	1.12	1.37
Rate of Change in Congestion 1982-1990	19%	22%	5%	25%	23%	-4%	28%
Transit Use							
Transit trips per capita (service area)	15	20	53	69	50	31	111
Transit mode share for commute (MSA)	2.1%	2.7%	7.9%	4.6%	5.4%	3.7%	13.3%

Sources: *Highway Statistics 1991,* Rosetti and Eversole (1993), Schrank et al. (1993), Dunphy (1997)

Table 3. Summary of Characteristics of International Case Study Regions

	Canada			Germany			
Regional Characteristics	**Calgary**	**Ottawa**	**Vancouver**	**Freiburg**	**Muenster**	**Munich**	**Rhein-Ruhr**
Population (1000s)	829	678	1,614	188 (city)	270 (city)	1,245 (city) 2,418 (region)	7,500 (24 cities)
Freeways in city	one north-south route		none	none	none	to inner beltway only	connecting cities
Transit Use							
Transit Trips Per Capita (1991)*	68	113	93	351	115	325	144
Modal Split for all non-pedestrian urban trips							
Auto				46%	47%	49%	70%
Transit				26%	12%	32%	20%
Bicycle				28%	40%	18%	9%

* Pucher (1997)

In Great Cities and Their Traffic, J. M. Thomson (1977) offers a useful way to understand differences among these cities and regions. He identified five prototypical ways in which cities could develop, depending on the nature of their investments in highways and transit and their land use policies. Of these prototypes, one applies mainly to large cities in Asia, South American, and Africa, but four are applicable to cities in the United States and to other developed countries. Although Thomson wrote this book 20 years ago, the prototypes he developed are relevant to an examination of the relationship between the interstate highway system and transit systems.

Thomson's four types of cities, listed from most to least accommodating to the automobile, are as follows:

- Fully motorized cities,
- Weak-centered cities,
- Strong-centered cities, and
- Traffic-limited cities.

Fully motorized cities are designed to ensure the free flow of automobile traffic. In large, fully motorized cities the level of employment in the center is limited by congestion. Most fully motorized city, therefore, have multiple centers or a dispersion of activities. Thomson theorized that the ideal form for a fully motorized city is a grid system with freeways forming the primary network connecting dispersed centers. Secondary roads move traffic, including buses, between the freeway corridors while distributor and access roads provide access to jobs, shopping, recreation and homes.

Weak-centered cities have a CBD that retains many of the cultural and economic functions traditionally associated with city centers. Because the city center is too large for all workers to arrive by car, it depends on transit for a substantial share of commuters. These cities have, however, built radial and beltway freeways whose intersections are attractive locations for industrial and commercial development and result in a multiplicity of centers. Hence, a tension exists between retaining the CBD as the center of the region and letting it become one of many centers, thereby becoming a fully motorized city. Maintaining CBD primacy requires policies that encourage (1) development in the center and discourage it elsewhere and (2) investments in a commuter transit system to the city center.

Strong-centered cities have retained the city center as the heart of the region. The center is supported by radial freeways and high-capacity transit that make the city center the most accessible place in the region. There are no beltways that confer the same regional accessibility to interchanges as in the city center. Instead, small subcenters develop along the radial transportation routes to serve local markets and use the labor force from nearby areas for non-central functions. Cities can remain strongly centered only as long as the quality of peak-period transit is roughly equal to that of peak-period driving. Without this balance between transit and automobile use, pressure would mount to move functions out of the CBD to locations where automobile access would be better.

Traffic limitation cities are designed to minimize the need to travel by private automobile. These cities have a hierarchy of centers ranging from neighborhood centers to the CBD that provide goods and services to ever larger parts of the region. Major subregional centers are linked to each other and to the city center with high capacity transit. Thus, most travel can be made by walking to a nearby center or using transit to reach a higher order center.

Automobile use is also restrained with high parking changes and priority systems for transit, bicycles, and pedestrians. Freeways serve mainly as a means of leaving the city for the countryside or other cities and are only built near the region's edge. Automobile traffic in the core of the city uses arterials.

Compared and contrasted in these terms, the case study cities sort themselves on a continuum from fully motorized to traffic limited. As illustrated in, Kansas City and Columbus offer examples of fully motorized cities. Extensive freeway systems offer high levels of mobility and accommodate large proportions of regional travel. As will be evident from the case study summaries that follow, transit is both weakly patronized and poorly financed. These regions are characterized by multiple activity centers and a relatively weak CBD, consistent with Thomson's taxonomy. In Houston, where transit is relatively well financed, the fully motorized pattern of urban form is equally well established. The CBD holds a relatively small share of regional employment in a region of extensive freeways and multiple activity centers.

Table 4. Motorization in Cities by City Type

Fully Motorized	Weak Centered	Strong Centered	Traffic Limited
Kansas City Columbus Houston	Atlanta Pittsburgh Washington DC Portland	Ottawa Calgary	Vancouver Muenster Freiburg Munich
CBD			
weak			strong
Suburban Activity Centers			
strong		weak	may be strong if linked by transit
Freeways			
network	beltways and radials	radials, no beltways	few or none
Transit			
weak			strong
Non-Motorized Modes			
no emphasis			strong emphasis

Atlanta, Portland, Washington DC, and Pittsburgh, while less automobile dominant than the fully motorized cities, nevertheless must be categorized as weak centered in comparison with other cases. In fact, no American city, with the possible exception of New York, crosses the mid-point in the spectrum from motorized to traffic limited. All the cities named above have downtowns which are the cultural and economic centers of their regions, but radial freeways and beltways support strong suburban activity centers, and strong tensions exist between central city and suburban constituencies. In short, America's most transit oriented major cities are, at best, weakly centered in comparison with case study regions from other countries.

Ottawa and Calgary exemplify Thomson's strong centered cities. Neither has beltways or radial freeways, with one or two minor exceptions. Transit enjoys a substantial accessibility advantage to the CBD, which contains a relatively large share of regional employment and office space, especially in comparison with U.S. cities. The CBD enjoys a distinct accessibility advantage as a result of premium transit service.

Vancouver, Canada and the German cities described in the case study which follows exemplify the traffic limited cities in Thomson's taxonomy. The central cities contain no freeways of any kind. Transit systems link regional and subregional centers with service on dedicated rights-of-way. By contrast, autos use arterial streets. Parking is scarce and expensive, and the city has implemented a wide variety of policies designed to reduce the need for automobiles, as well as their impacts, and to encourage walking, bicycling, and transit use.

Thomson's taxonomy thus serves to set the stage for a more detailed analysis of each of the case studies identified above. Fully motorized cities and regions with extensive freeways provide high levels of accessibility to multiple centers and transit services are few. In the weak centered cities, while transit plays an important role in serving the CBD, freeways provide sufficient accessibility to suburban locations to compete strongly with the urban core. As the cities and regions progress from weak to strong centered, one can observe a growing role for transit and a declining one for freeways. Moving on the spectrum from strong centered cities to traffic limited cities, one finds a growing share of non-motorized travel, the growing prominence of policies that favor alternative modes and the dominance of patterns of urban form and transit service that offer high levels of accessibility by means other than the automobile.

Information in the case studies permit the reader to answer the following questions, when seeking to understand the effects of the interstate highway system, (or analogous freeway systems in other countries):

- To what extent did public transit decline as a result of the interstate era, as an institution and a public service?
- To what extent were land use policies implemented which support the use of modes other than the automobile?
- To what extent and in what form did the region's CBD continue to grow and develop?
- To what extent did citizens advocate alternatives to freeway construction?

The section that follows answers these questions in each of the case study communities.

3.1 KANSAS CITY, MISSOURI

Kansas City, Missouri, ranks first in the nation in freeway miles per capita, and it ranks near the bottom in transit trips per capita. Few places in the country exemplify the demographic and geographic changes that have swept the country post-World War II as well as Kansas City. The city's core has changed. As a result of the trend in the 1960s and 1970s of Caucasian residents moving out, the city's core population has changed to being predominately African-American and poor, while the suburbs are predominantly Caucasian and relatively affluent. Stately older homes in the urban core are no longer the favored housing in the region; their role has been taken over by suburban housing on large one-half to five acre plots. "Edge Cities" are sprouting along the perimeter of the region offering employment as well as housing opportunities. The circumferential and radial freeway systems make almost any commute possible if you own or have access to a car.

In the 1940s the city's development pattern was relatively compact. The early highway and arterial system was primarily radial in nature. Suburban growth began along the boulevard system and state and national highways.

During this period, Perry Cookingham, City Manager of Kansas City, was instrumental in working with the Missouri Department of Transportation (MoDOT) and the federal government to lay out the original highway system for Kansas City. It was Cookingham's contention that highways would save the city from inevitable decline.

Cookingham used the period during World War II to gain a competitive advantage over other cities with regard to the development of transportation infrastructure. He joined with the city's planning engineers to plan for the time after the war when federal money would be available for a road system for Kansas City.

On the other hand, the transit system was already undergoing retrenchment. Many former transit dependents were purchasing autos during the period of post-war prosperity. Automobile registrations rose from 151,000 to 266,000 in the Kansas City Metropolitan Area between 1946 and 1954. During the same time, transit ridership dropped from 136 million annually to 66 million. This represents a decline in weekday transit ridership from approximately 430,000 to 210,000. The transit ridership in 1954 was roughly half that of 1924 levels.

In 1955, Kansas City began the conversion of trolley bus routes to motor bus. At the time it was thought that moving to an all motor bus fleet would help shareholders reap larger dividends. Uniformity of rolling stock was seen as a key to cutting costs and maximizing profits. The last of the streetcars were taken out of service in 1957.

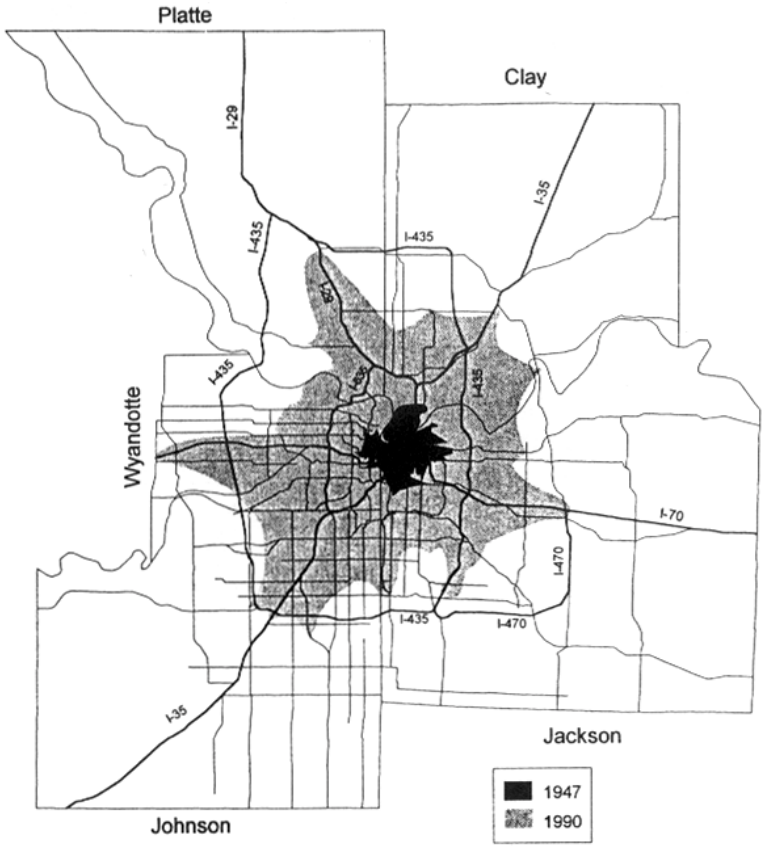
By 1960, the post-World War II "baby boom" was in full swing. Suburban development continued to spread outward as an improved roadway system increased accessibility to the Northland, Johnson County and communities east of Kansas City, Missouri. US 69/169 and US 71 increased north/south access and development access further from the urban core. Land area and population continued to increase, while density continued to decrease. The effects of auto-mobility were beginning to be seen as new transportation linkages allowed for greater distance travel in any given amount of time (see Figure 1).

Figure 1. Travel Distance from Downtown in 20 Minutes, 1947 vs 1990, Kansas City, MO

Travel Distance From Downtown in 20 Minutes
1947 vs 1990

Improvements to the highway system vastly increased the amount of land accessible to jobs and available for development.

Source: Kansas City, Missouri, Plan Commission, MARC



In the mid-1960s, further retrenchments were made including service cuts and fare increases. Wider headways and revised routes were an item of intense public concern. During this same time, the St. Louis Public Service Co. (the St. Louis, Missouri transit operator) was near collapse, with public ownership being arranged via a bi-state compact. The continuing decline of transit in Kansas City led to the creation of the bi-state Kansas City Area Transportation Authority (KCATA). The agreement was signed in on December 28, 1965 in the middle of a bus straddling the state line. The KCATA officially assumed operation and ownership of the transit system on February 1, 1969.

The attitude of times toward the future role of transit can be summed up in this statement from the *1970 Freeway and Expressway Plan for the Kansas City Metropolitan Region,* prepared by the Kansas and Missouri Departments of Transportation and the Metropolitan Planning Commission.

> "Rising affluence has increased the use of the private automobile and suppressed the use of the mass transit system. However, there are areas remaining in the urban structure which rely heavily upon mass transportation - the ghetto, areas of high density, the economically underprivileged, the very young and the very old."

The 1970 *Freeway and Express Plan for the Kansas City Metropolitan Region* developed a freeway and expressway system that was based on a regional population in 1990 of 2.58 million. In 1990, actual population was approximately 1.3 million.

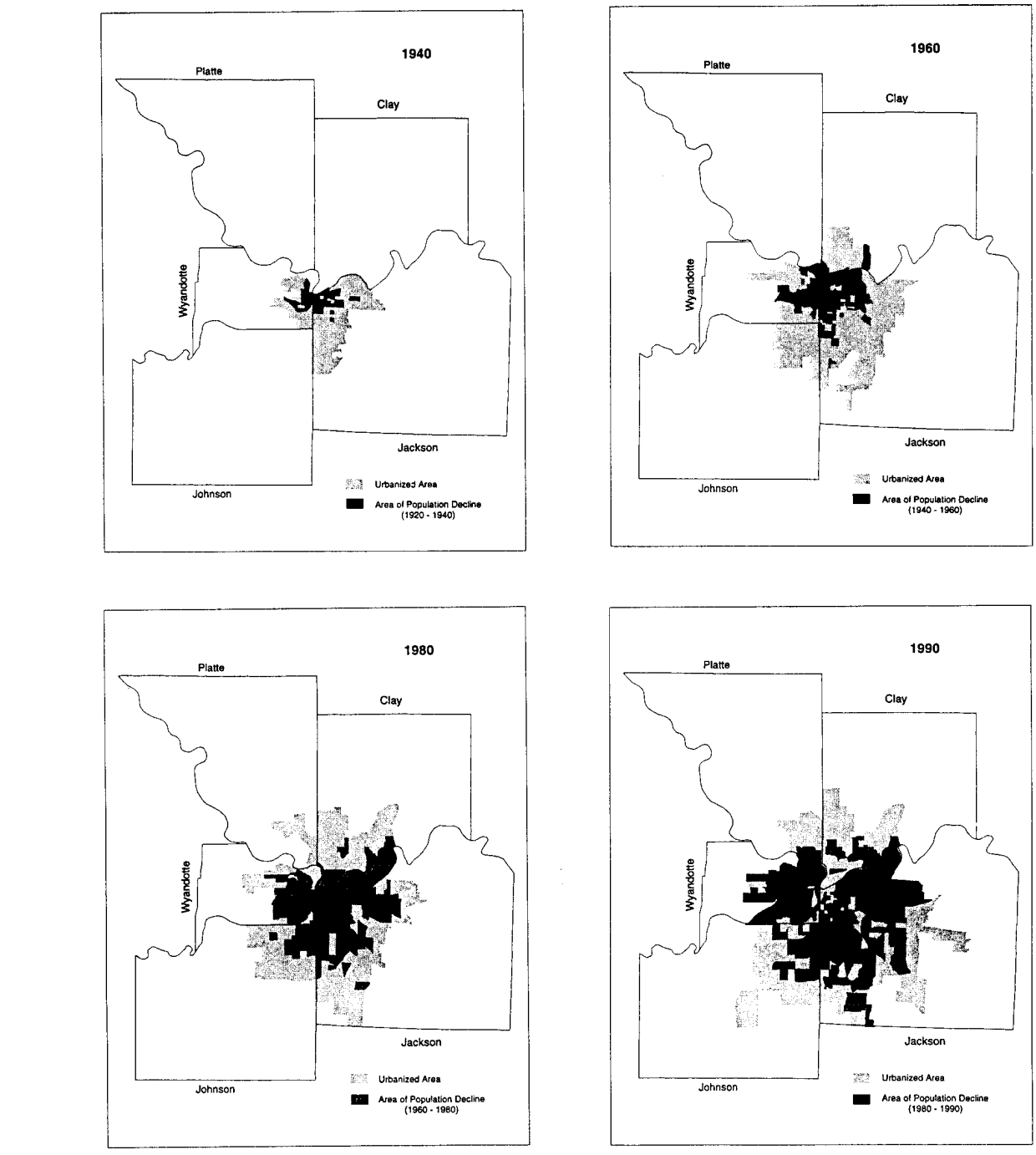
Every ten years, the Kansas City area extends two miles further in diameter as the edge of new developments moves away from downtown. This "golden ring" contains the highest average housing values in the region. This ring moved from ten to 12 miles from downtown in 1970 to 14 to 16 miles away in 1990. As the ring expands it leaves lower housing values behind. The relationship between population growth and land consumption is shown in Figure 2.

The suburbs have continued to grow in population and area, while the urban core has lost population. This theme of core decline and booming suburbs has been the defining one for Kansas City for the last 40 years.

Since 1960, the core area has lost over 200,000 residents, a decline of 40 percent. Poverty in the core is now three times that of the suburbs. The unemployment rate in the core is three times that of the suburbs. Median housing values in the core are half that of the suburbs. The core has declined relative to the suburbs in virtually every category that could describe a healthy urban area - per capita income, housing vacancy rates, and home ownership.

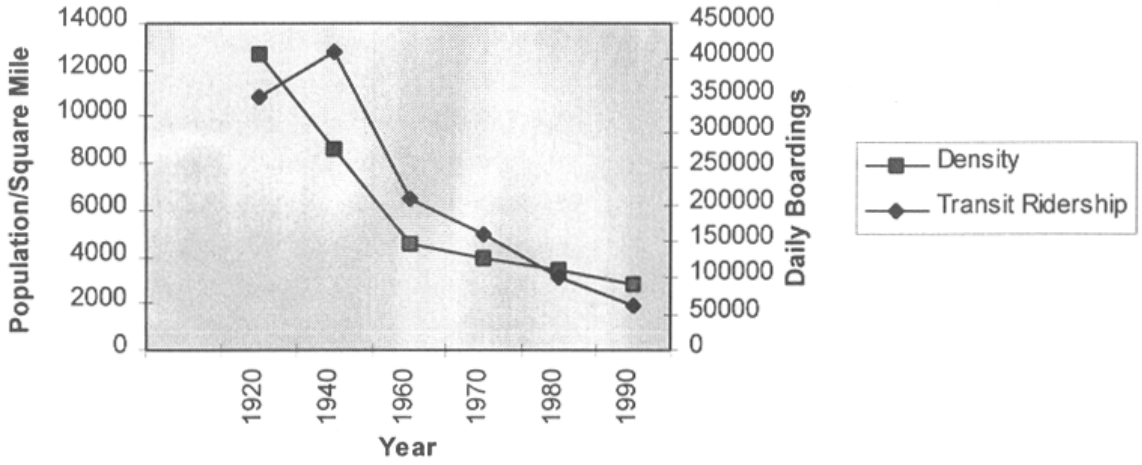
As the region's density and clustering of trip ends became less concentrated, transit continued to lose ridership and market share; as origins and destinations become more dispersed, conventional fixed-route transit became problematic. Figure 3 shows the relationship of land area to transit ridership. As the Kansas City region grew in land area and became less dense, transit's role has diminished greatly. Mode split for transit stood at 50 percent in 1928. By 1971, it had dropped to 5 percent. Today, transit mode split stands at less than 2 percent.

Figure 2. Expansion of Metropolitan Kansas City



Source: U.S. Bureau of the Census, MARC

Figure 3. Density and Transit Ridership, Kansas City, MO



Source: MARC, Urban Core Report, 1995, p.27; Cassidy Motor Coach Age, Vol. XXVII No. 11-12, 1975; and KCATA, Public Transit Planning Study, 1996

3.2 COLUMBUS, OHIO

The City of Columbus, Ohio, largely located within Franklin County, is the heart of a seven county metropolitan area. In 1990, the metropolitan area had about 1.4 million residents, 70 percent of whom lived in Franklin County.

Columbus has developed as an automobile city in the interstate era. Table 5 shows that residents of the Columbus metropolitan area are more likely to drive alone to work and less likely to carpool or use transit than are residents of the nation as a whole or of the 39 largest metropolitan areas.

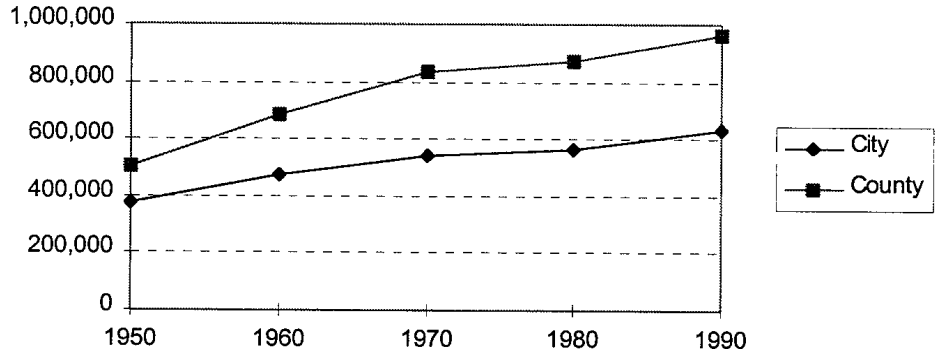
Table 5. Comparison of Columbus and National Mode Share for Journey to Work

Mode of Journey to Work	National	39 Metro areas with more than 1 million residents	Columbus Metropolitan Area
Drive Alone	73.2%	70.7%	79.5%
Carpool	13.4	12.7	11.4
Public Transit	5.3	9.0	2.7
Walk	3.9	3.8	3.2
Bike and Other	1.3	1.3	0.8
Work at Home	3.0	2.6	2.3

Source: Rosetti and Eversole, 1993

As Figure 4 shows, Franklin County has grown from just over half a million residents in 1950 to 961,437 in 1990. The city of Columbus has shared in this growth because of its annexation policies and its control of water and sewer within Franklin County. With annexation, the city has grown from 39.4 square miles in 1950 to 190.9 in 1990. About 66 percent of Franklin County residents currently live within Columbus, down only slightly from its three-fourths share in 1950. Residential densities within the city have declined to 3,300 persons per square mile, about one-third the 1950s level.

Figure 4. Population Growth in City of Columbus and Franklin County, OH



Data Source: *County and City Data Book,* Various Years

Two major interstates run through Columbus, forming parts of the five-mile inner beltway that encircles the downtown. I-71 running north-south through Columbus connects Cleveland to Cincinnati and goes on to Louisville. The east-west I-70 connects Pittsburgh to St. Louis. I-270 is a 56-mile outer beltway that is 4 to 10 miles from the downtown Columbus. Altogether, the Columbus urbanized area has 112 miles of interstate highways and 29 miles of other freeways.

Only 3.5 percent of the roadway mileage in the Columbus urbanized area is interstate highway, but in 1991 these highways carried over a third (36.6 percent) of all daily vehicle miles of travel. The 29 miles of other freeways carried an additional 8.2 percent of daily vehicle miles of travel. Thus nearly half of the region's travel occurs on freeways. In contrast, the 468 miles of arterials make up 14.7 percent of the roadway system, but carry less travel than the interstates (only 31.1 percent).

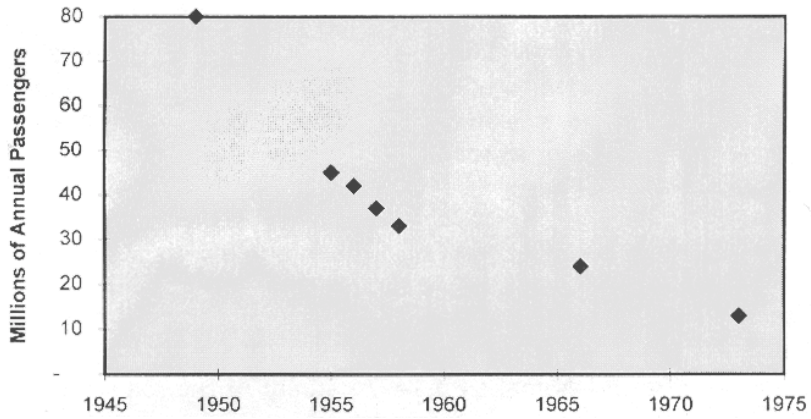
The plans for the freeways were developed in a 1953 study prepared under the direction of the Franklin County Regional Planning Commission. This study identified the need for north-south and east-west radials, the inner beltway, and three-fourths of the outer beltway. Franklin County and the Ohio Department of Highways further refined these plans in 1958 and identified seven alternative routes for the outer beltway. The City of Columbus supported the building of the beltway far in advance of need because it, along with sewer and water expansions, supported the city's goals of economic and territorial growth. Because the area had already developed freeway plans when the Interstate Highway Act passed in 1956, it was one of the first areas to begin building interstates.

Access to downtown was improved first with the completion of I-71 in 1963, the inner beltway in 1964, I-70 east in 1967 and I-70 west in 1975. The outer beltway was built in segments beginning with the connector between I-71 and Highway 315 and completed in 1975. I-670 from downtown to the airport was completed most recently, twenty years after its initial plans. The last segment of the interstate system, I-670 west of downtown to I-70, is now under construction.

As in Kansas City, the area's transit providers were focused on rubber-tired vehicles. In 1950, the Columbus Transit Company had already converted from streetcars to a mix of electric trolley-buses and motorized buses that carried 80 million riders annually. The transit company operated 241 trolley-buses on 8 heavily used routes covering a total of 64 miles. In addition, 79 buses operated on 12 routes of 46 miles. Transit operations became more dependent upon buses as the urbanized area expanded. Rather than extending its trolley lines, the transit company added feeder buses. In addition, interstate highway construction, beginning in 1957, disrupted some trolley routes resulting in conversion to the more flexible buses.

Figure 5 shows the sharp drop in ridership during the 1950s and 1960s. By 1957 when construction began on the interstate highways in Columbus, ridership was less that half of the 1949 level, and by the mid-60s when the first sections of interstates were complete, ridership was less than a third of the 1949 level.

Figure 5. Decline in Columbus Transit Ridership, 1949 to 1973



Data Source: Bownas, 1990

In 1964, a Citizens Transit Study Committee recommended that transit become publicly owned in order to maintain a viable system, but nothing was done at that time. In 1970, the Ohio General Assembly passed legislation authorizing the formation of Regional Transit Authorities governed by locally appointed boards and funded by sales or property taxes approved by the voters. The Franklin County Commissioners and the City Councils of the 11 cities in the county authorized the formation of the COTA in 1971. The first two attempts to pass a tax levy for the district, however, failed. Finally in 1973, after the Columbus Transit Company declared it was shutting down on New Year's Eve, the voters

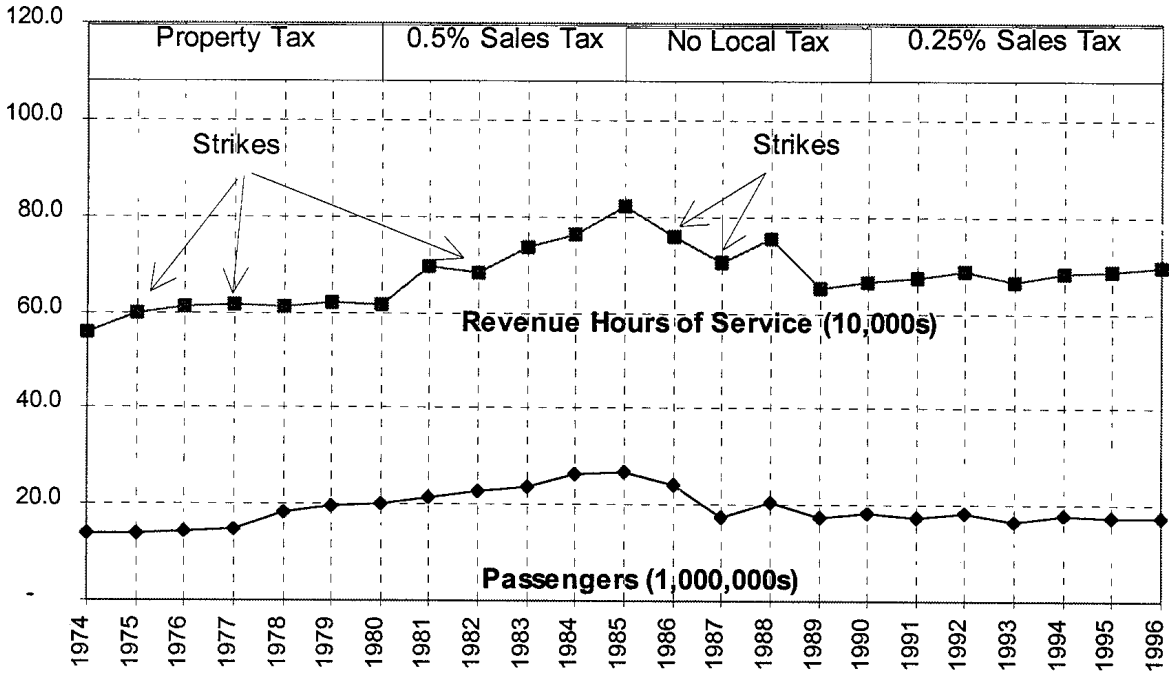
approved a three-year property tax levy for transit. COTA bought out the system and began operating on January 1, 1974.

Voters rejected a proposal for a half percent sales tax in 1979, but approved a similar tax in 1980. This tax rate was in effect for five years with the understanding the COTA would be able to operate at least until 1986. With the additional funds, COTA was able to expand service and this boosted ridership. A proposal for a half percent sales tax to be shared by transit and a convention center failed in November 1986. Voters also rejected a proposal for a 0.25 percent sales tax in 1988, forcing COTA to reduce services by 12 percent. In 1989 voters approved a one-fourth percent sales tax for the next ten years which enabled the agency to restore services and regain some ridership.

Current funding expires in 1999. The COTA board will again need to go to the voters for local funding.

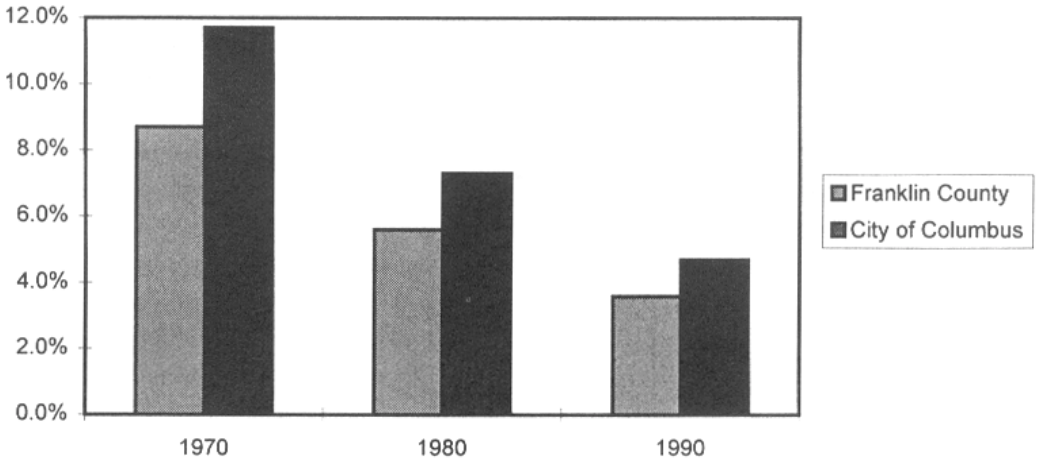
Figure 6 shows how transit ridership has fluctuated with the level of service of COTA is able to provide. Several labor disputes of 7 to 41 days have also adversely affected hours of service and ridership. When COTA has been able to expand service, more riders have come. However, these small increases have not kept pace with population growth in the region. Figure 7 shows the shrinking share of work trips made by transit in the region despite COTA's service improvements.

Figure 6. COTA Financial Sources, Revenue Hours of Service, and Ridership



Data Source: COTA 1997

Figure 7. Transit Mode Share for Work Trips in Columbus and Franklin County, 1970-1990



Source: *County and City Data Book,* Various Years

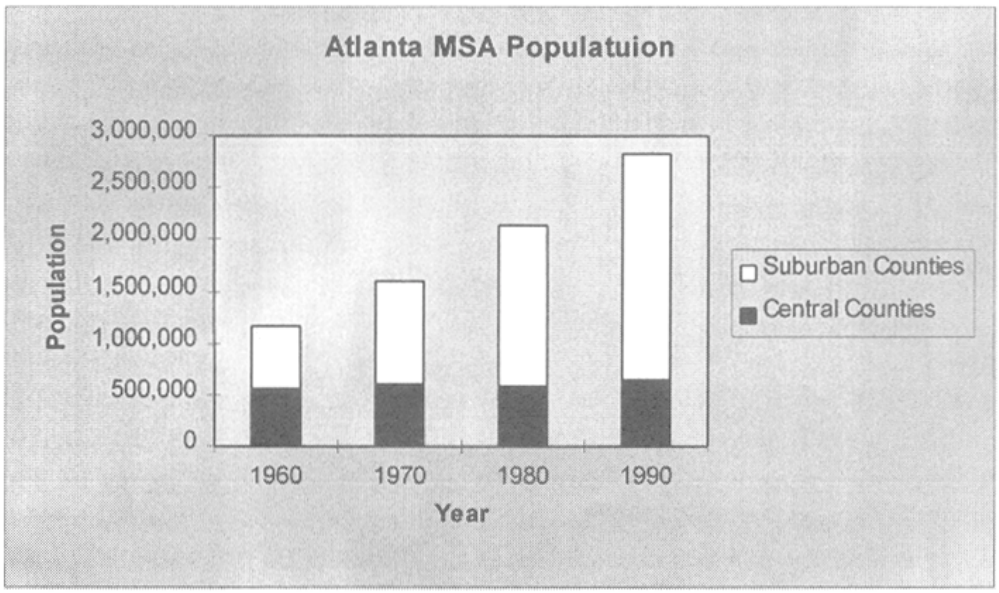
According to a Texas Transportation Institute index of congestion, Columbus is one of the least congested large metropolitan areas in the United States. On a measure that compares peak period flows on freeways and principal arterials to free-flowing standards, Columbus scored 0.68 in 1982 and 0.83 in 1990. The 22.1 percent increase in the congestion was almost equal to the 23.3 percent growth in workers, but still indicates a low degree of congestion on the system (Schrank et al. 1993). Of course, Columbus residents who drive in the parts of the region that do experience congestion may think that relief is needed. Indeed, reducing congestion is one of the primary criteria for putting projects in the regional transportation plan.

3.3 ATLANTA, GEORGIA

Location and transportation have always been the drivers of Atlanta's growth. Historically, Atlanta grew up around the intersection of rail lines and served as a major transportation hub. Its inner suburbs were shaped by a streetcar network. The development of Hartsfield International Airport, now the busiest in the country, made Atlanta the transportation center of the southeast. Atlanta's railroad corridors extend from the core of the city in a radial pattern.

Atlanta is the Southeast's largest city. It's Metropolitan Statistical Area (MSA) covers twenty counties and 5,121 square miles. Since 1900, the population of the Atlanta region has tripled approximately every 30 years. The current population of 2.6 million (1990) reflects a 3 percent compound growth rate per year that shows no signs of slowing down. Annual population growth in the Atlanta Regional Commission (ARC) region (a smaller 10 county region used for regional planning purposes) has averaged 66,000 residents between 1985 and 1995.

Figure 8. Suburban and Central County Population 1960 - 1990



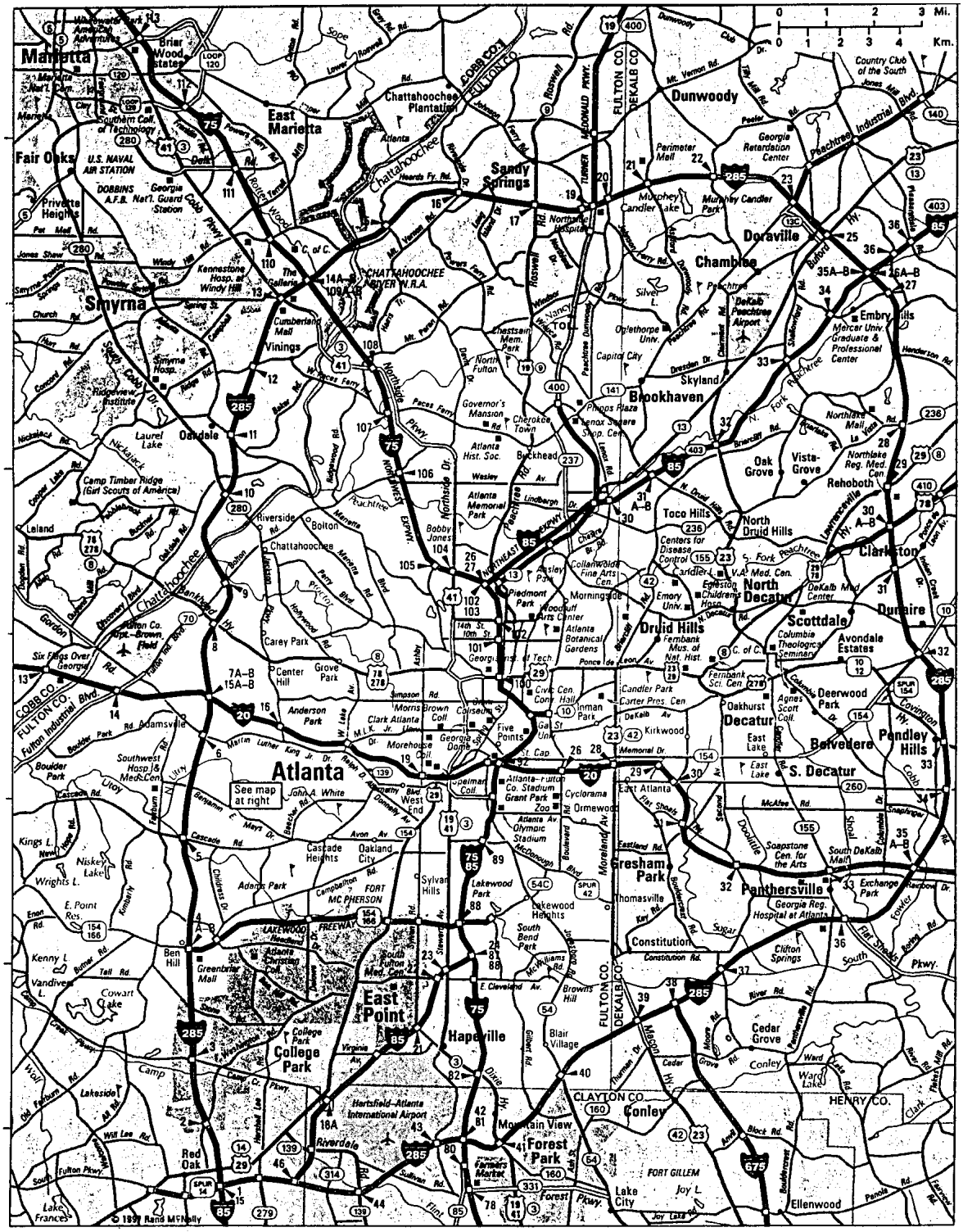
Along with its rapid growth, the Atlanta region has also experienced a trend that it shares with many cities - a declining or flat central population and booming suburbs. Figure 8 shows population of the central area of Atlanta compared to the suburbs from 1960 to 1990. The city of Atlanta's population, in contrast to the region, declined from nearly 500,000 in 1970 to 394,000 in 1990. This was the fifth largest population loss for any major US city during the same period.

Atlanta has a relatively small central city in terms of area and population. In 1990, the City of Atlanta had 19 percent of the ARC (ten county) region's population and occupied just 5 percent of the region's land area. This is substantially smaller than the average 33 percent central city population share of the nation's 47 largest cities. This ratio of central city to suburban population has led to Atlanta's being referred to as the most "suburbanized" region in the country.

An extensive network of interstate highways blankets the region. The major east-west corridor is I-20. The major north-south corridors are Interstates 75 and 85. Interstate 285 is the region's circumferential highway or "beltway." Major highways in the region include (See Figure 9):

- I-285 Beltway
- I-85 and I-75, The Downtown Connector
- I-20, The East-West Expressway
- I-675 Bypass
- Georgia 400
- Peachtree Street and other arterials

Figure 9. Metropolitan Atlanta Highway System



Atlanta does not have a region-wide transit system. The Metropolitan Atlanta Rapid Transit Authority (MARTA) serves Fulton and DeKalb Counties with bus and heavy rail service. Cobb County Transit serves Cobb County providing direct express service to downtown Atlanta. Figure 10 shows the extent of the MARTA heavy rail system.

Universally referred to as the document that set the future of Atlanta's highway system, The Lochner Plan, prepared for the Georgia DOT by the H.W. Lochner Co. and DeLeuw, Cather and Co. in 1946, laid out what is essentially today's transportation network. The plan had a 1970 time horizon. This plan had its basis in the belief that highway *and transit* expansion was a key to Atlanta's economic prosperity. In the cover letter transmitting the plan, H.W. Lochner and C.E. DeLeuw wrote:

> "There is every indication that Atlanta is approaching a period of great growth and prosperity. Improved highway and transit facilities are essential if the community is to capitalize on its natural assets. Failure to take prompt action would not only retard growth but add to the overall cost of the capital improvements required."

The common understanding is that Lochner planned highways, but his plan also included a transit element. The Lochner Plan laid out expressways that would eventually become I-75, I-85 and I-20 as well as state highways. Lochner's plan also envisioned a downtown bus transit terminal on air rights above railroad tracks to permit convenient transferring. In addition, the plan contained a transit line on a beltway approximately two miles from the CBD to "integrate the various radial routes." The plan estimated ridership of 42,000 daily on this beltway route. This radial and cross-town approach was the precursor to the modern multi-destinational grid systems that would be implemented 30 years later in other cities. The multimodal aspect of this plan has been either forgotten or ignored. Lochner's legacy, deserved or not, is as the father of the Atlanta freeway system.

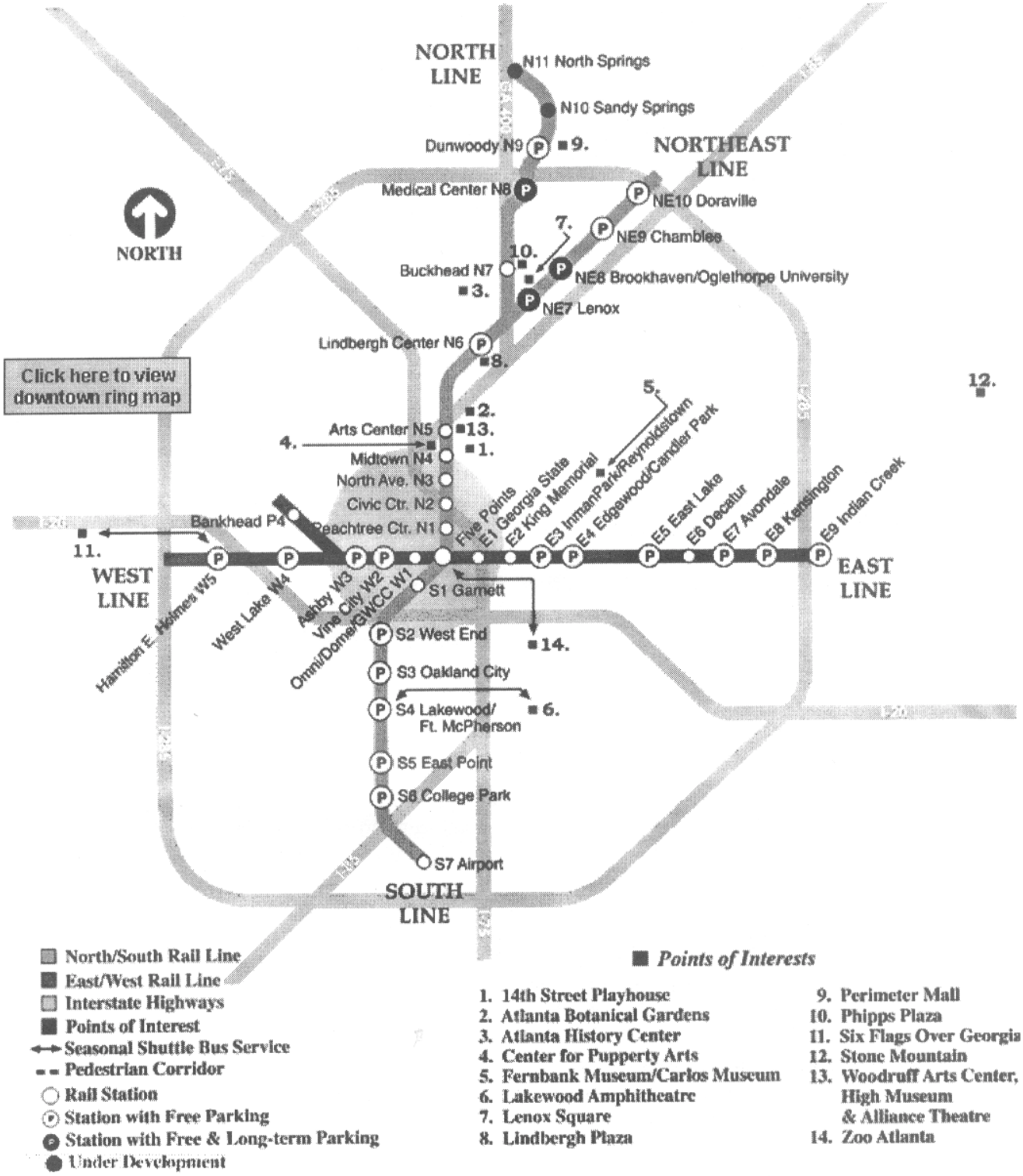
In 1946, voters approved a bond issue for almost $20 million to implement the Lochner Plan. The Lochner Plan preceded the actual funding of the Interstate System by ten years. This foresight put Atlanta in a very favorable position to receive federal highway funds when they became available in the mid-1950s.

The first highway to be constructed was the "Downtown Connector" portions of what later came to be known as I-75 and I-85. This section was opened to traffic in 1964. By 1969, over 122 miles of interstate freeways were opened, 118 miles of which were four lane freeways with two lanes in each direction.

A circumferential beltway was proposed in plans following the Lochner Plan. The initial proposal for I-285 appeared in the 1952 *Up Ahead* plan. The eventual route of the beltway followed the alignment in this plan.

An excerpt from the *Up Ahead Plan* of 1952 described the intended function of the beltway, later known as I-285:

Figure 10. MARTA Rail System Map



Source: MARTA Web Page

> "The proposed Outer Beltway [I-285] would flank a railroad beltline and with it form the boundary line of the metropolitan development area. It would circle the entire area, serving primarily as a fast-track route between the large industrial districts on the rim. Portions of it could be built as each new industrial district is developed. Although its full effectiveness as a circumferential highway would not be felt until the entire loop is developed. It would open up a large area for residential expansion where land, utilities, public facilities and a considerable amount of housing are already available."

The attitude of the times when the Lochner Plan was developed and for the next ten to twenty years was that expressways were a way to stay economically competitive and a way to clear blighted areas. One telling page in the plan shows pictures of housing in older neighborhoods with the caption: "Views of substandard areas that would be razed by the expressways."

Originally, it was thought that the beltway would define the limit of urbanization, but this has not been borne out. By the time the beltway was completed in the late 1960s, suburban development had spread well beyond it in several directions, eliminating the possibility of using it for an urban development boundary.

Whether intentionally done or not, the policy effect of the Lochner radial highway plan, with its clearance of "substandard areas" and the beltway's function to "open up a large area for residential expansion," was to divide inner city neighborhoods and hasten their decline while promoting new growth at the edge of the region. Core decline and the trend of Caucasian residents moving to the suburbs had their roots in transportation policy as well a myriad of other social and economic factors.

The next major initiative in the development of the Atlanta highway system was a program called *Freeing the Freeways,* undertaken by the Georgia DOT. The planning for this program began in 1980, with completion of construction in 1989. The *Freeing the Freeways* program was a $1.4 billion widening project that added capacity to 122 miles of urban freeways, within the beltway. The need for this program was identified after Atlanta had seen tremendous growth in population, vehicle miles traveled and congestion in the years following completion of the interstate system.

The *Freeing the Freeways* program charted one course for Atlanta's transportation future: acting on the region's belief that it is possible to build your way out of congestion. Fourlane facilities were widened to between six and twelve lanes, almost tripling capacity. Lane miles increased from 500 in 1980 to 1,400 in 1990.

The GDOT firmly believes that building additional highway capacity is a viable option for Atlanta, and that the *Freeing the Freeways* program demonstrated this conclusively:

> "The successful results in Atlanta are persuasive testimony that capacity expansion options should not be discounted. By having a state of the art rapid rail transit system, one of the world's most efficient and accessible airports and a truly free-flowing freeway system Atlanta is well positioned for today's as well as tomorrow's business. Complex problems require complex

> solutions: demand management, transit incentives, and highway capacity improvement all are effective when developed together."

Implementing the neglected part of the Lochner vision, the Metropolitan Atlanta Rapid Transit Authority (MARTA) was created by the Georgia State Assembly to become the regional transit authority. MARTA became an operating agency in 1971, with the purchase of Atlanta Transit Services. MARTA and Atlanta had bigger plans than to be the regional bus system. Development of a rail system was seen as a progressive step to secure Atlanta's place as a transportation leader, with a high level of passenger and freight railroad access, a world class airport, and a top notch urban transportation system. The underlying philosophy was that transit would indeed reshape the region's development. This philosophy guided the thinking of the early transit planners.

Business and civic interests saw public transit in general, and a rail transit system in particular, as part of their ambitious plan to place Atlanta among the nation's most prominent and prosperous cities. Land use and transportation goals mingled with civic and social ones in creating the necessary coalition for the creation of the region's transit system.

In 1968, an initial bond measure to fund construction of the system failed, due to voter dissatisfaction with the use of property tax to finance the project, uncertainties about the costs of the project and a lack of public involvement in the planning process. In 1971, a revised one percent sales tax measure passed that included 53 miles of rail, and eight miles of exclusive busways. Although the vote was regional (five counties), the measure was only approved in the two central counties in the region, Fulton and DeKalb. MARTA cannot extend into any other counties without their residents' voting to be taxed to fund the system. The I-285 Beltway is roughly the boundary between the area MARTA serves and the rest of the region.

MARTA ridership reached its peak in 1985 and has been declining since. Bus ridership and rail ridership increased as additional stations were opened until 1985. After 1985, bus and rail ridership have been experiencing a decline, not unlike most other cities in the country. Between 1990 and 1995, Atlanta experienced the fourth greatest (-16.4 percent) decline in per capita transit ridership compared to 24 other cities with a similar transit service area population.

Today, Atlanta shows the effects of investing heavily in both transit and highways. One Atlanta consists of the City of Atlanta itself and the rest of Fulton and DeKalb Counties. The area bounded roughly by the I-285 beltway contains the entirety of the MARTA rail and bus system, as well as three interstate freeways of between six and twelve lanes that intersect in Atlanta. It is this area that best represents the balanced nature of the transportation system. The $3 billion investment in the Metropolitan Atlanta Regional Transit Authority (MARTA) rail system and the $1.4 billion expansion of portions of the interstate freeways within the beltway illustrates the commitment to balanced transportation infrastructure made by the region. An accessible downtown with civic, educational, cultural and diverse business activities is one result of this investment.

The other Atlanta is a huge suburban expanse creating a 20 to 30 mile diameter ring around the beltway. It is in these suburbs that the tremendous growth of Atlanta has

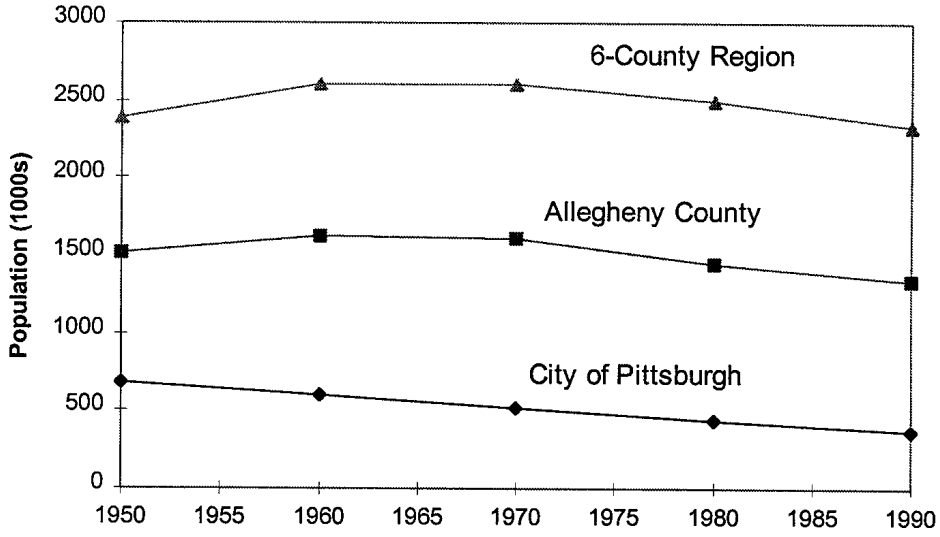
occurred in the last twenty years. This growth is entirely served by highways and freeways. This expanding suburban ring has given Atlanta a very long average journey to work of 29.6 miles round trip, as of 1995. In addition, the region has per capita vehicle miles traveled of 32.8 miles per day. There is resistance in the suburbs to the expansion of transit. The suburban counties have turned down transit funding measures consistently. Together the political, racial and economic differences of the two Atlantas the story of development.

3.4 PITTSBURGH, PENNSYLVANIA

In the 1950s the Pittsburgh region did not build highways as ambitiously for urban transportation as many other cities did. Rivers and steep hills limited the opportunities for highways; and, when most of the steel mills and associated manufacturing plants closed their doors in the 1970s and 1980s, Pittsburgh chose to build a multi-modal transportation system to serve the new economy based on services and trade. Today, about 55 percent of trips to the CBD are made by bus and rail transit.

Over 2.3 million people live in the six-county Pittsburgh region, about 266,000 less than in 1960 or 1970, as shown in Figure 11. Allegheny County, where about six out of ten of the region's residents live, had the largest number of people leave--about 295,000 residents--and the highest rate of decline--18 percent. Since there has been no regional population growth during the interstate era, the parts of the region that have grown have done so at the expense of other parts of the region. The City of Pittsburgh, for example, has lost nearly half its population, dropping from 677,000 residents in 1950 to 367,000 in 1990. The share of the regional population within the city has declined from 28 to 16 percent, a proportion similar to Atlanta.

Figure 11. Population Change in the Pittsburgh Region, 1950-1990



Source: County and City Data Book, Various Years

Although the six-county transportation network is crossed by three major interstate highways, much of the mileage is outside the urbanized area. Three interstate highways form a triangle around the urbanized area as shown in Figure 12. The Pennsylvania Turnpike (I-76), the major east-west route across the state which dates from the 1940s runs about 15 miles to the north and east of downtown Pittsburgh. I-70, the southern side of the triangle, is located around 25 miles south of downtown Pittsburgh. I-79 is the west leg of the triangle and is located within the urbanized area about midway between downtown and the airport.

Within the federal aid urbanized area, there are 138 miles of interstate highways serving a population of 1,679,000 persons. This gives Pittsburgh only 0.08 miles of interstate per 1,000 persons. About 18 percent of daily vehicle miles of travel within the urbanized area occurs on interstate highways, roughly half the proportion of the other United States case study cities. The urban area also has 67 miles of other limited access highways, including the Allegheny Valley Expressway to the northeast, the Penn-Lincoln Parkway west of I-79, and State Route 60 by the airport.

The Penn-Lincoln Parkway is the oldest limited access highway in the urban area. It was built as a four lane highway in the 1950s, and sections of it were later designated as part of the interstate highway system. This four-lane, 1950s highway is a primary route into the downtown with tunnels on both the east and west approaches that delay traffic for half an hour or more during rush hour. The region developed plans for the urban interstate highway system in the 1950s, which were approved by the Bureau of Public Roads in September 1955. However, it took more than 30 years to complete this highway system.

The north-south route, I-79, was the next urban interstate facility constructed. This route runs through the western suburbs and was built between 1965 and 1971. Because the only major route from I-79 to downtown is the Penn-Lincoln Parkway with its peak period bottleneck at the Pitt Tunnel, the completion of this highway did little to improve peak period travel to downtown, although it improved north-south flows through and within the region.

The last segments of the interstate system improved travel from downtown Pittsburgh to the northwestern suburbs. These highways were constructed between 1984 and 1989. Topography limited the options for building I-279 north, and it took nearly 30 years of design work, engineering, public hearings, and adjustments to arrive at the final design and route. Late in the process, 4.1 miles of HOV lanes were added to the facility so that it would support transit use.

The urbanized Pittsburgh region also lacks direct circumferential routes. Much of the traffic in the city center is through traffic since radial routes often provide the fastest and most direct paths.

The Port Authority of Allegheny County (PAT) bought out transit operations in 1964 in order to coordinate and consolidate the services of a streetcar system and a number of bus companies and to improve service. With public funding, PAT was able to improve and upgrade the system and boost ridership. Today, PAT operates a system with a mix of technologies including two busways used exclusively by buses, HOV lanes shared with carpools, light rail, regular bus service, and an historic funicular or incline.

Figure 12. Interstates in the Pittsburgh Region

Pittsburgh has the most extensive system of exclusive busways in the United States. These are essentially two-lane bus-only highways with turnouts at stations. They were built in portions of railroad rights-of-way that were no longer needed for train service. Busways provide both local service for people who walk to stations from adjoining neighborhoods and express service for buses that collect people in their neighborhoods and then go directly to downtown. There are no park-and-ride lots along the busways although there are some small lots in the communities where buses circulate before beginning express service because communities have not wanted park-and-ride lots.

Because busway routes bypass bottlenecks in the highway system, they are competitive with peak period automobile travel. Express service on the East Busway takes about 10 minutes between Wilkinsburg and downtown, local service about 15 minutes, and highway driving 25 minutes during the peak.

A seven-mile busway to the west, known as the Airport Busway, is being developed. The current project will run from downtown to I-79, bypassing the congestion at the tunnel and bridge on the Penn-Lincoln Parkway (I-279). The Regional Long-Range Transportation Plan also includes plans to extend the existing busways and upgrade additional streetcar lines to light rail.

Major investments in transit, like the downtown subway and the East Busway, coincided with downtown investments in new office buildings. Improved transit service to and within the CBD was available at the same time that more people were working in the CBD.

The Pittsburgh region's two largest activity centers -- downtown and Oakland -- with a total of 185,000 workers, are in the center of the region. The downtown is a compact area with many office centers that were built in the 1980s. The health care and education center of Southwestern Pennsylvania, known as Oakland, is three miles east of downtown. This area contains seven hospitals and clinics, four colleges and universities, several museums, commercial activities serving students and workers, and dense housing. It is the third largest job center in the state after downtown Philadelphia and Pittsburgh.

In summary, Interstate highways have had less impact in Pittsburgh than in many major cities in the United States. Steep hillsides and rivers have limited the ability to build highways within the urban area, and most interstates are outside the urbanized area. Transit has had the leadership necessary to assume public operation of the system earlier than in many areas and to build busways, HOV lanes, and light rail so that transit can operate at speeds that favorably compare with the automobile.

Of course, interstate highways have improved mobility in the corridors where they are located. For example, the opening of I-279 north in 1989 improved travel times between downtown and the northern suburbs. But from the regional perspective, most travel occurs on other routes and by other modes, because the interstate highway system does not connect the places within the urban area where people want to go.

Because of hills and rivers, most of the highways to downtown Pittsburgh have tunnels and bridges that result in delays during peak periods. The transit agency has been successful in developing transit on exclusive or limited access rights-of-way that bypass these

bottlenecks and can provide travel times that are competitive with driving for peak period trips to and from the CBD. Suburban communities that once rejected busways now would like to be included in the system because of the high levels of service they provide to the region's two major job centers. These investments in improved transit service coincided with the 1980s redevelopment in downtown. Thus, transit was able to provide competitive service for a growing centrally located workforce.

Pittsburgh's more limited interstate highway system, which lacks a beltway, has not created suburban places that have same level of access to employees and customers as the CBD which is the heart of the transit and road system. Sixty percent of the office space in the region is still within the CBD, while other similar-sized regions in the U.S. have only 30 or 40 percent of office space in central locations. More of the region was built around the streetcar systems that existed from 1888 until the 1960s. Suburbanization has not been as widespread because the region has not grown in population during the interstate era.

Pittsburgh is now debating alternative visions for its future. One vision puts renewed emphasis on transit and revitalization of inner areas. Another vision sees highways as the key to promoting growth and economic turnaround. It remains to be seen what direction the region will take as it heads into the 21st century.

3.5 CALGARY, CANADA

In Canada, the lack of federal incentives to build urban freeways has interacted with a willingness to invest in innovative transit service, a more transit-supportive pattern of urban development, and controls on parking to support three to four times the level of transit use of similarly-sized United States cities.

Canada's constitution provides for a separation of powers between the national and provincial governments. Urban issues, including transportation and land use planning, are the responsibilities of provinces. The National Transportation Act of 1967 specifically forbids federal involvement in urban transportation. As a result, there has been no national interstate highway program, or federal transit subsidies with their guidelines about how the funds could be used.

Another major difference between Canadian and U.S. policy is that in Canada federal and provincial gas taxes are not dedicated to highways, or even to transportation. Transportation must compete with other governmental programs for provincial and local funding. As a result, Canadian provinces vary widely in their funding priorities.

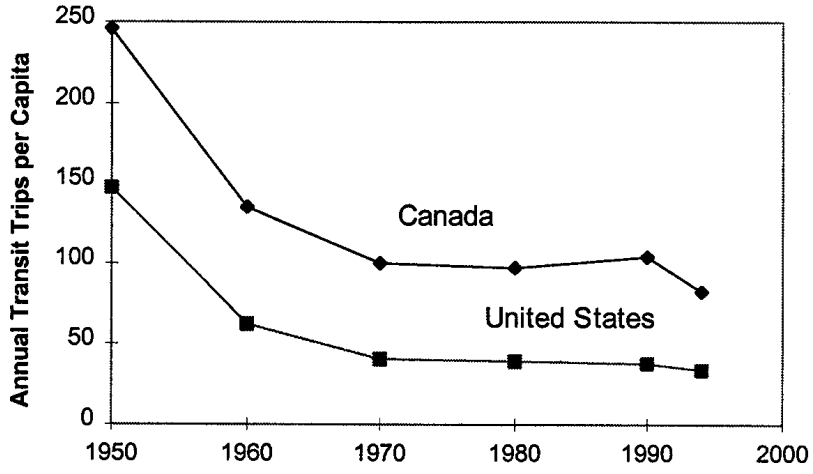
The absence of a federally funded urban interstate program does not mean that no urban freeways were proposed or built. At some time, most Canadian cities had ambitious plans for high-speed, limited access highways, but these plans were often scaled back because of their high costs and neighborhood opposition. Lacking the 90 percent federal funding for a specific solution to urban transportation problems, Canada cities considered both road and transit alternatives. Most chose transit as a major component of their transportation system.

The decisions to limit the construction of radial freeways constrained the volume of automobile traffic that could access the central business district, making transit essential for bringing workers to this concentration of jobs. Larger Canadian cities opted for rapid transit systems that could provide superior service and effectively compete with the automobile.

In addition, the lack of an urban interstate program meant less disruption for inner city neighborhoods. Indeed, many of the residents of these neighborhoods vigorously opposed planned freeways and expressways. A greater mix of people stayed in the inner city areas than occurred in many United States cities and helped broaden the base for transit.

Canadians have made greater use of transit throughout the interstate highway era than United States residents, as shown in Figure 13. In 1950, the average Canadian made 246 transit trips annually compared to 147 by Americans. While transit ridership, measured on a per capita basis, declined in both countries throughout the 1960s and 1970s, Canadian use exceeded United States use by more than two to one in 1970 when Canadians made 100 trips per capita annually while Americans made only 41. Despite the downturn in Canadian transit ridership in the 1990s due to economic recession, high unemployment, and increased fares, the ratio of trips per capita remains at the 1970 level of 2.44 trips by Canadians for every one by Americans.

Figure 13. Transit Trips Per Capita in Canada and United States, 1950-1994



Source: Data from Perl and Pucher, 1995

Many Canadian cities invested in transit in the 1950s and 1960s when transit was still considered a private business in most United States cities. Because of these early investments, Canadian transit systems were able to stabilize ridership levels in the 1960s while ridership continued to decline during that decade in the United States, as shown in Table 6. By 1980, Canadian transit ridership rose almost to the 1950 level and by 1990, exceeded that level, while United States ridership has remained at less than half the 1950 level.

Table 6. Public Transit Ridership in the United States and Canada, 1950-1994

	Ridership in Millions	
Year	Canada	United States
1950	1,396	14,245
1960	973	7,821
1970	980	6,182
1980	1,315	6,682
1990	1,519	6,863
1994	1,345	6,650

Source: Perl and Pucher, 1995

Canadians also have experimented with new public transportation technologies including advanced light rail in Vancouver and Toronto, early adoption of light rail in medium-size cities like Calgary and Edmonton, busways in Ottawa, timed transfer systems, bus priority measures, and computerized passenger information systems. These technologies have made transit easier and more pleasant to use, as well as making travel times more competitive with those of the automobile.

Canadian cities have developed in ways that are more conducive to transit service than many United States cities. They have more employment in their CBDs, more vibrant inner neighborhoods, and denser residential development. The central cities of the seven largest metropolitan areas in Canada average twice the density as the central cities of the ten largest U. S. metropolitan areas (28.6 persons per hectare in Canada compared with 14.7 persons per hectare in the United States).

Recent history in Calgary, Alberta furnishes evidence supporting and illustrating all the above conclusions. Calgary has grown rapidly. The Calgary metropolitan area has almost tripled in population since 1960, growing from 279,000 in 1961 (the size of present day Spokane, Washington, or Des Moines, Iowa), to 829,000 in 1995 (about the current size of the Louisville, Kentucky, or Salt Lake City, Utah). Over 90 percent of the metropolitan area population lives within the City of Calgary.

In particular, Calgary remains a city where transit use is high because of the following factors:

1. The City of Calgary makes all the governmental transportation and land use decisions for the urbanized area.
2. The City has been committed to a balanced transportation system since the 1960s.
3. The City canceled plans to build freeways to the city center in the early 1970s.
4. The City developed an express bus system in the 1970s and built a three-line, 28 km light rail network in the 1980s.
5. The downtown developed as a dense, high-rise office center during the oil and gas boom of the 1970s and early 1980s and continues to house nearly one-fourth of the region's jobs.
6. Suburban neighborhoods are designed to accommodate transit service.

7. The City has curbed automobile use for commuting by limiting the supply of long-term parking in the downtown.

In the 1960s, the City of Calgary incorporated all urban municipalities and became the sole local government in the urbanized area. In addition, the Alberta Municipal Government Act gives cities control over all highways, streets, and bridges within their boundaries. Transit has been a city function since the streetcar days early in this century. The city, therefore, makes virtually all public decisions about transportation and land use within its boundaries. In addition, during most of the city's growth years, land use planning, transportation planning, and the transit agency were overseen by a single city commissioner (one of four civil servants who manage city operations) providing a unique opportunity to coordinate transportation and land use throughout the urban area.

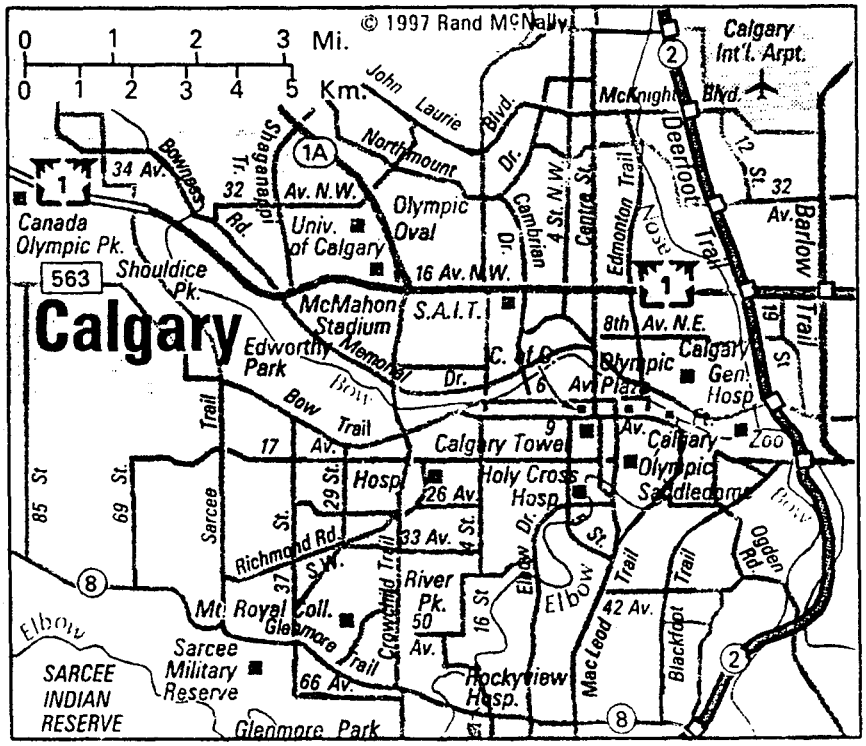
The province subsidizes transportation in the city through per capita grants for transportation. At one time, the city received $75 per person annually, but this has shrunk to $30 per person per year. The amount of provincial funding for capital costs hovered around 50 percent between 1976 and 1987 when the city was building its most expensive transportation projects. However, the province provided up to 90 percent funding for sections of the Deerfoot Trail. This freeway is the urban section of the major north-south route connecting Edmonton, Calgary, and the United States.

Calgary's plans for freeways borrowed from the United States experience. These plans were developed by American consultants in the mid-1960s when most United States cities were already well into their freeway building periods. The plans to put extensive road projects through existing neighborhoods generated considerable opposition, as was also already happening in the United States.

Freeways were also rejected because of their costs. The city has built expressways with lower engineering standards including some signalized interchanges and arterials to serve most mobility needs outside the central area. The only freeway in Calgary is the north-south Deerfoot Trail which runs in the Nose Creek and Bow River valleys several miles east of downtown (Figure 14). This route serves both local travel needs and is the urban part of the highway which connects Edmonton and Calgary with the United States and Mexico. Since Calgary is the only major city for hundreds of miles, except for Edmonton, very little traffic passes through the city without stopping.

In 1909, the City of Calgary began operating a streetcar system. By 1951, streetcars had been replaced by trolley buses on high density routes and diesel buses elsewhere. By 1974, the trolley buses also disappeared, but Calgary continued to develop a transit system as it grew. In order to efficiently move increasing numbers of workers to downtown, Calgary Transit began operating an express bus system in the early 1970s. Between 1971 and 1981 when the metropolitan area grew at an average annual rate of 4.7 percent, bus route miles expanded from 450 to 1,150 and hours of operation from 657,000 to 1,377,500. Transit's mode share for the evening peak hour traffic the central business district increased from 34 percent to almost 50 percent.

Figure 14. Limited Freeways in Calgary



In the mid-1970s, Calgary debated whether to remain a bus-only system or built a bus and light-rail system. They chose the latter option building the light rail in the two corridors first identified for heavy rail in the 1967 Transportation Plan plus another to the northeast where more growth was occurring. The first line serving the congested southern corridor opened in 1981. The second line was opened to the northeast in 1985, and the third to the northwest, serving the University of Calgary, in opened in 1987 just before the 1988 Winter Olympics. The system utilized the same technology as the Edmonton light rail, although Calgary's system runs at grade on the transit-only street in downtown while Edmonton's is in a subway.

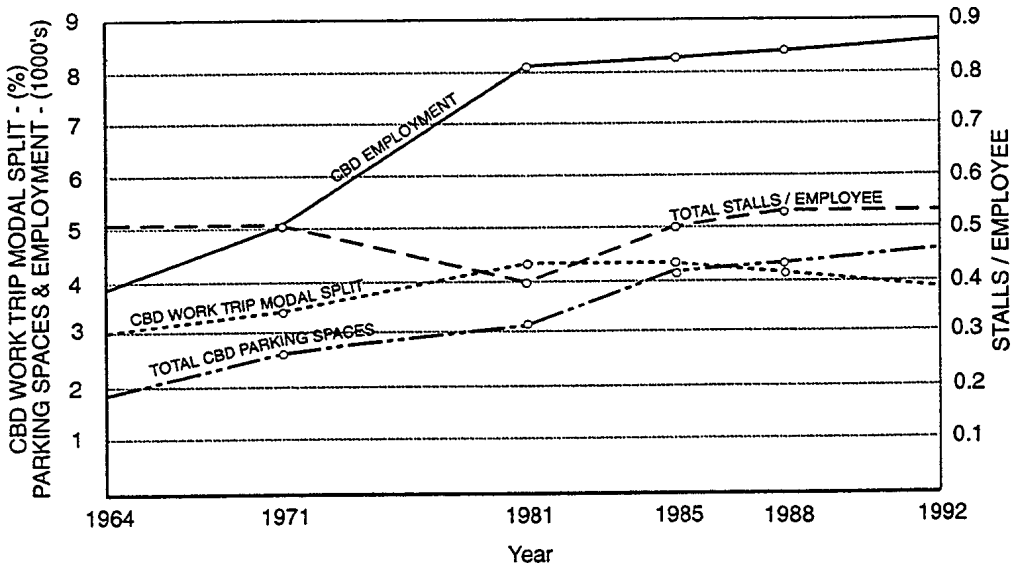
Calgary's transit system now operates near capacity at peak times. Most trains and some buses are full. Ridership went up to 60.5 million trips in 1996, up from 52.1 million in 1990. This equaled about 79 trips per capita in 1996, up slightly from 75 trips per capita in 1950. Mode shares for work trips to the CBD are currently 39 percent.

Since most of Calgary has been built since 1960, the bulk of housing is in suburban areas with curving streets and cul-de-sacs. Currently, new construction is averaging four to five units per acre, although the city's goal is seven units per acre. Despite this low density, suburban style of development, transit functions within neighborhoods. It is Calgary's policy that every house be within 400 meters (one-quarter mile) of a bus stop.

In the downtown, Calgary has used limits on parking in the downtown as a primary tool for constraining automobile trips to downtown and encouraging use of transit, and it has been highly effective. The city's development regulations allow one parking space per 1,500 square feet of office space, which they consider to be the space used by four office workers. In addition, during the period of extensive building, only 20 percent of the spaces could be located on site. The remainder of the spaces were constructed by a semiautonomous city parking authority using in-lieu payments as their revenue source. The city located its parking on the edges of the office core to keep traffic out of the core area and to provide the best connections with routes in and out of the downtown. City parking garages were linked to office buildings using a system enclosed sky bridges.

When parking limitations were implemented in 1972, downtown had 34,000 parking spaces for 12 million square feet of office space or about one stall for every 350 square feet of office space. The majority of these spaces were in surface parking lots. In 1981 after a decade of intense office development, office space had more than doubled to 25 million square feet, while the number of parking spaces was reduced to 33,000 or one space for every 760 square feet of office space. Just under half the spaces (49 percent) were in structures. Figure 15 shows how this reduction in the number of parking spaces per worker is correlated with higher transit use.

Figure 15. Changes in Modal Split with Changes in Stalls per Employee in Downtown Calgary



Source: Calgary GoPlan, 1994

Calgary illustrates why Canadian urban areas have higher levels of transit use than United States cities of similar sizes. First, the city chose to build a balanced transportation system emphasizing transit service for trips to and within the inner area and automobile use for trips within the outer area. The city borrowed heavily to build a 28 km light rail system that was planned when the region was in the midst of a boom in the oil and gas industry but completed during a downturn in its major industry. Light rail has attracted new riders to the system and is the backbone of the city's transit network. Instead of freeways, the

city has built a system of expressways and arterials. This system of roadways has kept pace with growth and, until recently, congestion has not been a serious issue in Calgary.

Secondly, because the City of Calgary makes all the transportation decisions within its boundaries, the city could focus on urban issues and pay less attention to the "highway" problem of moving through traffic. The city could chose transportation investment that it thought best met its needs, including a light rail network. In the early 1970s, Calgary introduced an express bus system that, like light rail, relied on park-and-ride lots and feeder buses. Calgary was also an early adopter of light rail and one of the smaller cities to adopt this technology. It has made an early and continuous commitment to transit.

Third, Calgary has a dense CBD where nearly a quarter of the city's jobs are located. Calgary is the headquarters location for numerous firms in the gas and oil industry. These firms drove the growth of the CBD in the 1970s and early 1980s because it was important for them to locate near each other. This advanced the growth in downtown office space despite the high cost of land in this physically constrained area. This concentration of 90,000 workers provides a strong focus for the transit system. Coupled with a well integrated transportation and land use plan, growth has supported transit.

Fourth, Calgary sees parking limitations, rather than congestion, as a primary means of encouraging transit use to downtown. Congestion is not effective because it also slows bus operations. Parking limitations constrain the supply of parking associated with new office development. When the city has allowed surface parking to develop, in contradiction to its policy of constraining supply, transit use has declined. Calgary also has the most extensive cash-in-lieu of parking program in Canada, which puts the city in charge of the location of a significant share of long-term parking within the downtown, and the highest number of park-and-ride spaces per capita, which shifts parking from the central area to more peripheral areas. In all, the Calgary experience has proven quite different from that found anywhere in the U.S.

3.6 FREIBURG, MUNICH, AND MUENSTER, GERMANY

Germany has the oldest and second largest system of limited access highways in the world. Moreover, the network of limited access highways in Germany is denser than in the U.S. because it is squeezed into a land area only four percent of that of the U.S. Germany also has the second most automobiles per capita, again second only to the U.S. One might expect that, as in the United States, the autobahn system in Germany would have strongly encouraged suburbanization, central city decline, and falling transit use. In fact, public transit ridership in Western Germany rose by 42 percent between 1950 and 1992. Moreover, German central cities have remained vibrant and attractive places to live and work.

German autobahns do not appear to have had the same negative impact on cities and public transit systems as the interstate highway system in the United States. Because they were not intended to serve urban travel needs, autobahns are mainly restricted to routes between cities. Thus, autobahns have not presented as much competition to urban public transit as in the U.S.

More important, however, is a range of public policies in Germany that have greatly restricted automobile use, and increased its cost, while facilitating walking, bicycling, and public transit use. Taxes on the ownership and use of autos are extremely high. Various traffic calming measures have reduced automobile access and speeds in residential areas. Parking supply in central cities has been reduced in most German cities over the past decade, and its price has risen steeply. Virtually every German city has extensive auto-free pedestrian zones and a network of bikeways that encourage walking and bicycling, generally complementing transit use. For many years, metropolitan wide transit systems have provided high-quality, well-integrated public transport services, and large subsidies have enabled them to offer regular riders inexpensive monthly tickets. Stringent land-use policies and building codes, together with high land costs, make low-density, sprawled suburbanization virtually impossible. All of these policies have directly encouraged transit use and discouraged automobile use.

In order to appreciate these differences in policy and outcomes, we examine three cities: Muenster (Westfalen) in northwestern Germany, Freiburg (Breisgau) in southwestern Germany, and Munich (Bavaria) in southeastern Germany. Although these three cities have been particularly successful at increasing transit use, bicycling, and walking, they are not so unusual as to be atypical. On the contrary, virtually every German city has implemented similar transport and land-use policy measures, and some have been equally successful.

Freiburg has about 180,000 inhabitants and serves as the economic, cultural, and political center of the Black Forest region of southwest Germany, which has a population of about half a million. Its economy is based on tourism, university teaching and research, government and church administration, and a broad range of services provided to the surrounding region.

Muenster has about 270,000 inhabitants and has long been the administrative capital of Westfalen, just north of the Ruhr region, in the northeastern part of the state of Nordrhein-Westfalen. Similar to Freiburg, its economy is based on services, government administration, education, and finance. It is much less focused on tourism than Freiburg.

Munich is the world-renowned capital of Bavaria, with about 1,245,000 residents in the city itself and a total metropolitan area population of 2,418,000, making it Germany's third largest city after Berlin and Hamburg. Its economy is very diverse, including government administration, education, research, light industry, and a wide range of services. Munich is even more important than Freiburg as a center of tourism and is included on virtually every foreign tourist's itinerary through Germany.

All three cities have long histories having been founded like many German cities over a thousand years ago. But the three cities share one significant historical event. Their central cities were almost completely destroyed in Allied bombing raids during the Second World War and had to be rebuilt. Although it was impossible to rebuild the three cities exactly as they had been prior to the war, they managed to resurrect much of the old urban form instead of adopting a modern, auto-oriented structure. Freiburg and Muenster, in particular, deliberately chose to preserve their historic layout of narrow, winding streets, pedestrian passageways, and monumental squares in their old towns, thus ensuring the continued feasibility of non-automotive transport in their central districts.

Of our case study cities, Freiburg and Muenster do not have any autobahn routes actually within their city limits, and even their long-distance autobahn links are quite limited: one in Freiburg (A-5) and two in Muenster (A-1 and A-43). Munich is much better supplied with autobahns, as might be expected for the third largest German city and capital of Bavaria. Even here, however, not a single autobahn penetrates beyond the inner traffic ring into the central city. Most of the autobahn routage is devoted to the beltway just outside the city limits (A-99) and the radial connections (A-95, A-96, A-8, A-92, A-9, A-94) between the inner beltway (2-R: not an autobahn) and the outer autobahn beltway (A-99) and the surrounding suburbs. Clearly, with that many routes, there is some use of the Munich autobahns for daily work commutation, but since they terminate well beyond the city center, the system encourages transfers to public transport for further travel toward the center.

Despite levels of automobile ownership higher than Canadian cities and only about 10 percent lower than in the United States, transit use has been increasing in all three of the case study cities. The number of passenger trips on public transport (including suburban rail) rose by 17 percent in Munich between 1980 and 1995, by 55 percent in Muenster, and by 136 percent in Freiburg.

One of the reasons for growing transit use has been enormous improvements in public transport systems. For example, the U-Bahn (metro) system in Munich has been steadily expanded since it was first built for the Olympics in 1972. The city has already completed its inner U-Bahn Network at 71 km and is now extending its radial lines further into the suburbs. Light rail lines have been extended or upgraded in Munich (85 km) and Freiburg (23 km). Suburban rail services have been significantly improved through more frequent services, new vehicles, more regular timetables (e.g., trains every 30, 20, or 15 minutes at the same time after the hour), and almost complete integration of these rail services into the metro and light-rail networks of Munich and Freiburg, in scheduling, routing, and ticketing. The bus fleet has been completely modernized, featuring mostly low-floor buses (for easy boarding) with large windows and comfortable seating. Moreover, all the cities have introduced a variety of measures to give buses priority in traffic. Park and ride facilities have been steadily expanding as well.

The most striking trend is the increase in public transport's share of modal split in all three of the model case studies. Perhaps most impressive is the trend in Munich, where public transport's share of all travel rose steadily from 19 percent in 1976 to 25 percent in 1995. Equally impressive, the percentage of travel by bicycling more than doubled (from 6 percent to 14 percent), reflecting the enormous investment in bike lanes and bikeways throughout Munich. By contrast, auto's share of travel fell from 42 percent to 40 percent. In Freiburg, the modal split of the automobile fell dramatically, from 60 percent in 1976 to only 46 percent in 1994, while transit modal split rose from 22 percent to 26 percent and bicycling rose from 18 percent to 28 percent.

Transportation policies in Germany were not always favorable to transit. Indeed, during the 1930s, Germany vigorously promoted automobile ownership and use. In 1933, the Nazis set up a special program to promote automobile travel. The Third Reich's Autoprogramm resulted in the world's first system of superhighways (4,000 km of autobahns by 1941); the development and widespread use of the Volkswagen; and the elimination of taxes and fees on automobiles. The Autoprogramm succeeded in sharply increasing automobile production, ownership, and use from 1933 to 1941. The devastation of the Second World War set back

automobile travel to negligible levels, however, as German cities and transport infrastructure throughout the country had to be almost completely rebuilt. Nevertheless, it did not take long before automobile use rebounded and quickly grew far beyond pre-war levels.

Similar to other countries in Western Europe and North America, West Germany pursued a policy of accommodating and facilitating automobile use from about 1950 to 1970. Over those 20 years, automobile ownership in Germany grew 19-fold, and passenger km of automobile travel grew 11-fold.

Basically, an attempt was made to emulate American cities by adapting German cities to serve the needs of the car. Gasoline tax revenues were earmarked to provide revenues for extensive roadway construction. From 1950 to 1970, the urban road network expanded by 53,000 km. In addition, large multi-level parking garages and extensive parking lots were built in virtually all German cities, further encouraging automobile use.

From 1970 on, however, policy toward the automobile shifted from accommodation to restriction of use. Environmentalists, community activists, and urban planners have increasingly viewed the auto-dominated transport system as an important cause of the social, economic, and environmental problems of German cities. In response, governments at various levels have adopted a range of measures to "tame" the automobile. The intent is not to limit automobile ownership, but to mitigate the harmful side-effects of excessive automobile use:

Traffic calming: Especially since 1980, most West German cities have reduced speed limits in urban residential areas to 30 km per hour (19 mph) and have further discouraged automobile traffic by narrowing streets, increasing the number of curves, and installing speed bumps, ornamental posts (bollards), concrete planters, wider sidewalks, and bicycle lanes.

Auto-free pedestrian zones: In virtually all German cities--as well as many smaller towns and villages--there is an interlocking system of streets in the old town center and main shopping district that is almost completely off-limits to private autos. Public transport is allowed direct access to this central zone, although buses and trams are usually required to travel at reduced speeds to ensure the safety of pedestrians and bicyclists.

Parking restrictions: Parking in German cities has become more difficult and much more expensive since 1980. In most cities, the price of on-street metered parking increases considerably with proximity to the city center. The largest cities now charge at least 5 DM per hour for parking in the center, roughly equal to the price of a round-trip by bus, tram, or metro. Moreover, special parking meters have been installed to prevent long-term parking by commuters in residential neighborhoods, and as a further disincentive, residential area parking permits are increasingly required for non-metered parking spaces.

Right-of-way priorities: Most German cities have constructed extensive systems of bicycle lanes and bikeways that are separated from motorized traffic. Buses benefit from reserved lanes on many streets, and both buses and trams are often given priority at traffic intersections.

Regulating driving behavior: Although Germany and other European countries have generally lagged behind the U.S. in regulating automobile manufacturers, they have been at the

forefront in regulating driver behavior. Particularly in Germany, licensing requirements, vehicle inspections, drunk driving laws, seat belt use laws, parking restrictions, and urban speed limits are much more stringent and also much more strictly enforced than in the United States.

Taxes on automobile ownership and use: Germany imposes considerable taxes on automobile ownership and use. Even in 1989, before various tax increases, total roadway user taxes by all government levels in Germany were more than double the total public expenditures on roadway construction, maintenance, and administration (International Road Federation 1991). Since 1990, taxes on automobile use have been raised considerably. Most recently, the gasoline tax was raised by 0.16 DM (about $0.10) per liter on January 1, 1994, bringing the total tax to 0.98 DM per liter (about $3 per gallon). That tax rate is roughly average for Western Europe but six times as high as in the United States. There is also an annual motor vehicle excise tax, ranging from 13.20 DM to 45.50 DM ($2.00 - $7.50) per ccm. engine size. The total tax depends on the size of the motor, whether it is gasoline- or diesel-powered, and whether its emissions are high or low.

Transportation Finance: In addition to these measures to "tame" the automobile, transportation finance in Germany has also been more conducive to supporting a balanced transport system than in the U.S. The federal government dedicates only a portion of the huge gasoline tax revenues specifically to transport infrastructure projects, with the remaining going to general government revenues. Of the federal urban transport fund, roughly 60 percent goes to public transport and 40 percent for roadways.

As in the U.S., financing for urban roads in German comes from all government levels. The more important a road is for long distance traffic (major highways, bypasses, connectors), the more state and federal aid is provided. Streets with exclusively local traffic are financed primarily by the cities themselves.

German autobahns are financed 100 percent by the federal government, including both construction and maintenance costs, since they are viewed as the country's key interregional and interstate links. Somewhat similar to the situation in the United States, the autobahn network is planned jointly by the federal government and the states. Autobahn planners have generally held to the original concept of avoiding routes through central cities, and fierce environmental opposition would have probably prevented such routing anyway. Even new autobahns planned through rural areas have been canceled or long delayed by environmentalists and local community groups. In contrast to American cities, the federal financing of autobahns in Germany has not led to massive autobahn projects within urban areas mainly to stimulate the local economy and create jobs, as in the United States (Altshuler et al 1981).

These policies affecting automobile use have clearly encouraged the use of public transport in Germany; but a crucial complementary policy has been the steady improvement in public transport systems over the past few decades. Both the quantity and quality of services has increased. Moreover, the various types of transit services have been better integrated than ever before, with improved coordination of routes, station stops, timetables, and ticketing.

The largest German cities rely on rail transit as the backbone of their route network, and that has been the focus of their efforts to improve the transit system overall. Smaller cities

generally have bus-only systems, but even they benefit substantially from short-distance regional rail services of the German Railroad.

Almost all large German cities, and many medium-sized cities, have been building new light rail lines or upgrading old streetcar lines to grade-separated light rail standards. The advanced LRT systems are designated as Stadtbahns or Schnellbahns, usually have their own rights of way, and sometimes are hardly distinguishable from full-scale U-Bahns (metros), especially since many run underground in the city center. Freiburg roughly doubled the extent of its LRT Stadtbahn from 16 km in 1985 to 23 km in 1995, and further extensions are being built. In addition, about 50 cities have retained their old streetcar lines, with shared rights of way, frequent stops, and thus much slower average speeds than the advanced light rail systems. But even on traditional streetcar lines, services have improved due to modernization of tracks and other infrastructure, new vehicles, and a variety of traffic priority measures that speed up streetcar travel in mixed traffic. Munich, for instance, has 85 km of streetcar routes.

Regional rail transit services also are far more important in Germany than in the United States. Indeed, virtually every German city benefits from such services. Freiburg and Muenster are at the center of extensive suburban rail networks serving their entire hinterlands, but in both cases, access to the system is mainly at the central train station, with very few other stops. In Munich, by contrast, the suburban rail system is tightly integrated into the U-Bahn (metro) network, with many shared station stops (albeit at different levels) in the city center. Moreover, in both Munich and Freiburg, ticketing and scheduling between suburban rail and other urban transit modes are fully coordinated into one unified system, thus greatly increasing convenience for riders.

Bus services have also been improved in most German cities, mainly through new vehicles, better transfer facilities, and various traffic priority measures to speed up bus travel. Special bus lanes, bus turnouts and access ramps, and bus-activated traffic signals are increasingly being installed to ameliorate the basic problem of buses being slowed down by other vehicles using the same roadway. Virtually all such "Beschleunigungsmassnahmen" (speed enhancement measures) have been quite successful, which accounts for their rapid spread.

The improvements were especially important for Muenster, which has a bus-only system (except for suburban commuter rail). From 1985 to 1995, the route network was only slightly expanded, but the network configuration, bus scheduling, and bus speeds were so much improved that the system attracted 58 percent more passengers with almost no increase in subsidy.

Germany has been at the forefront of regional coordination of public transport services in urban areas. Starting with Hamburg in 1967, an increasing number of German cities have established various organizational forms of regional cooperation and integration. By 1990, virtually all Western German cities had integrated their public transport systems. From the perspective of the passenger, it is as if only one firm were providing all public transit services within each German metropolitan area. The same ticket or monthly pass can be used for any mode of public transit. Route maps, timetables, and service standards are uniform. Transfers among modes and routes are easier due to the physical coordination of services and the zone-based unification of the regionwide fare structure.

In summary, we can draw four main conclusions from our examination of the overall situation in Germany and the specific cases of Freiburg, Muenster, and Munich. First, the design of the autobahn network in Germany has minimized their impact on cities and their public transport systems. Although autobahns often provide bypasses or beltways around German cities, they very rarely pass through the center city. Instead, they primarily serve long-distance intercity travel needs and thus provide less direct competition with urban transit than in the U.S.

Second, for many decades, federal, state and local governments have continuously invested large subsidies in the expansion, modernization, and improvement of the whole range of public transit modes. Especially during the past two decades, impressive advances have been in intermodal coordination and truly regional integration of transit services.

Third, owning and using a car in Germany have been much more expensive and difficult and less convenient than in the U.S. Higher gasoline taxes, sales taxes, and parking fees make automobile use at least twice as expensive as in the U.S. Moreover, the use of autos is far more restricted than in the U.S. Extensive auto-free pedestrian zones, traffic-calmed residential neighborhoods, and limited parking supply in the city center are just a few examples of those restrictions.

Fourth, land-use controls in Germany have been much stricter in the U.S. and have helped produce urban and suburban development that are several times denser and more compact than American cities. The more limited extent of suburbanization in Germany, and its higher density, have certainly helped keep transit a viable alternative to the automobile.

The combination of these transportation, land-use, and housing policies has produced urban structures and travel behaviors vastly different than those in the United States. German cities are much denser and more compact than American cities, and their citizens are not nearly so dependent on the automobile, since they have a wide range of excellent alternatives in walking, bicycling, and using public transit. They key to success in taming the automobile in Germany has been a coordinated, multifaceted strategy that has limited the intrusion of high-speed freeways into urban areas and simultaneously restricted automobile use and made it much more expensive while providing attractive, inexpensive alternatives to the auto.

4.0 SUMMARY OF CASE STUDY FINDINGS

Evidence from the case studies described above confirms that the development of the interstate highway system adversely affected public transit directly and indirectly. We can observe the declines in transit ridership, the increasing difficulty in maintaining transit service levels, and the decentralization and dispersion of households and jobs in case study regions with the highest use of interstate highways. We also observe a set of factors and conditions that mitigated these effects. However, the relationship is not a simple one of cause and effect.

First it is necessary to clarify the role of interstate highways themselves. In all the regions studied, the trend towards motorization preceded the advent of interstate highway construction. Kansas City's municipal manager and the engineering staff of Columbus had ambitious plans for highways as early as 1940. The interstate program merely provided the funds to implement these visions. In Atlanta, the city's early transportation plans were more multi-modal; however, highway elements were in place well before 1956. In Calgary, where regional transportation plans have origins nearly as old as those of Atlanta or Kansas City, visions of highways persisted well into the 1960s. The German's fascination with the automobile affected public policy beginning in the 1930s.

Thus to argue that the interstate highway program alone caused transit's decline or suburbia's boom is mistaken. In the US, automobile ownership had already reached high levels before 1956, and transit ridership plummeted in most communities following World War II. Likewise, considerable suburbanization preceded the construction of interstate highways.

But more importantly, from the point of view of national and local public policy, we can see clearly how the local and national context in which the development of highways took place affected both the timing and magnitude of the adverse effects of interstate highways. Contrasting Kansas City and Columbus, for example, with Calgary and German cities, one is struck by the fact that the relative scarcity of freeways in the strongly centered and traffic limited regions is only one of many reasons why transit has remained viable, city neighborhoods have remained attractive and land use more compact. Among the American cities, with their relatively similar systems of growth management and automobile dependence, the location and extent of highway development appears to play an important role in explaining travel choices and urban form outcomes, but other factors clearly are involved.

However, the case studies do show a relationship between urban interstate highways and transit. The key points of this relationship are as follows:

- Public funding has influenced the choices between highway and transit investments, and these investment choices have, in turn, influenced the travel choices of consumers.
- Where there has been strong investment in transit, transit use is higher and urban centers are stronger.
- Regions must have strong, well-respected institutions building and operating transit in order to minimize the impact of interstate highways on urban travel choices.

- Citizens have played a strong role in limiting the impacts of interstate highways on cities and their transit systems.
- In regions that integrate transportation and land use planning and policy, interstate highways have had less negative impact on communities and public transit.
- Public policies that support use of transit, bicycling, and walking also limit the negative impacts of interstate highways.
- In general, urban areas with less interstate infrastructure have experienced fewer negative impacts from automobile use.

The balance of this section contains a discussion of each of these factors and illustrates the ways in which they have their effect.

The magnitude and certainty of public funding has influenced modal investment choices. These choices, in turn, have affected regional travel.

Evidence from the case study communities clearly shows that local engineers and officials were eager to take full advantage of 90 percent federal funding for interstate highways. Visionary officials went so far as to develop their plans in advance of the federal program to enhance their ability to capture funds when and if they became available. These communities have continued to emphasize additional highway capacity as the way to solve transportation problems. Atlanta, for example, had an extensive "Freeing the Freeways" program in the 1980s that widened all of the two lane interstate highways in the central city. Columbus continues to widen congested sections of its interstate network and add interchanges to improve access to new development sites.

By contrast, funds for transit capital expenditures did not become available nationally for over a decade after the inception of the interstate highway program. Further, the national funds for transit operations have been a hotly debated topic for decades; and in the 1990s these funds have been dramatically reduced. The argument that users paid for the full costs of the nation's highway system, which has been refuted in a number of studies completed in the last decade, weighed heavily in legislators' thinking about federal subsidization of local transit operations.

Even with federal support, local transit operations have been difficult to finance. In Kansas City bi-state disagreements over taxes led to a shrinkage of the transit service area to one county in Missouri although KCATA was originally regional in nature. The KCATA is now a central city system with decreased service and ridership because suburban counties withdrew their support. In Columbus, public reluctance to support the operations of the Central Ohio Transit Authority (COTA) led to service-level cutbacks and patronage declines. Even in Atlanta, one of America's success stories in transit finance and development, several suburban counties opted not to participate in the rapid rail system. The absence of MARTA services in Cobb and Gwinnett Counties has adversely affected congestion and the pattern of suburban development.

Those cities whose citizens have shown a continuous commitment to and investment in high-quality transit service, have strong urban centers and higher transit use.

In the United States, communities where highways have had their least adverse impacts on transit are places where local governments stepped in relatively early in the motorization

process to acquire private transit operators and invest in both equipment and frequent service. In both Pittsburgh and Atlanta the public sector acted decisively to maintain as much transit service as their communities could afford. By contrast, in both Kansas City and Columbus, local officials were slow to take up the challenge of public transit operations. Decades of underinvestment and neglect took a heavy toll on transit.

In the Canadian and German examples, public operations had always been in place. In contrast to the United States, the German investments in transit, both inter- and intra-city, have been huge. Though costly, these services have not only precluded patronage loss but actually made possible substantial increases in transit use over the last 20 years.

In Canada, Calgary (as well as Ottawa and Vancouver) give evidence of the public's commitment to extensive, continuous transit services. Canadian cities have also been innovative in transit technology and operations. Today, Canadian transit has an enormous variety of technologies in place to meet the public's travel needs.

While automobile ownership levels in Canada and Germany were far below those in the US as late as the 1970s, they are nearly comparable today. Differences in transit use thus cannot be explained by the absence of choices. Nowhere in these countries do residents lack the opportunity to use their car for virtually any trip purpose. The impact of highways and high levels of automobile ownership on travel choices has, however, been mitigated in both countries by extensive, well integrated, frequent, and highly competitive public transit service as well as higher fuel prices. In these national environments, gains or losses in transit patronage have not resulted from highway construction, but rather factors internal to the transit industry itself, such as fare and pricing policies, service levels and investments, as well as demographics, economic trends, restrictions on automobile use, and other factors.

In Pittsburgh and Atlanta, corridors where transit offers competitive service to the automobile are well patronized. However, there are few such corridors in US metropolitan areas relative to those found in German or Canadian cities.

Strong, well-respected institutions build and operate transit systems in the regions where the impacts of highways on transit are low.

In the Kansas City region, the cities, counties, and the State Departments of Transportation were well organized, motivated, and influential in transportation policy. The transit agency, by contrast, was not part of the transportation planning process during the formative years of this city's modern transportation infrastructure.

In Columbus, there was no public transit operator until 1971 and no funding until 1974. In the subsequent generation funding has waxed and waned, and transit patronage has continued to decline.

In Georgia, despite Atlanta's relatively successful program of transit development, the transit agency's operations were limited to two counties where voters approved financing public transportation. Transportation infrastructure in the other suburban counties became largely the domain of the Georgia Department of Transportation, and throughout the Atlanta region, the DOT developed and expanded highway infrastructure. Thus, two powerful transportation

agencies, MARTA and the Georgia DOT, have directly competed in the same travel markets. In light of this relationship, MARTA's success is noteworthy.

By contrast, transit in Canadian cities has a long history of being a public service. Investments in transit continued throughout the 1950s and 1960s. In Calgary, the transit agency was a function of the single local government which provided all municipal services within the metropolitan area. As such, it not only had access to opportunities to integrate plans with those of other departments, but also to the funds necessary for system enhancements and expansions.

Evidence from previous case studies conducted for TCRP Project H-1 furnish further evidence to support this conclusion. In Vancouver, a powerful provincial agency funded Skytrain. In Portland, Tri-Met has benefited from both a dedicated payroll tax, an award winning transit system and wide-spread public support resulting from the quality of services which it delivers.

Active, well-organized citizen groups mitigated the impacts of highways by successfully opposing certain highway designs as well as highway construction itself.

Over time, public policy must be congruent with the tastes and values of the electorate. In Kansas City, citizen preferences for automobiles undoubtedly facilitated the early and extensive implementation of highway plans. Where preferences clashed with plans, highways were canceled or redesigned. Kansas City's long battle over the midtown freeway resulted in a design which mitigated some of that road's adverse community impacts. In Columbus, citizen opposition to a beltway affected its location. In Pittsburgh, a long controversy over I-299 North resulted in the introduction of high-occupancy-vehicle lanes which support express buses.

Generally, Canadian and German cities (where most of the middle-class live and work) have not been supportive of highway investments. The "green" party in Germany has proved highly influential since the 1980s in influencing local and national transportation and environmental policy. Citizen activists in Calgary vocally opposed numerous freeways, resulting in their elimination or redesign into arterials which better fit the fabric of their neighborhoods.

The integration of transportation and land use policies, plans and projects has mitigated the impacts of automobile infrastructure.

Differences in land use policy, as well as philosophical differences in the very willingness to regulate the use of urban land, certainly explains the differences in urban form found in the United States, Canada and Germany. Notwithstanding the fact that many portions of German cities predate motorized transport, late twentieth century development in Germany (as well as Canada) has occurred in a more compact fashion than is found in the American suburbs. This is due to the interaction of land use policy and land prices. The absence of the deductibility of mortgage interest in Canada, combined with stronger regulations about the conversion of land to urban uses, makes housing more expensive and the need to economize on the use of urban land more necessary. In Germany, suburbanization has occurred at densities higher than that of the United States because of the scarcity of land.

The most compelling evidence for the difference of philosophy between United States and other countries regarding the use of urban land is the way in which central cities in the United States and Germany were rebuilt in the generation following World War II. In the United States, federal programs subsidized the demolition of urban homes and businesses. Developers replaced these structures, again with public subsidy, largely with designs that reflected American's affection for the automobile. Downtown "shopping centers" replaced main street stores. "Garden apartments" replaced traditional urban housing stock. The older, grid street pattern was replaced with large blocks and wide streets designed for ease of automobile access. Both the public and private sectors invested in structured parking.

Columbus, Kansas City, Pittsburgh, Atlanta and virtually every other "progressive" American city pursued these visions of urban revitalization. Auto-oriented land use and design supported auto-oriented transportation infrastructure in a seamless fashion.

In contrast, German officials faced the need for urban renewal as a result of military defeat. Large portions of German cities, destroyed by allied bombs, needed every form of infrastructure, including transportation. Government investments in German urban revitalization, however, produced in many cases, including those of the case studies described above, a pattern of streets quite similar to those which preceded the war's destruction. Only in a few cities did officials replace the historic fabric of city centers with large blocks, wide arterials, or freeways.

Thus, the American version of the integration of transportation and land use policy resulted in the development of infrastructure and zoning codes that were designed to the needs of the automobile. Only a few regions pursued the implementation of multi-modal plans. One has to look further still, however, to find city codes and policies which take the needs of pedestrians and transit riders into consideration. Among the earliest of these are New York's density bonuses for pedestrian plazas and Portland's requirements for ground floor retail space even in parking structures. The cities that were successful in developing strong business districts, such as Pittsburgh and Calgary, were successful in creating markets which transit could serve on dedicated rights-of-way. Cities where downtown policies and markets did not support reinvestment became places where surface parking was often more profitable than older office space. Both Kansas City and Columbus give evidence of the results of these trends.

Even in the suburbs, the integration of transit support of land uses with transit service was the norm in Germany and Canada and the exception in the United States. Only recently have US suburban jurisdictions turned to ordinances that ensure transit supportive design. In Canada, Calgary, Ottawa, Toronto, Vancouver, and other cities committed to suburban transit, service required land use plans and designs which maximize transit accessibility even as they accommodated the automobile. Going a step farther, Germany is among the earliest countries to introduce traffic calming techniques designed to reduce automobile speeds, increase pedestrian safety and convenience, and enhance the competitiveness of alternative modes to the automobile, both motorized and non-motorized.

In cities where highways' adverse impacts are fewest, public policies support the use of alternative modes.

One must look outside the United States for innovations in public policy which mitigate the impacts of automobiles. In the last decade many of these have found their way into practice in the United States.

The government of Calgary's policy to own and manage parking supply in the central business district played a key role in affecting mode choice decisions. The dramatic rise in employment in that city's downtown, which occurred without meaningful increases in parking supply, gives evidence that an integrated transportation and land use policy that supports transit is completely consistent with economic growth and development. The extensive system of park-and-ride lots along the city's light rail corridor, while partly precluding transit-oriented development in those locations, has the benefit of maintaining transit's market, both by attracting riders through its convenience and by freeing scarce downtown land for more productive uses.

Both Canada and Germany impose heavier taxes on automobile ownership and use, which are amply documented in other literature. Public and private parking are quite expensive by U.S. terms. In addition to land use policies and codes, described above, cities have adopted pedestrian zones which, unlike some U.S. counterparts, have remained economically viable because they are a part of a large urban fabric which is also pedestrian friendly and of an urban transportation system which provides high levels of accessibility to users of alternative modes.

Portland, one of the case studies in the TCRP Project H-1, is widely known as an example of best U.S. practice in the set of public policies which support a balance of transportation systems. Portland's downtown plan in the 1970s imposed zoning requirements for mixed use in the downtown area, limited increases in supply of parking, dedicated several streets for the exclusive use of the city's transit system, invested in parks, civic plazas and other amenities to increase the city's attractiveness, and timed movement of traffic through the downtown at a slow pace which both minimizes congestion and inconvenience to pedestrians. Coupled with strategic investments in both light rail and freeways, the city's planners have created a downtown that is accessible by multiple modes, attractive to residents and workers alike and highly competitive locally and nationally as a business location.

Notwithstanding all the factors described above, city centers with less freeway infrastructure have experienced fewer adverse impacts from the automobile.

Importantly, strongly centered and traffic limited cities such as those found in Canada and Germany are places where few freeways exist in the city center. The combination of national policy, financial policy and citizen preferences that combine to bring this about have not been duplicated in the United States.

The German system of freeways connects cities but does not go through them. The federal government finances the autobahn system because it serves interregional travel. In the United States, where one-third of the interstate route mileage is in metropolitan areas, two-thirds of the vehicle miles traveled are on the metropolitan segments of the system. Various organized interests combined to oblige the federal government to pay for highway facilities which serve local travel needs almost exclusively. This policy is supported by the well established perception that these state and federal highways are, indeed, of state and federal

significance. If this were the case one would expect that the majority of vehicles (and user benefits) would be attributable to through trips.

Across the United States, in every metropolitan area, the facts contradict this expectation. As scarce federal transportation dollars continue to be spent for highway and freeway improvements almost exclusively benefiting local markets, the line between national and local needs continues to be blurred, as it has been since the later stages of motorization in America. One of the least discussed aspects of the interstate system is its success in financing urban roads, when previous federal aid was principally for rural or intercity routes. The rhetorical title of "National Interstate Defense Highway System" is no less a rationale for the interstate system of the 1950s than the "Highways of National Significance" program is today.

It would be difficult to argue that the Canadian and German economies are less powerful or productive than that of the United States because national policy and local preference precluded the extensive use of non-local dollars for local highways. Further, as the goods production and distribution functions in US metropolitan area have largely decentralized and now occupy land at the urban edge, there is an opportunity today to rethink the relationship between funding and functional classification which has contributed to automobile dominance in the United States.

In Canada, where few federal dollars have ever been available for transportation improvements and responsibility has fallen instead on provincial and local governments, cities like Calgary made a very different set of choices than their counterparts in America. When and where highways were clearly of international, national, or regional significance, provincial governments stepped in to foot a large portion of the bill. Where projects (either highway or transit) were designed to meet largely local needs, local sources supplied most of the funds. In a similar fashion, the Federal Republic of Germany has paid for 100 percent of the cost of the autobahn system. However, most autobahns stay well away from the urban core of German cities, leaving a different set of transportation choices and outcomes.

In the United States, the Pittsburgh metropolitan area is a coincidental example of this. Geographic constraints precluded the development of Interstate highways to any extent in Pittsburgh's urban core. Interstate facilities, some of which were constructed as early as the 1940s, carry through traffic in counties up to 25 miles from the city center. The restructuring of the local economy in the 1970s and 1980s, combined with local opposition to transportation facilities devoted exclusively to single occupant vehicles, produced an integrated transportation and land use outcome highly supportive of transit. While unintended, Pittsburgh example is closer than perhaps any other in the US to the German situation described above.

By contrast, the Atlanta case study illustrates the ways in which interstate highway dollars financed a highway system designed largely to meet urban and suburban needs for mobility. Atlanta today has one of the highest rates of automobile use of any metropolitan area in America. Transit is competitive in only a few selected corridors and destinations. Atlanta, like many US cities, simultaneously invested in highways and transit. While this afforded a high degree of central city accessibility by all modes, the price tag was also high.

In the United States, large sums are invested in transportation relative to other kinds of infrastructure. In both Germany and Canada, transportation taxes and fees raise far more revenues than are spent on transportation infrastructure investments. This system not only served to dampen demand for automobile use (and, to a lesser extent, ownership) but also supported a flexible investment strategy for several decades before such a strategy found its way into US policy in the 1990s. The result, evident after two generations, can be found in the travel choices made by residents of their cities, where multi-modal investments have led to multi-modal use.

This case study analysis has shown that national public policy interacts with local policy and institutions to shape the transportation investment choices of regions and the transportation behavior of residents. In the United States, the federal government, through legislation and administrative initiatives, created an irresistible incentive to build urban interstate highways with its generous funding formula for the interstate highway system. Most US cities adopted increasing highway capacity as their primary means of addressing congestion. A few regions, due to geographic constraints, citizen involvement, or civic leadership also developed high quality transit systems, but many cities allowed their transit to decline to systems that basically serve those without other travel options. In contrast, Germany built an extensive autobahn network, but restricted the system to intercity traffic. Autobahns, in most cases, do not serve the daily urban commuter. In addition, in the past two decades German cities have restrained automobile use, invested heavily in improved transit, made their transit systems easier to use, and improved facilities for bicyclists and pedestrians. The result for the case study cities have been increasing transit and bicycle mode shares and declining automobile use. In Canada, there has been no federal interstate program. A greater diversity of solutions to urban transportation problems has appeared than in the US with large cities emphasizing transit as a major mode of urban travel.

The interstate highway program interacted with a wide range of other policies and citizen preferences to make most US cities weakly centered or fully motorized cities where nearly all travel occurs in the private automobile. Cities in Canada and Germany show that other paths are possible, even in auto-dominated cultures.

References

Altshuler, A., J. P. Womack, and J. R. Pucher. *The Urban Transportation System: Politics and Policy Innovation.* MIT Press, Cambridge, MA (1981).

Bownas, W. T. "Columbus." *Motor Coach Age,* Vol. 42, Nos. 3 and 4 (March-April 1990) pp. 4-36.

Calgary GoPlan. *Calgary Downtown Parking and Transit Study Summary Report.* PPS-No. 0312-94. Calgary, Alberta, Canada (December 1994).

Carlino, G. A. and E. S. Mills. "The Determinants of County Growth." *Journal of Regional Science,* Vol. 27, No. 1 (1987) pp. 39-53.

Cassidy, T. W. "Kansas City." Motor Coach Age, Vol. 27, Nos. 11-12 (1975).

Central Ohio Transit Authority. *1997 Short Range Transit Plan.* Columbus, OH (April 1997).

Dunn, J. A., Jr. *Miles To Go: European and American Transportation Policies.* MIT Press, Cambridge, MA (1981).

Dunphy, R. T. *Moving Beyond Gridlock: Traffic and Development.* The Urban Land Institute, Washington, DC (1997).

Edner, S. M. and G. B. Arrington, Jr. *Urban Decision Making for Transportation Investments: Portland's Light Rail Transit Line.* Technology Sharing Program, U.S. Department of Transportation, Washington, DC (1985).

Federal Highway Administration. *America's Highways, 1776-1976.* U.S. Department of Transportation, Washington DC (1977).

Federal Highway Administration. *Highway Statistics 1991.* U.S. Department of Transportation, Washington DC (1992).

Flink, J. J. *The Automobile Age.* MIT Press, Cambridge, MA (1988).

Forkenbrock, D. J., T. F. Pogue, N. S. J. Foster, and D. J. Finnegan. *Road Investment to Foster Local Economic Development.* The Public Policy Center, University of Iowa, Iowa City, IA (1990).

Foster, M. S. "The Role of the Automobile in Shaping a Unique City: Another Look." In *The Car and the City,* ed. M. Wachs and M. Crawford. University of Michigan Press, Ann Arbor (1992) pp. 186-193.

Garreau, J. *Edge City: Life on the New Frontier.* Anchor Books, New York (1991).

Garrison, W. L. and R. R. Souleyrette II. "Transportation, Innovation, and Development: The Companion Innovation Hypothesis." *The Logistics and Transportation Review,* Vol. 32, No. 1 (March 1996) pp. 5-38.

Georgia Department of Transportation. *Freeing Atlanta: More Capacity Proves Viable Strategy for Congestion Relief.* Atlanta, GA (August 1981).

Hughes. J. W. and G. Sternlieb. "The Suburban Growth Corridor." In *America's New Market Geography: Nation, Region and Metropolis,* eds. G. Sternlieb and J. W. Hughes. Center for Urban Policy Research, Rutgers University, New Brunswick, NJ (1988).

Humphrey, C. R. and R. R. Sell. "The Impact of Controlled Access Highways on Population Growth in Pennsylvania Nonmetropolitan Communities, 1940-1970." *Rural Sociology,* Vol. 40, No. 3 (1975) pp. 332-343.

Jackson, K. T. *Crabgrass Frontier: The Suburbanization of the United States.* Oxford University Press, New York (1985).

Jones, D. W., Jr. *Urban Transit Policy: An Economic and Political History.* Prentice-Hall, Inc., Englewood Cliffs, NJ (1985).

Kansas and Missouri Departments of Transportation. *1970 Freeway and Expressway Plan for the Kansas City Metropolitan Region.* Prepared jointly by the Kansas City Metropolitan Planning Commission, Missouri State Highway Commission, and State Highway Commission of Kansas (1970).

Kansas City Area Transit Authority. "Comprehensive Service Analysis." Vol. 1 (April 1996).

Kemp, M. A. and M. D. Cheslow. "Transportation." In *The Urban Predicament,* eds. W. Gorham and N. Glazer. The Urban Institute, Washington, DC (1976).

Leinberger, C. B. "Metropolitan Development Trends of the Late 1990s: Social and Environmental Implications." In *Land Use In America,* eds. H. L. Diamond and P. F. Noonan. Island Press, Washington, DC (1996).

Lichter, D. T. and G. V. Fuguitt. "Demographic Response to Transportation Innovation: The Case of the Interstate Highway." *Social Forces,* Vol. 59, No. 2 (1980) pp. 492-512.

Linneman, P. D. and A. A. Summers. "Patterns and Processes of Employment and Population Decentralization in the Untied States, 1970-87." In *Urban Change in the United States and Western Europe: Comparative Analysis and Policy,* eds. A. A. Summers, P. C. Chesire, and L. Senn. The Urban Institute, Washington, DC (1993).

Lochner, H. W. and C. E. DeLeuw. *Highway and Transportation Plan for Atlanta, Georgia.* Georgia Department of Transportation, Atlanta, GA (1946).

Louis Berger International, Inc. "Transportation Investment and Economic Expansion: Case Studies." National Cooperative Highway Research Program Project 20-07, Task 59, Transportation Research Board, Washington, DC (October 1995).

Meyer, J. R. and J. A. Gomez-Ibanez. *Autos, Transit and Cities.* Harvard University Press, Cambridge, MA (1981).

Mid-America Regional Council. *Metropolitan Kansas City's Urban Core: What's Occurring, Why It's Important and What We Can Do.* Kansas City, MO (1993).

Mid-America Regional Council. *Transportation 2020: A Long-Range Transportation Plan for the Kansas City Metropolitan Region.* Kansas City, MO (May, 1995).

Muller, P. O. "Transportation and Urban Form: Stages in the Spatial Evolution of the American Metropolis." In *The Geography of Urban Transportation,* 2nd edition, ed. S. Hanson, The Guilford Press, New York (1995) pp. 26-52.

Parsons Brinckerhoff Quade and Douglas. "Transit and Urban Form, Vol. 1. Part I: Transit, Urban Form, and the Built Environment: A Summary of Knowledge." *TCRP Report 16,* Transportation Research Board, Washington, DC (1966a).

Parsons Brinckerhoff Quade and Douglas. "Transit and Urban Form, Vol. 2. Part IV: Public Policy and Transit-Oriented Development: Six International Case Studies." *TCRP Report 16,* Transportation Research Board, Washington, DC (1966b).

Payne-Maxie Consultants and Blayney-Dyett. *The Land Use and Urban Development Impacts of Beltways.* Final Report No. DOT-OS-90070, U. S. Department of Transportation and Department of Housing and Urban Development (1980).

Perl, A. and J. Pucher. "Transit in Trouble? The Policy Challenge Posed by Canada's Changing Urban Mobility. *Canadian Public Policy,* Vol. 21, No. 3 (1995) pp. 261-283.

Pisarski, A. E. *Commuting in America.* ENO Foundation for Transportation, Westport, CN (1987).

Pucher, J. "Urban Passenger Transport in the United States and Europe: A Comparative Analysis of Public Policies, Part 2--Public Transport, Overall Comparisons and Recommendations." *Transport Reviews,* Vol. 15, No. 3 (1995) pp. 211-227.

Pucher, J. "Urban Transport in Canada: Lessons for the United States?" Draft paper (1997).

Rephann, T. and A. Isserman. "New Highways as Economic Development Tools: An Evaluation Using Quasi-Experimental Matching Methods." *Regional Science and Urban Economics,* Vol. 24 (1994) pp. 723-751.

Rose, M. H. *Interstate: Express Highway Politics,* 1939-1989. Revised edition. University of Tennessee Press, Knoxville (1990).

Rosetti, M. A. and B. S. Eversole. *Journey to Work Trends in the United States and Its Major Metropolitan Areas, 1960-1990.* U. S. Department of Transportation, Washington, D.C. (1993).

Schrank, D. L., S. M. Turner, and T. J. Lomax. *Estimates of Urban Roadway Congestion - 1990.* Research Report 1131-5, Texas Transportation Institute, College Station, TX (1993).

Schwartz, A. "Review of 'Future Highways and Urban Growth.'" *Journal of the American Planning Association,* Vol. 28 (1962) p. 204.

Simpson, B. J. *Urban Public Transport Today.* E & FN Spon, London (1994).

Smerk, G. M. *The Federal Role in Urban Mass Transportation.* Indiana University Press, Bloomington and Indianapolis, IN (1991).

St. Clair, D. J. *The Motorization of American Cities.* Praeger, New York (1986).

Thomson, J. M. *Great Cities and Their Traffic.* Victor Gollancz Ltd., London (1977).

Transportation Research Board. *Expanding Metropolitan Highways: Implications for Air Quality and Energy Use.* Special Report 245. National Academy Press, Washington, DC (1985).

Vuchic, V. R. *Urban Public Transportation: Systems and Technology.* Prentice-Hall, Inc., Englewood Cliffs, NJ (1981).

Weiner, E. "History of Urban Transportation Planning." In *Public Transportation,* 2nd edition, eds. G. E. Gray and L. A. Hoel. Prentice Hall, Englewood Cliffs, NJ (1992) pp. 46-78.

Wilbur Smith and Associates. *Future Highways and Urban Growth.* The Automobile Manufacturers Association, Detroit, MI (1961).

The **Transportation Research Board** is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results. The Board's varied activities annually draw on approximately 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purpose of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation