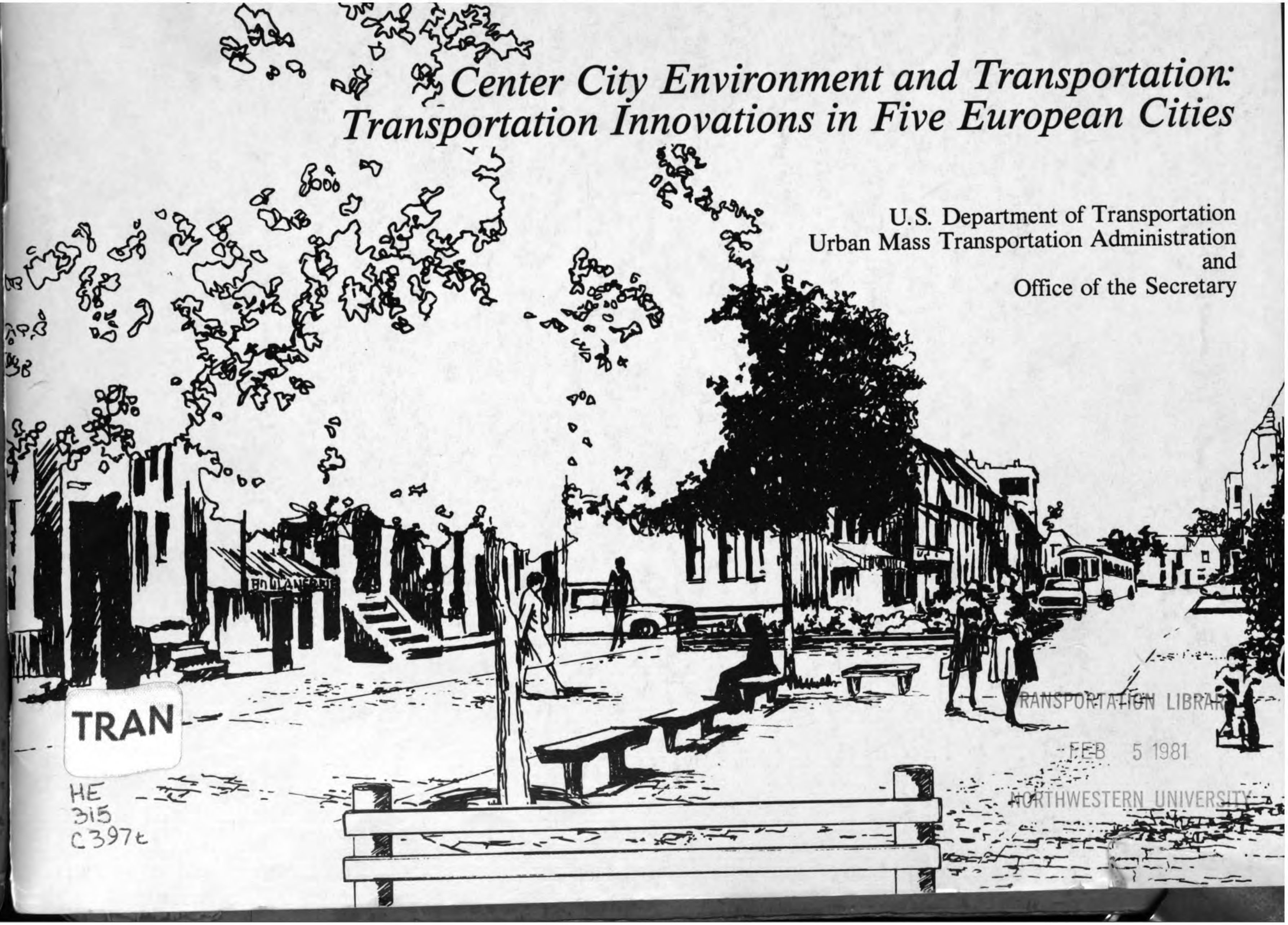
Center City Environment and Transportation: Transportation Innovations in Five European Cities

U.S. Department of Transportation
Urban Mass Transportation Administration
and
Office of the Secretary



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The Urban Consortium for Technology Initiatives was formed to pursue technological solutions to pressing urban problems. The Urban Consortium is a coalition of 37 major urban governments, 28 cities and 9 counties, with populations over 500,000. These 37 governments represent over 20% of the nation's population and have a combined purchasing power of over $25 billion.

Formed in 1974, the Urban Consortium represents a unified local government market for new technologies. The Consortium is organized to encourage public and private investment to develop new products or systems which will improve delivery of local public services and provide cost-effective solutions to urban problems. The Consortium also serves as a clearinghouse in the coordination and application of existing technology and information.

To achieve its goal, the Urban Consortium identifies the common needs of its members, establishes priorities, stimulates investment from Federal, private and other sources and then provides on-site technical assistance to assure that solutions will be applied. The work of the Consortium is focused through 10 task forces: Community and Economic Development; Criminal Justice; Environmental Services; Energy; Fire Safety and Disaster Preparedness; Health; Human Resources; Management, Finance and Personnel; Public Works and Public Utilities; and Transportation.

Public Technology, Inc. is the applied science and technology organization of the National League of Cities and the International City Management Association. It is a nonprofit, tax-exempt, public interest organization established in December 1971 by local governments and their public interest groups. Its purpose is to help local governments improve services and cut costs through practical use of applied science and technology. PTI sponsors the nation's largest local government cooperative research, development, and technology transfer program.

PTI's Board of Directors consists of the executive directors of the International City Management Association and the National League of Cities, plus city managers and elected officials from across the United States.

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Foreword

Many cities in the United States are continuing to struggle against deteriorating downtown business districts and residential neighborhoods. Better management of pedestrian and vehicle circulation can help revive decayed urban cores, as experiences in several American and European cities have shown.

This report shows how five European cities are using innovations in transportation and pedestrian movement as major tools in downtown improvement. Each of these cities has taken a different approach toward the same goal—better access to and mobility within the center city areas.

It is important to find new solutions to old problems, and these European cities provide some excellent, new ideas. Because we think that you will find these examples stimulating and useful, the Urban Mass Transportation Administration asked the Urban Consortium for Technology Initiatives, working through the staff of Public Technology, Inc., to make them available for use by local officials and citizens who are interested in using transportation as an instrument of urban revitalization.

Preface

Center City Environment and Transportation: Transportation Innovations In Five European Cities is one of a series of studies concerned with helping American cities provide better access to and mobility within their downtown centers prepared by Public Technology, Inc. for the Urban Mass Transportation Administration, Office of Policy, Budget, and Program Development, U.S. Department of Transportation. The first volume in this series, *Center City Environment and Transportation: Local Government Solutions,* was published in 1977. This volume, the second in the series, will be followed by a companion study dealing with a number of American center city transportation and circulation projects.

The material in this volume is derived primarily from a larger work, *Transportation Systems Management in Europe* by Francis E.K. Britton and associates of EcoPlan International. Additional information comes from *Innovations in Urban Transportation in Europe and Their Transferability to the United States* (UMTA-MA-06-0049-80-5) by Howard Simkowitz. We appreciate the cooperation of Mr. Britton and Mr. Simkowitz during the development of this report.

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Introduction

In September, 1975, the Urban Mass Transportation Administration and the Federal Highway Administration issued joint regulations that require that metropolitan areas develop Transportation System Management (TSM) plans. The regulations state that:

> The objective of urban transportation system management is to coordinate these individual elements (automobile, public transit, pedestrians, and bicycles) through operating, regulatory, and service policies so as to achieve maximum efficiency and productivity for the system as a whole.[1]

Although TSM as a formally stated concept is not used in Europe, many methods for coordinating and making more productive use of transportation facilities have been in place there for many years. In an effort to aid cities throughout the United States in identifying and implementing TSM measures, UMTA has funded several studies of similar measures taken in European cities within the past few years. The five studies included in this publication each provide a particularly good example of planning for a variety of transportation modes in contexts not dissimilar to those of many U.S. cities. In addition, each of the cities has taken an exemplary approach to resolving one or more traffic management problems common to cities with large numbers of automobiles.

London and Paris are examples of major urban areas that approached similar transportation problems from opposite points of view. London adopted its policies under severe financial constraints, while Paris benefited from a firmer financial basis, in the form of a payroll tax, in coordinating and expanding its system.

Gothenburg and Delft each have pioneered a different traffic management concept giving increased importance to pedestrians that has aroused international interest: the traffic cell in Gothenburg, and the woonerf in Delft. Caen, on the other hand, is included because in size and configuration it is very similar to many smaller U.S. cities, and because it has taken coordinated, gradual steps to improve and unify its transportation system. The approaches taken in each of these cities collectively suggest the range of possibilities available under transportation system management.

Notwithstanding the tremendous variations in size, land area, population density, and urban form, there are very real similarities in the way that transportation has developed in both U.S. and European cities since World War II. The private automobile has become the desired, and

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[1] U.S. Department of Transportation, Federal Highway Administration and Urban Mass Transportation Administration, "Transportation Improvement Program." *Federal Register,* Vol. 40, No. 181 (September 17, 1975), p. 42979.

dominant, transportation mode. Roads and highways have been planned and built between and within cities with emphasis on accommodating the car rather than the pedestrian. Parking garages have proliferated in city centers. Europeans and Americans alike have held love affairs with their cars. Although some existing public transportation systems were upgraded or rebuilt after the war, gradual decline was the norm, especially in the United States, as auto ownership climbed.

It was not until the late 1960's or early 1970's that conscious decisions were made in many European and some U.S. cities to place greater emphasis upon the development of public transportation and less emphasis on automobile-oriented construction. European cities acted a little sooner than U.S. cities because with more limited land and energy resources they were more sensitive to the problems of congestion and pollution. Consequently, some of the European efforts to relate land use to transportation planning, maximize use of public transportation facilities, and thus conserve energy are more fully developed than counterpart efforts in the United States.

Now, however, in 1980, European and U.S. cities are grappling with many of the same problems. Soaring energy costs have increased governmental awareness throughout the western world of the need to arrest the decline of city centers. Low density suburban sprawl is increasingly viewed as profligate from an energy standpoint and environmentally unsound. Apprehension at the rising cost of fuel and growing transit deficits is felt in every developed country. There is, however, no single European formula for successful traffic management-transportation-land use coordination. London has a single agency responsible for both land use and transportation planning; Miami-Dade County, Florida is an example of a similar unified planning structure in the U.S. In Caen, coordinated planning came about as a result of the election of new officials, concerted local effort, encouragement by the French government, and great patience; such a mixture could be equally successful in any American city.

Cities on both sides of the Atlantic are seeking solutions to urban transportation problems. Indeed, many of the European innovations described herein have been tried in one or more American cities. All of them could be replicated in appropriately modified form in this country.

TSM Matrix for 5 European Cities

● Outstanding Use ◑ Utilized ○ Not Implemented	Central Paris	Caen	Delft	Gothenburg	Greater London
Population	2,330,000	123,000	90,000	450,000	7,000,000
Land Area (square miles)	40	10	4.3	172	610
Population Density (per square mile)	58,250	12,300	20,930	2,616	11,475
TSM Measures					
Improved Signalling	◑	◑	◑	◑	●
[illegible]e Way S[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Parking Controls	◑	◑	○	◑	●
[illegible]heral Parking Facilities	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Traffic Channelization	◑	○	◑	●	●
[illegible] Zone (Traffic Cells)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CBD Pedestrian Zones	◑	●	○	●	◑
[illegible]served Lanes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HOV Signal Preemption	○	◑	●	●	○
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Integrated Fare Policies	●	◑	◑	●	○
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Payroll Tax	●	●	○	○	○


20 Gallieni

Paris, France

Severe traffic congestion in the early 1960's, with consequent public transit delays and financial costs, caused Paris to set a transportation goal of supplying public transportation in direct response to mobility requirements.

The layout of Paris is a traffic planner's nightmare. Except for its famous broad boulevards, most of the City's streets are narrow and winding, having been laid out in the 18th and early 19th century. The Seine River flows through the center of the City, forming a traffic barrier in itself; it is crossed by 34 bridges! Metropolitan Paris has a population of 10 million and a land area, including the City, inner and outer suburbs, and five new towns on the outskirts, of 12,000 square kilometers (4,600 square miles). The central core of Paris is very densely settled with a population density of 58,250 people per square mile.

Paris transportation policy, prior to the early 1970's, was intended to accommodate increased automobile use. A ring road, new underpasses, underground parking facilities, and a mid-town expressway were built. The mass transit system suffered from obsolete equipment, a profusion of independent and uncoordinated private and public operators, poorly coordinated services, declining demand, and official reluctance to make the necessary improvements. Much of the rail system had been in place since 1915 and required extensive rejuvenation.

CITY: PARIS

Population Per Car: 3.5

City Population: 2.3 million
Regional Population: 10.0 million
City Area: 40.3 Square miles
Regional Area: 4,610 Square miles

City Population Density per square mile: 58,250

● Outstanding Use
◐ Utilized
○ Not Implemented

TSM Measures	
Improved Signalling	◐
One Way Streets	◐
Parking Controls	◐
Peripheral Parking Facilities	◐
Traffic Channelization	◐
Auto Restricted Zone (Traffic Cells)	○
CBD Pedestrian Zones	◐
HOV Reserved Lanes	●
HOV Signal Preemption	○
Bikeways	○
Integrated Fare Policies	●
Modal Coordination	●
Payroll Tax	●

In the early 1970's a major transportation policy reversal occurred, spurred by the realization that the aesthetic and financial costs of accommodating the rapidly increasing number of automobiles would be prohibitive. Plans to build a second mid-town highway were abandoned. Efforts to upgrade, extend, and increase the capacity of the transit system were intensified. Paris officials began to coordinate transportation management measures to speed traffic flow and give priority to public transit. As a result, an extensive, interconnecting high speed system (primarily heavy rail) has been carefully integrated with shorter distance surface transport (mainly buses) to form one of the world's most convenient urban transportation systems. Today, in the center city and along major suburban-center city axes, where the system works most effectively, 60% of all trips are taken by public carriers. There is less satisfaction with the system's performance elsewhere, however, particularly in the outlying areas.

The development in 1972 of a city traffic plan (mandated by the French government) provided the framework for the improved traffic flow, transit priority techniques, and transit improvement and coordination methods which Paris now enjoys. The plan also limits the number of highways and roads that can enter the City from the suburbs although a ring road was completed around the City in 1973. Auto use continues to grow in Paris, but so does public transportation use.

Traffic Flow Improvements

Three specific measures have been taken to improve traffic flow, particularly in the center city.

- Ramp signals or meters are used in some locations to control peak hour flow on major motorways.
- Size restrictions were placed on trucks and delivery vehicles in 1971, in the central city where traffic congestion is severe. This has resulted in the use of smaller delivery vehicles, better running time, increased use of containers, and break-down and reconsolidation of loadings at peripheral terminals, with some attendant easing of congestion.
- Parking control policies are, however, not highly developed, but police are beginning to attempt to reduce the number of cars illegally parked on the narrow streets of downtown Paris. In 1979, a residential and short-term parking ticket scheme was introduced to encourage use of off-street parking facilities. The scheme covers 9,500 of the capital's 42,000 metered spaces. Tickets are sold from automatic vending machines to residents for $2 a day; short-term visitors pay $1.20 for a two-hour ticket. Those who own garages now park their cars in the garage rather than pay to park on the street. The scheme is working well and has been favorably received.

Existing park and ride lots at the City's periphery are being actively promoted, and new ones are being constructed.

Bus Preferential Treatment

Paris has made extensive use of bus preferential treatment measures. With the support of local government units, reserved lanes have been established on 95 kilometers (59 miles) of city routes and 31 kilometers (19 miles) of suburban routes. Twenty-five percent are contraflow lanes, while the remaining seventy-five percent are concurrent flow. They are shared by taxis, ambulances, police, and other emergency vehicles.

Reserved lanes are set off by painted lines; no physical barriers are used. The criteria for establishing reserved lanes are a bus volume of at least one bus every three minutes and a minimum roadway width of 14 meters (45 feet) or nine meters (30 feet) for one-way streets. The guidelines state that any given bus lane should not carry more than 100 vehicles an hour. If this volume is exceeded, other measures, such as a separate busway, are called for.

Concurrent Flow Bus Lane in Paris

Enforcement of the parking ban in the concurrent flow lanes is a constant necessity. A policy of stiff fines and strict surveillance was successfully implemented in 1979. For several months, buses using the lanes carried prominent red signs asking motorists to obey the reserved lanes. Bus drivers can issue traffic tickets for illegal parking. Enforcement in the contraflow lanes is not such a serious problem; they are painted red and are clearly marked.

The City's principal public transit operator, the RATP (Regie Autonome des Transports Parisiens), estimates that, for buses using the reserved lanes, there have been:

- a 5% increase in bus speed.
- a 37% decrease in bus delays.
- an 18% increase in passengers carried.
- a reduction in annual bus accidents from nine to one and one-half per kilometer of bus route in the reserved lanes.

Paris: Sign on Front of Bus Asking Motorists to Observe Reserved Bus Lanes

Seven "lignes pilotes," special bus routes between major passenger generators emphasizing speed and service, have been established on some reserved lanes. The number of passengers on the "lignes pilotes" doubled between their inception in 1973 and 1978.

A new 5 kilometer (3.1 mile) busway project, consisting of a separate exclusive bus lane paralleling a heavily traveled suburban arterial to the south of the City, is currently under construction.

Some bus traffic signal preemption measures are in use in the Paris region. A microwave signal from an approaching bus to the traffic light can hold the green signal for up to one minute longer than the normal phase or decrease the duration of the red light. Signal measures have helped increase bus speed and service regularity.

In a similar experiment, six consecutive traffic lights in the city center and 44 buses have been equipped with special microwave equipment programmed to operate during inbound and outbound peak periods. This has reduced bus trip times by more than 5%.

Transit Improvements

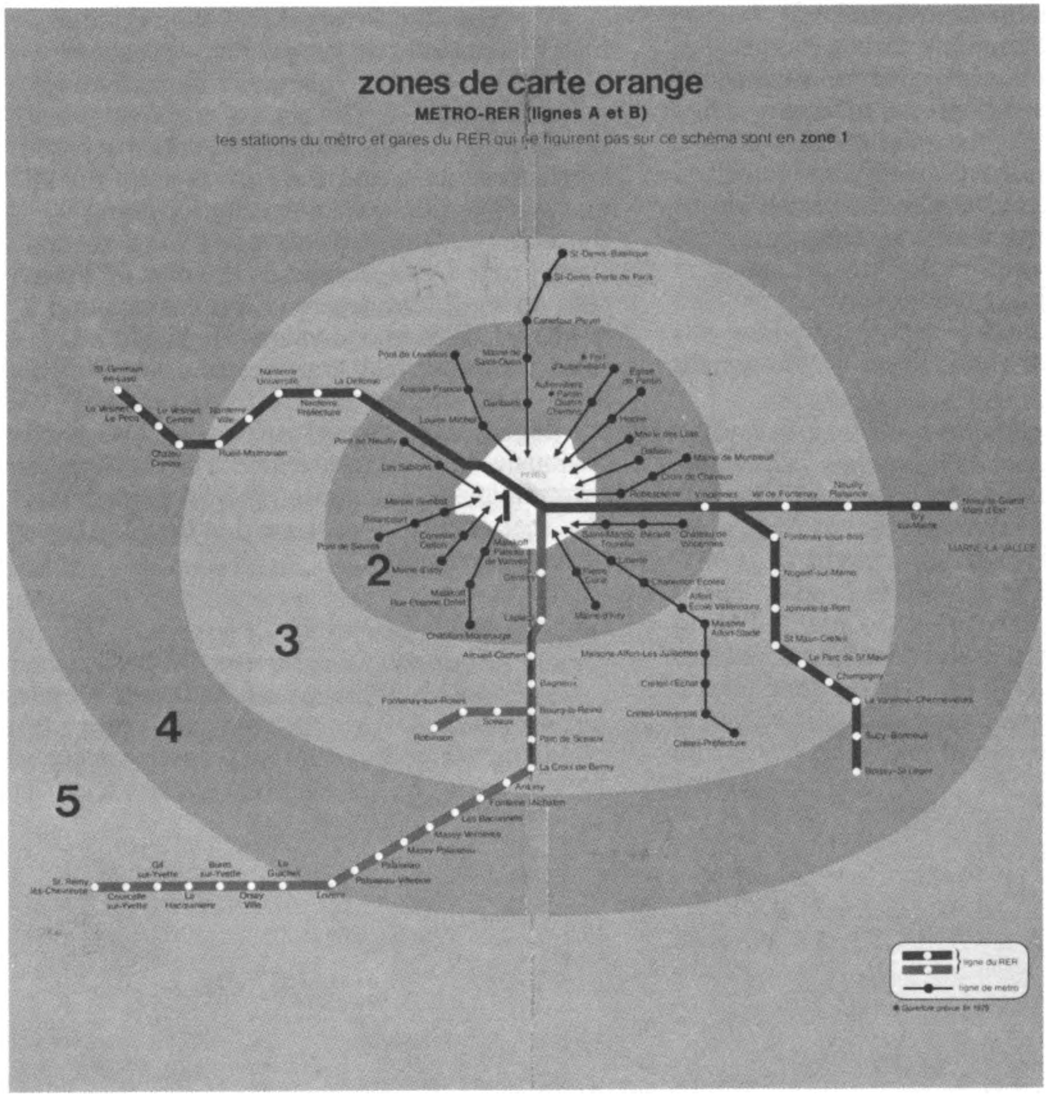
Because three separate operating agencies provide transit service in the Paris region, a high degree of interagency cooperation has been essential to bring about transit improvements and service and fare integration.

Fare Reform

An especially significant reform was a complete revision of the complicated and confusing fare structure. In 1971 there were over 400 different fares depending upon travel mode and trip length.

The major modifications to the fare structure include:

- a flat fare on the Metro, with first and second class tickets.
- a unified zonal fare structure for the two major suburban railway systems.
- a zonal fare structure on RATP bus lines.
- an incremental rate based on distance travelled outside Paris.
- free inter-modal transfer within a single zone.



Paris: Each Concentric Circle Represents a Zone Requiring Additional Fare

Paris: *Carte Orange*

Carte Orange

The key feature in minimizing the complexities of the region's fare structure, however, has been the introduction of the *Carte Orange*. This is a single, machine readable, magnetic ticket good on all bus, Metro, and commuter rail lines. Cards are available for either first or second-class and are sold either by the month or the year.

The Paris region has been divided into five concentric geographic transport zones. There is a unique price for travel within each zone. The cost of a *Carte Orange* is a function of the number of zones crossed by the traveller, and the card is valid for all means of public transportation crossing those zones. The monthly price for a second class *Carte Orange* valid in the city of Paris plus a ring 2 kilometers (1.3 miles) around it is $13.50. This is equivalent to 45 Metro rides including free transfer to other Metro lines or 22–45 bus rides with no transfer privileges. The price of the *Carte Orange* has obviously been set quite low. The consequent revenue losses are made up by a payroll tax. The cost of a first-class card is double that of a second-class card.

The *Carte Orange* program was launched in July 1975, accompanied by a massive program of public information. It was an immediate and immense success. More than one million passes were being sold monthly by the end of the first year. Current monthly sales total approximately one and one-half million. There are 1800 card sale outlets.

A public survey indicates that people feel the *Carte Orange* has simplified travel and improved access to different areas of the city. Users of the card feel that for the entire month (or year) travel is easier and less expensive.

Fare collection techniques vary. The Metro system uses magnetic ticket readers, and the one-man buses have automatic ticket cancelling machines for single tickets. Drivers check the *Carte Orange* visually. The mechanized devices permit substantial labor savings and allow better information flow and control, as they can store information for later retrieval or feed it directly into the system's central computer.

Marketing and Public Information

The RATP has an ongoing intensive public information program. Public attention is captured by free concerts and other cultural and educational events in both Metro and commuter railroad stations, free travel at the opening of new interconnections, and promotional campaigns. Public information stands dispensing schedules, route and fare information, and other consumer information are located throughout the region served by the public transport system. These are supplemented by a telephone information center.

Stations have been renovated by adding escalators, better lighting, moving sidewalks, and small concessions. Bus shelters have been placed at many stops at no cost to the government by a contractor who sells advertising space on one of the panels. The shelters are of high quality and provide maps of the network, directional markers, and schedule notices. Many contain a telephone. Where no shelter exists, a panel attached to a bus stop pole includes a map and gives schedule, ticket sale, and fare information.

System Integration

Physical and operational integration of the different modes of the transportation system has proceeded concurrently with these improvements. Significant first steps include the opening of new stations linking extensions of the Metro to suburban rail lines. Bus terminals and park and ride lots will eventually adjoin these facilities. The rail systems are moving towards the use of interchangeable rolling stock, and common maintenance facilities and signalling systems. By 1984, system-wide coordination of equipment, routing, and scheduling should be complete.

Financing

The strategy of increasing transit use through extensive system improvements has been expensive. The capital costs of expansion and modernization were $500 million in 1975 alone. Ridership has increased significantly, but farebox revenues cover only 33% of operating costs. Operating and capital funds come from farebox revenue, direct grants from the French government, and from a payroll tax instituted in 1971.

Payroll Tax

The payroll tax, two percent of gross salaries, is levied on firms with nine or more employees in the Paris region. Businesses in the suburban new towns are exempted to encourage development and employment growth. The tax currently generates $570 million a year or 22% of total operating and capital expenditures for public transportation in the Paris region.

To reduce administrative costs, the Social Security Administration collects the tax. A separate coordinating agency, the STP, distributes revenues from the tax to the operating agencies and to local authorities for transit improvements. There is no set distribution formula.

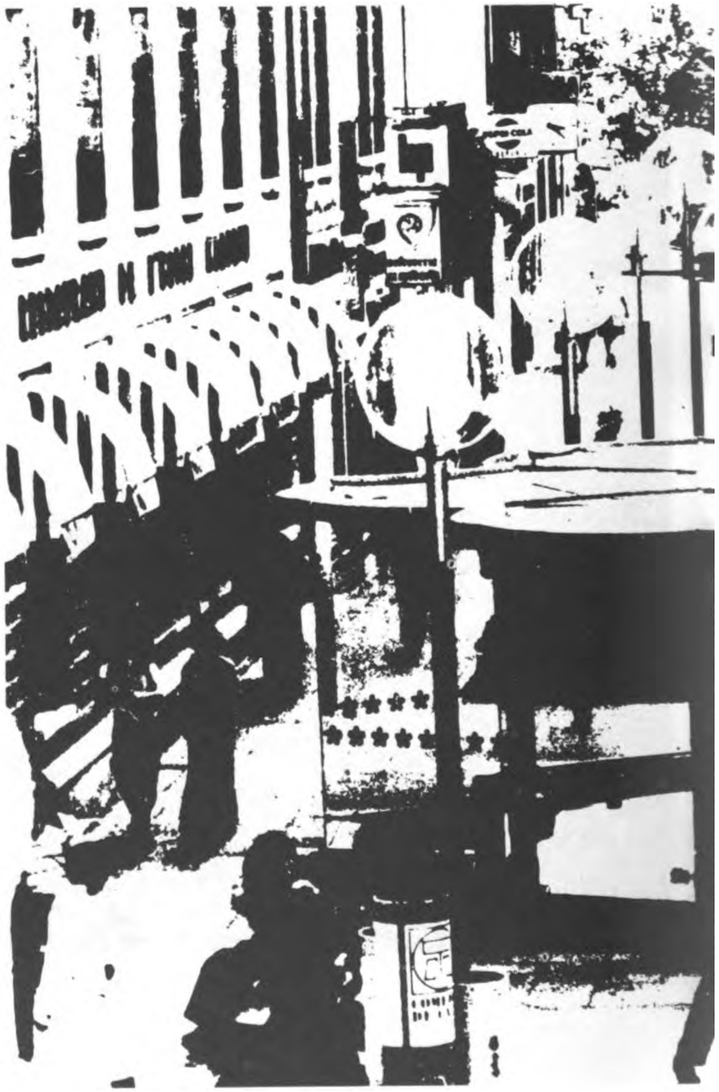
Governmental Structure

The complex relationships among the multitude of governing bodies that have an impact on the Paris Transportation System rival the most complicated American regional organizational structures.

The Metro, city buses, and some commuter rail lines are run by one agency (RATP), and suburban buses by another private umbrella agency for 54 bus companies. In addition, the national government operates a large share of the commuter rail lines serving Paris. The major unifying factor is the strong role the French government has taken in Parisian matters. Both the head of the national railways and the head of the RATP are appointed by the national government. The STP (Parisian Transport Syndicate) was created by the national government, which maintains control over it, to oversee coordination and financing for transportation in the Paris region. Major policy matters are controlled by these organizations, while such matters as parking and enforcement are the responsibility of the many local governments within the Paris region.

Paris is a large, complex city where all modes of transportation have been effectively coordinated and the public transportation system works well. Successful measures such as the *Carte Orange* and the payroll tax are being copied elsewhere in France.

Metro passenger inserts magnetic portion of *Carte Orange* into fare gate



Caen, France

Caen, a city where the automobile is the primary means of transportation, has developed a set of policies that benefits all forms of transportation.

A city of 123,000, Caen is located near the English Channel about 200 kilometers (125 miles) west of Paris. An important agricultural center before World War II, Caen is now an active commercial center, having attracted branches of three of France's leading manufacturers (buses, automobiles, and household appliances) in the 1950's and 1960's to join Caen's reopened steel-works. The city was badly devastated during World War II, and 80% of its buildings had to be reconstructed in the two decades following the war. The city proper consists of a built-up area of 25 square kilometers (9.5 square miles) with a small core area containing historical buildings, shops, business places, small winding streets, and pedestrian areas. Reconstruction plans emphasized planned, low density development. Building height was limited to five or six stories, and design standards were imposed so that the new buildings would be compatible with the older structures. During the past decade, emphasis has been placed on developing pedestrian facilities, providing good public transit access, and facilitating traffic movement through parking restraints and one-way streets.

CITY: CAEN

City Population: 123,000
Population Regional Population: 200,000
Per Car: City 3 City Area: 10 Square miles
(Regional 4) Regional Area: 1,140 Square miles
City Population Density per square mile: 12,300

● Outstanding Use
◑ Utilized
○ Not Implemented

TSM Measures	
Improved Signalling	◑
One Way Streets	◑
Parking Controls	◑
Peripheral Parking Facilities	◑
Traffic Channelization	◑
Auto Restricted Zone (Traffic Cells)	○
CBD Pedestrian Zones	●
HOV Reserved Lanes	◑
HOV Signal Preemption	◑
Bikeways	●
Integrated Fare Policies	◑
Modal Coordination	●
Payroll Tax	●

Caen is comparable to many American cities in that the primary mode of transportation is the automobile, and no single institution has overall responsibility for transportation matters.

In 1970, a law was passed by the French government requiring each city to prepare an urban master plan. In that same year a new mayor took office in Caen, and new directors were appointed to head both the city transit agency and the Department of Public Works. City officials established a policy of developing public transit as the preferred alternative to the automobile for work trips. Their strategy included traffic flow improvement, parking restrictions, creation of pedestrian zones, and encouragement of bicycles and mopeds (which then accounted for 11% of all travel).

In 1972, French cities were also required by the national government to develop a separate traffic plan. Caen was awarded the status of pilot city (*Ville Pilote*) based on these plans and became eligible for a State subsidy of two-thirds of all costs of projects related to traffic flow and one-half of costs of other public works. By the end of 1973, Caen's traffic plan had been approved, and the city began to undertake the planned improvements. The final major step was the creation of a regional Transport Syndicate and establishment of a uniform fare structure for the entire Caen region.

The policy goals established in 1970 are being realized. In 1975, the modal split for total daily trips was: automobile, 75%; transit, 14%; and two-wheel vehicles, 11%. The respective percentages in 1980 are expected to be 71%, 19%, and 10%, an increase of 36% for transit in five years. Traffic flow through the city center has been improved, the central core area has been made an attractive place for pedestrians and tourists, and the decline in transit ridership has been reversed.

Pedestrian Center

Caen was an early leader among French cities in making improvements to the pedestrian environment. The City's central commercial area first was closed to traffic and linked to the historic district. The pedestrian area was extended in two stages to neighboring streets. Street furniture, such as benches and kiosks, decorative lighting, and trees and planters, has been added to the repaved streets. Parking facilities for bicycles and mopeds are provided at all entry points to the pedestrian zone. Delivery vehicles may enter the zone only between 6:00 and 10:00 a.m. and must use lanes reserved for them.

By the end of 1977, the project included seven streets. Total cost was $550,000, much of which was covered by State subsidies as this was a pilot project.

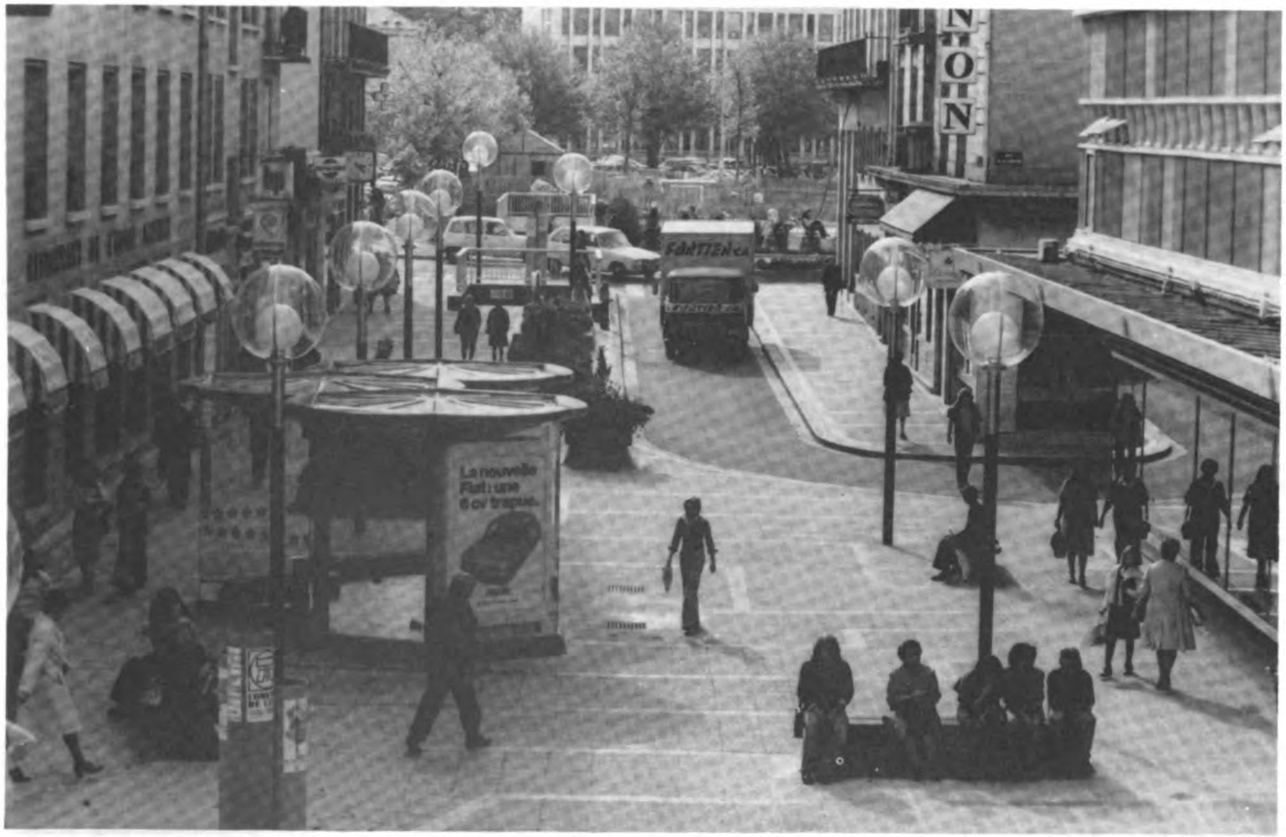
The pedestrian zone has enhanced safety, proven highly popular with the citizens, and improved commercial activity. A recent survey showed that about 50,000 pedestrians visit the zone during the course of a single day. Over one third of the persons surveyed within the zone had no specific destination but simply enjoyed walking in an area that is both pleasant and safe.

Transit Improvements

In accordance with its master plan and traffic plan, Caen instituted the following transit improvements in 1972:

- New vehicles were purchased and older vehicles were modernized with an emphasis on greater passenger comfort, including carpeting on floors and cloth seat covers. Expansion and modernization of the bus fleet is continuing so that by 1981, the average age of the buses in the fleet will have declined to four years.
- Eight existing radial bus routes were reorganized into four through routes, each of which was given a name associated with the area's historical origins. Small buses were introduced on some routes. Some exclusive bus lanes and signal preemption programs are in use, and more are planned.
- An aggressive marketing strategy has been pursued. A key element has been an increase in both bus frequency and route coverage. Bus headways are now 5 to 10 minutes on the more important routes.
- Fare simplification is a vital element in Caen's transit marketing strategy. Weekly and monthly passes that benefit users by lowering fares have been introduced. Half-price tickets may be purchased by senior citizens, students under 20, and all persons under 17. Certain low income senior citizens and

Caen: Pedestrian Area Development—
Before and After



unemployed persons may travel free with a special identity card which is available from the Mayor's office.

- Between 1970 and 1976, the number of bus shelters increased from 4 to 109. The shelters, very useful in Caen's wet climate, are installed and maintained by a private contractor at no public cost.
- In 1977 a Transport Syndicate linking the city with its surrounding suburbs was formed, and a uniform fare structure was established. As a matter of public policy, fares have been kept relatively low. In addition to farebox revenue and grants from the central government, Caen relies on a payroll tax similar to the one in effect in Paris to finance its public transportation system.

Traffic Flow

A 1972 survey of downtown Caen showed acute congestion at traffic intersections during peak periods. This prompted local authorities to develop a policy that would improve traffic flow, increase public safety, and enhance the quality of life in the city.

A total of 40 kilometers (25 miles) of two-way streets were converted to one-way pairs to speed through traffic. Complete public adjustment to the changes took six months although they were preceded by an extensive public information program.

To complement the one-way streets, an improved signal system controlled from a central computer was installed at intersections throughout the downtown area. The Green Wave System, utilizing 10 different signal patterns, is credited with speeding through traffic and reducing trip time.

The central control post operates 24 hours a day. Using a system including a small computer, television cameras, a radiotelephone, and a large visual display showing traffic movement, controllers can monitor traffic volume, speed, direction, and mode; detect emergency situations (accidents and traffic jams); and give priority treatment to emergency vehicles when necessary.

Additionally, the computer can provide information on bus location that enables the public transit operator to coordinate the operation of those buses equipped with radiotelephone equipment.

The capital cost of the control room was $600,000. Annual maintenance costs are about $60,000.

Traffic is effectively channeled in and around the city by clear, frequent marking of road surfaces and the installation of new road signs and directional arrows.

Parking controls have been introduced to facilitate vehicle flow and to encourage motorists to switch to public transit. Outside the pedestrian zone, the exclusive

Caen: Traffic Channelization and Street Marking—
Before and After

bus lanes are the only places where parking has been totally prohibited. Parking rates at street meters and at a central parking garage are set to encourage shoppers and discourage commuters. Although the demand for parking spaces is expected to increase, the long-term plan calls for a reduction in downtown parking spaces from 9,394 to 9,195 by 1985. Several new parking lots on the periphery of downtown are planned. They will be connected to downtown centers by small buses.

Bicycle Paths

The final component in Caen's coordinated downtown circulation plan is a series of bicycle and moped paths. Existing paths are being extended, and new ones are being built. Three separate bikeways, totalling 6.2 kilometers (almost 4 miles) in length are planned. One of these will be adjacent to existing sidewalks, a second will be part of the sidewalk but separated from pedestrian traffic by a painted divider, and the third will be marked off by a painted band on the roads. These improvements are not expected to create a major shift in transportation mode, but will make cycling safer and more convenient and help retain the present 10–11% mode share. This percentage is especially impressive since one half of the city is hilly, and the climate is damp.

Urban crowding and traffic congestion led Delft citizens and planners to create a novel means of sharing limited city space between people and cars—the woonerf.

Delft, founded in the 12th century, is located halfway between The Hague and Rotterdam and has a population of 90,000. The city itself is relatively small, and lies between a major motorway on one side and a railway line on another. It is bisected by one major canal and laced with other smaller canals. Many of these canals are crossed by narrow, humpbacked bridges. Near the city center, the population density is quite high, but within one kilometer (.6 mile), suburban style housing constructed after World War II is prevalent. As the city has expanded in the last two decades, there has been an increase in automobile ownership and a concurrent decrease in bus and bicycle use. The bicycle, which had been the dominant transportation mode, still accounts for many trips to and within the city center. The average bicycle trip is about 10 minutes; the longest trip from periphery to city center takes less than 30 minutes. Though many residents commute to The Hague or Rotterdam, Delft is an attraction in its own right. Over 1.5 million tourists visit the city annually to see its historic center and to shop. Local industries are healthy, and Delft serves as a shopping and work center for towns within a 20 kilometer (12 mile) radius.

CITY: DELFT

Population Per Car: 3.5

City Population: 90,000
Regional Population:
City Area: 4.3 Square miles
Regional Area:

City Population Density per square mile: 20,930

● Outstanding Use
◑ Utilized
○ Not Implemented

TSM Measures	
Improved Signalling	◑
One Way Streets	◑
Parking Controls	●
Peripheral Parking Facilities	◑
Traffic Channelization	◑
Auto Restricted Zone (Traffic Cells)	●
CBD Pedestrian Zones	●
HOV Reserved Lanes	◑
HOV Signal Preemption	●
Bikeways	●
Integrated Fare Policies	◑
Modal Coordination	◑
Payroll Tax	○

Until the mid-1960's, Delft officials and planners pursued policies that favored the automobile. Since that time, after a citizens' revolt against a proposed parking garage in the historic city center, planning has been based upon two assumptions: (1) the size of Delft is such that walking and cycling should be the preferred modes, and (2) increasing automobile use would lead to serious congestion in the city center. The principal outgrowth of this policy has been the development of one of the most widely admired methods of living with and managing the automobile in modern urban neighborhoods—the woonerf. (The literal translation of woonerf is *living yard.* The term describes an extension of living or play space near a residence or business into what had formerly been a street designed primarily for use by cars.)

Woonerf design is premised upon two assumptions that can be applicable to any urban setting, irrespective of the size of the city or its age:

> A street is valuable public space and, as such, should be shared by all users. Streets, which in many cities occupy over 20% of the total land area, may be altered to allow pedestrians, bicycles, children, and leisure seekers to share the space with cars safely and without conflict.
>
> A hierarchy of street uses and types must be established. Streets in primarily residential areas may be extensions of the residents' yards where priority is given to pedestrians and bicycles (a woonerf). Streets in concentrated shopping areas should be primarily for pedestrians. Access and distributor roads to both of these areas are for use primarily by public and private transportation modes; in Delft, in the congested city center, priority on access roads is given to buses.

It should be noted that this first assumption is quite different from the traditional American engineering practice which has been to separate cars from other users of public street space to the maximum extent possible.

Acceptance of these assumptions allows a community to extend the environment of an auto-restricted zone to entire sections of a city while maintaining necessary access for automobiles. Making residential and commercial areas safer and more attractive for pedestrians becomes feasible even in a city where the automobile is the dominant mode.

The Woonerf

The following measures, in various combinations, are taken in implementing a typical woonerf:

- The width of the roadway is narrowed considerably at strategic points; sufficient room for emergency vehicles is always retained.

Street After Construction of a Woonerf

Delft: Residential Street Before Construction of a Woonerf

- Long, low, speed reduction humps are installed, particularly at pedestrian crossings and at intersections.
- Obstacles such as bollards (posts), chicanes (S-curves), and marked parking spaces are installed in the street so that cars have to slow down to maneuver around them.

Woonerf In A Residential Area

Bicycle racks, plantings, and street furniture, including benches and even play objects, are installed on the street surface along with provision for parking for residents.

- Direct sight lines are reduced (by using a serpentine roadway) to under 50 meters (165 feet), so drivers are forced to move very slowly.
- Distinctive street markings are developed to delineate the boundaries of a woonerf and to emphasize the need for low vehicle speeds. No sidewalks or curbs separate vehicles from pedestrians.

Woonerf In A Commercial Area

A woonerf is established only on a street which is not a principal arterial where peak traffic is less than from 100 to 150 vehicles an hour. Any house within a woonerf must be within 300 meters (1000 feet) of the local distributor road network. Streets that carry a high volume of traffic are designated as distributor streets and frequently form the boundaries of a woonerf.

The major problem that has emerged as woonerf construction increases is provision of adequate parking for residents. Providing parking spaces for too many cars detracts from the environmental quality of a woonerf.

Although woonerven have been constructed primarily in residential areas, an area containing schools, shops, and recreation facilities may be designated as a woonerf even if it is crossed by special segregated routes for buses, trains, or service vehicles.

Construction costs for a woonerf vary depending on local desires and resources. Because much of Delft is built on land reclaimed from the sea, the condition of the road sub-surface requires that streets be rebuilt every five years. Consequently, opportunities frequently arise in the natural cycle of road reconstruction for creating or extending a woonerf. Actual costs for constructing a woonerf presently range from 30% to 80% above those for normal street reconstruction depending on local conditions and the elaborateness of the design. Some of the early woonerf construction was very inexpensive since it was carried out by local residents on a do-it-yourself basis. The time needed to plan and complete a woonerf is often longer than that needed for normal street reconstruction, however, because local residents must be involved in the project planning process.

Transit Improvements and Priority Measures

Public transit in Delft also operates in accordance with the concepts of space sharing and use hierarchy. Buses cannot penetrate a woonerf because of the narrowed winding road; however, distributor routes are provided around the woonerf perimeters, so bus service is convenient. In Delft's city center, a variety of car restraint-transit priority schemes have been developed to provide adequate access to the center for pedestrians and bicyclists.

- Transit improvement measures include unlimited use monthly and weekly bus passes, bus service within 300 to 400 meters (less than 1500 feet) of all houses in Delft, 15-minute headways, and quick, easy transfers. All buses are equipped with radios, and a driver can request another bus to hold briefly at a transfer point for an arriving passenger.
- Bus lanes, bus streets, and signal priority measures have been implemented. Separate bus lanes are designated on streets whenever bus volumes warrant them. Where space for separate lanes is inadequate, queue-jumper lanes are provided at intersections. (A queue-jumper lane is a short, extra lane which allows buses to pass cars waiting at intersections.) Presently, bus lanes exist on almost the entire length of the main north-south arterial that brings regional bus service to the edge of the city center. These lanes run over existing, active light rail lines and are shared with public service vehicles and turning private automobiles.
- The Phillips VETAG bus priority signal system used in Delft is a relatively simple one. A bus carries a small, battery powered transponder which answers roadside interrogation as the bus passes over a loop buried in the road surface. When the traffic signal senses that a bus is approaching, it either holds the green for the bus or advances the red so that the bus can proceed through the signal. This system has been successful and has been adopted by neighboring towns. All buses operated by the regional bus company now carry transponders.
- Delft planners have developed and installed a dynamic signal computer which is programmed to provide green lights for buses that are running behind schedule until they have made up lost time and are back on schedule. This program is updated every second and collects data every tenth of a second using detectors buried in the road surface near intersections.

Traffic Cell System

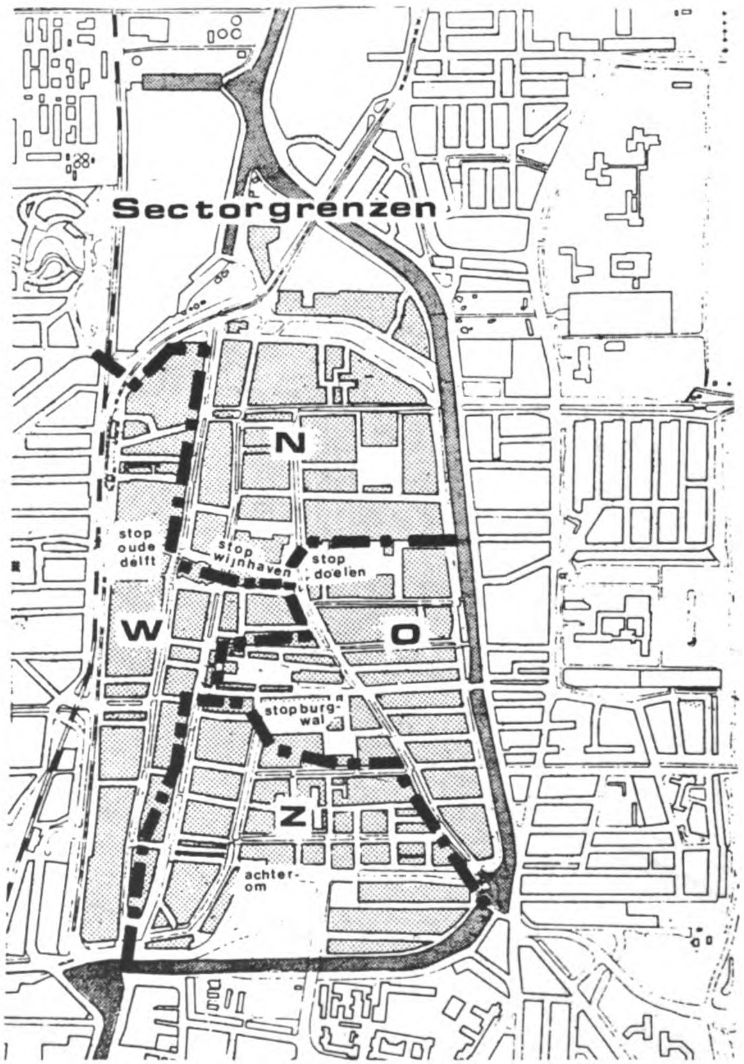
In April 1978, a modified traffic cell system, inspired by the system in Gothenburg, (see page 37), was installed. The objective was to improve the city center by eliminating all through traffic and limiting auto access to that necessary for business and shopping trips within the city center. Public transit service was improved to encourage a shift from private automobiles to buses.

- The city center has been divided into four cells, each of which has only one access point. Canals form natural boundaries for some of the cells. In gradual phases, traffic flow between cells has been restricted by blocking off selected streets, making some streets one-way, and limiting still other streets to transit vehicles. Interzonal traffic must stay at an acceptably low level, or access between cells will be entirely eliminated. Automobile parking is restricted in the center city, but parking is provided in city-operated lots on the periphery.
- Transit support is provided by north-south and east-west bus routes. Special buses that are eight meters (27 feet) long and have high floors are required for the new north-south line in order to maneuver on the street network and cross the narror hump-backed canal bridges. The central government is underwriting the cost of these new vehicles.

The primary beneficiaries of these changes are pedestrians and bicyclists although many of the city center roads are still shared with automobiles.

Bicycle Paths

Special bicycle lanes, either at the edge of the roadway or separated slightly from it, have been constructed. Shortcuts, underpasses for safe passage under busy arterials, and special bridges over canals aid bicyclists. The City also provides numerous, secure bicycle storage facilities. These measures have helped keep the number of bicycle trips at one third of the total trips in and to the center city. In the U.S., Davis and Santa Barbara, California, and Madison, Wisconsin, have made substantial efforts to encourage bicycle use.

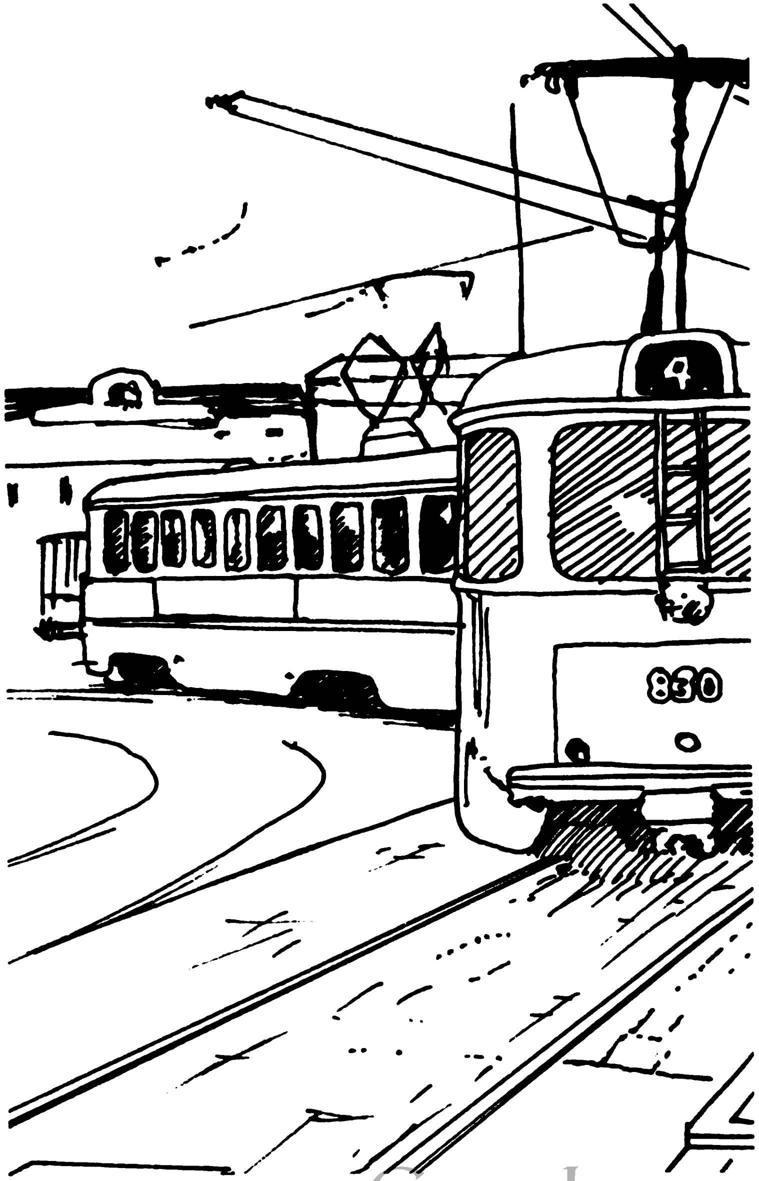


Delft: Central Area Cell System

Governmental Structure

The City of Delft has a mayor and a strong city council form of government. Local transportation plans must be approved by the city council. The Department of Public Works prepares and implements all land use and traffic plans. Delft also has a Public Traffic and Transport Committee that brings together on a monthly basis planners, police officials, social workers, traffic engineers, and concerned citizens, including merchants and environmentalists, to discuss local transportation matters. Public education and local participation and support have been crucial to the successful implementation of the new programs.

Land values have increased in neighborhoods where woonerven have been constructed, and Delft's programs have been so successful in meeting local, visual, safety, and traffic objectives that the central government has decided to promote concepts developed and proved there for extension to other cities in the Netherlands. The woonerf has been widely imitated and adopted in many European cities. In the U.S., the cities of Boston and Cambridge, Massachusetts, are studying the woonerf for possible implementation, and Columbia, South Carolina, is using the woonerf concept in Wheeler Hill, a new residential development now under construction.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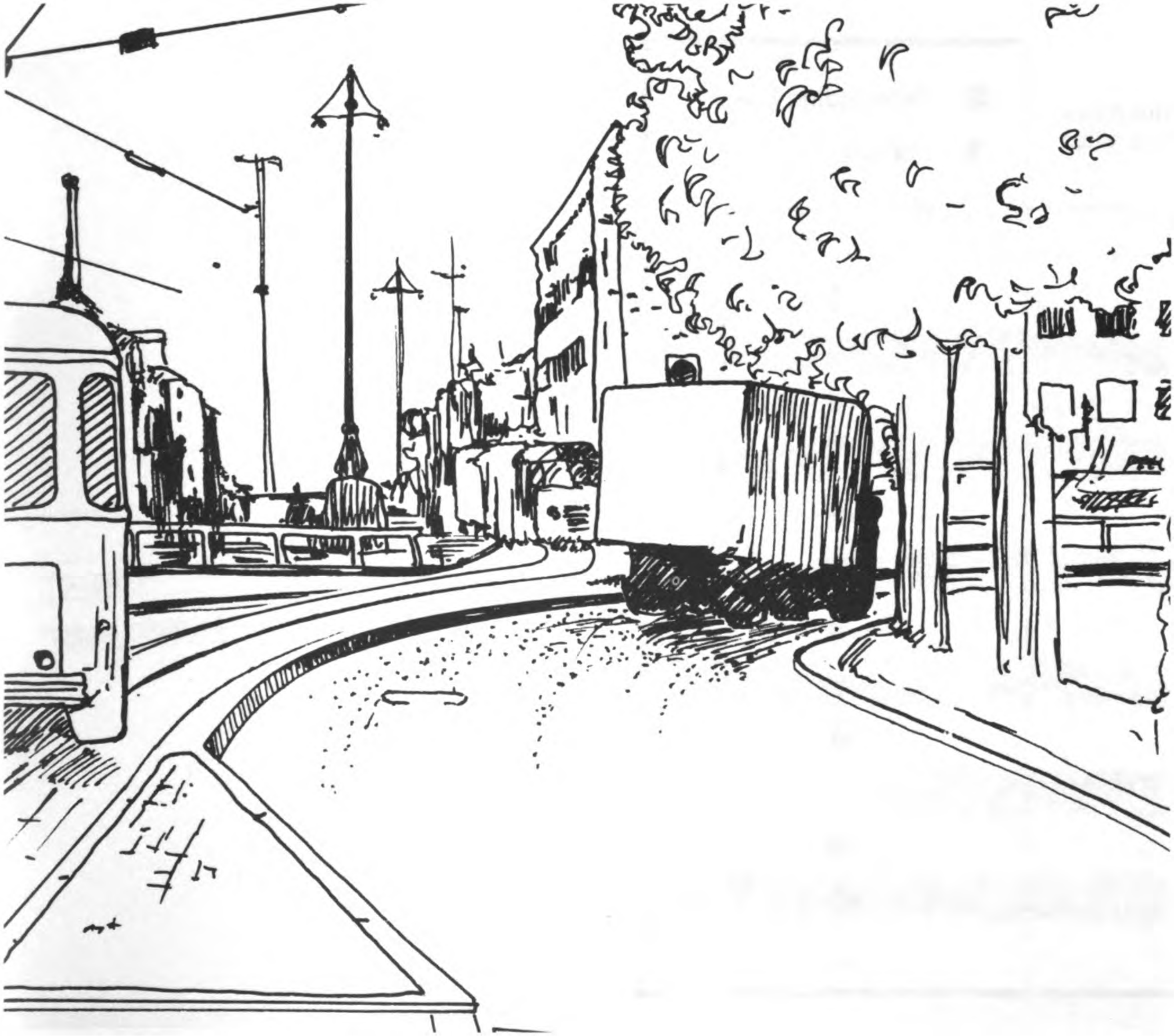


Dividing the city center into traffic cells, imposing traffic restraints, and encircling the area with a ring road proved a successful way to relieve traffic congestion in downtown Gothenburg.

Gothenburg, with a population of 450,000, is the second largest city in Sweden and a large commercial and shipping center. The Gota River cuts through the city forming a barrier between the main city, including its historic center, and the industrial and shipping centers in the northwestern section. The oldest part of the city has a population of 35,000 and includes the present central business district, the city's principal employment center with 65,000 jobs. The northwestern section is the secondary employment center with 25,000 jobs.

The City's basic transportation problem for years was the imbalance between the locations of residential and employment areas, as a consequence of which many work trips were made either to or across the center city, creating congestion and pollution.

In 1964, Gothenburg developed a coordinated plan to preserve the old city center and develop a clearly defined central business district around it. To keep the city center from strangling on commuter automobile traffic, the plan proposed dividing the area into separate traffic cells and prohibiting private vehicles from travelling between cells. A ring road was planned to accommodate commuter and through traffic. Each cell was to have direct access to the ring road.

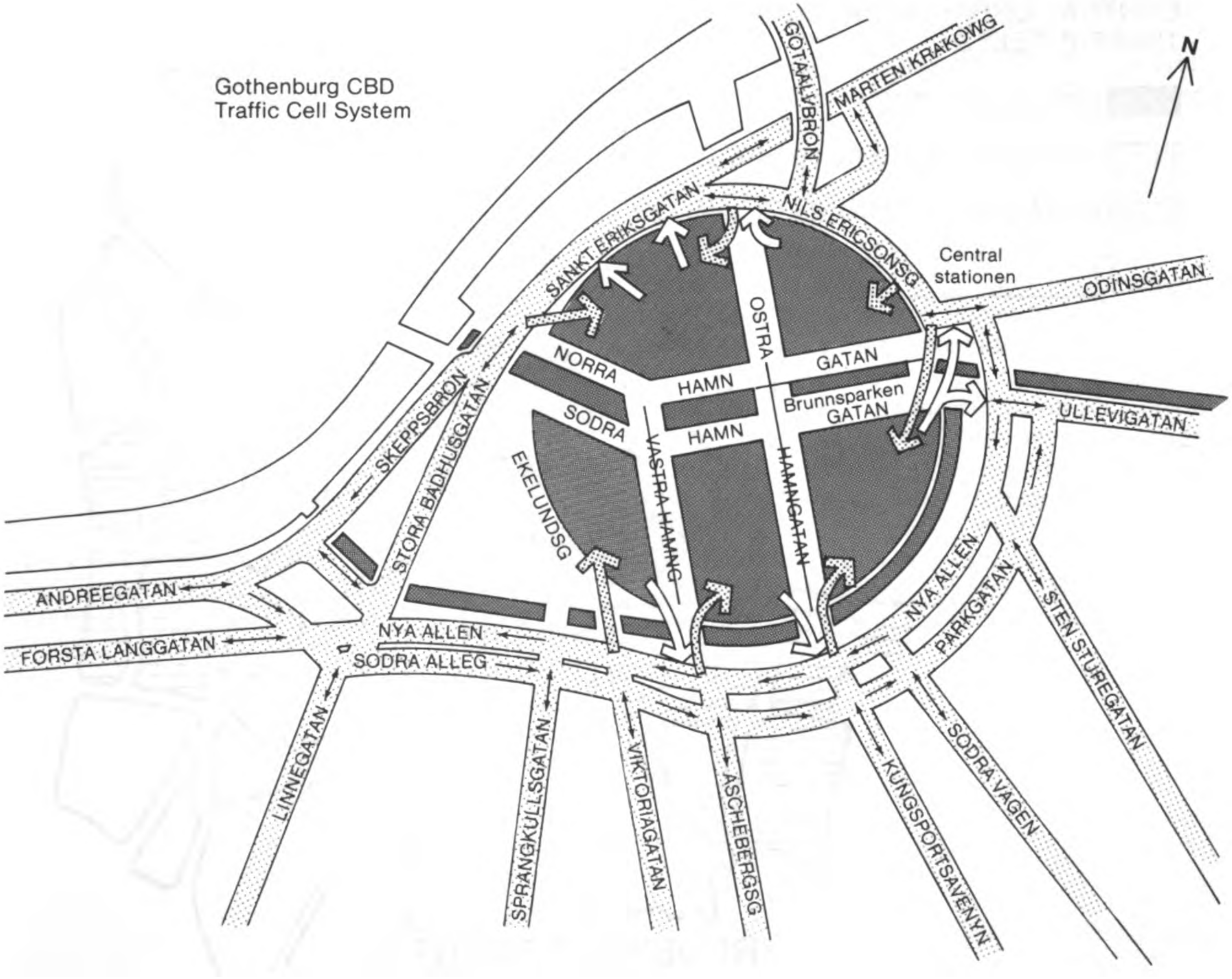
CITY: GOTHENBURG

Population Per Car: 3.9

City Population: 450,000
Reginal Population: 693,000
City Area: 172 Square miles
Regional Area: 1,131 Square miles

City Population Density per square mile: 2,616

TSM Measures	● Outstanding Use ◐ Utilized ○ Not Implemented
Improved Signalling	◐
One Way Streets	◐
Parking Control	◐
Peripheral Parking Facilities	◐
Traffic Channelization	●
Auto Restricted Zone (Traffic Cells)	●
CBD Pedestrian Zones	●
HOV Reserved Lanes	●
HOV Signal Preemption	●
Bikeways	●
Integrated Fare Policies	●
Modal Coordination	●
Payroll Tax	○



Original Traffic Cell Plan (1970)

Traffic Cell System

In 1970, with the ring road in place, the City Planning Board and Traffic Regulation Board, after consultation with the Street Office, the Transport Authority, and the Police, decided to implement the cell plan. They hoped to accomplish the proposed changes rapidly without extensive and expensive modifications.

Central Gothenburg was divided into five separate traffic cells, each encompassing several blocks. The original restrictions were as follows:

- Temporary barriers were placed to regulate traffic flow. Borderlines between cells could be crossed only by emergency and public transit vehicles. Taxis could cross each border at a single point only. Safe, convenient pedestrian crossings between cells were provided; these were shared by bicycles and mopeds.
- Other traffic into, out of, and between cells had to use the adjoining ring road.
- Transit vehicles (buses and trams) followed their regular routes between cells. They were provided with reserved lanes, which often formed the borderlines between cells, and special gates through which to cross cell boundaries.

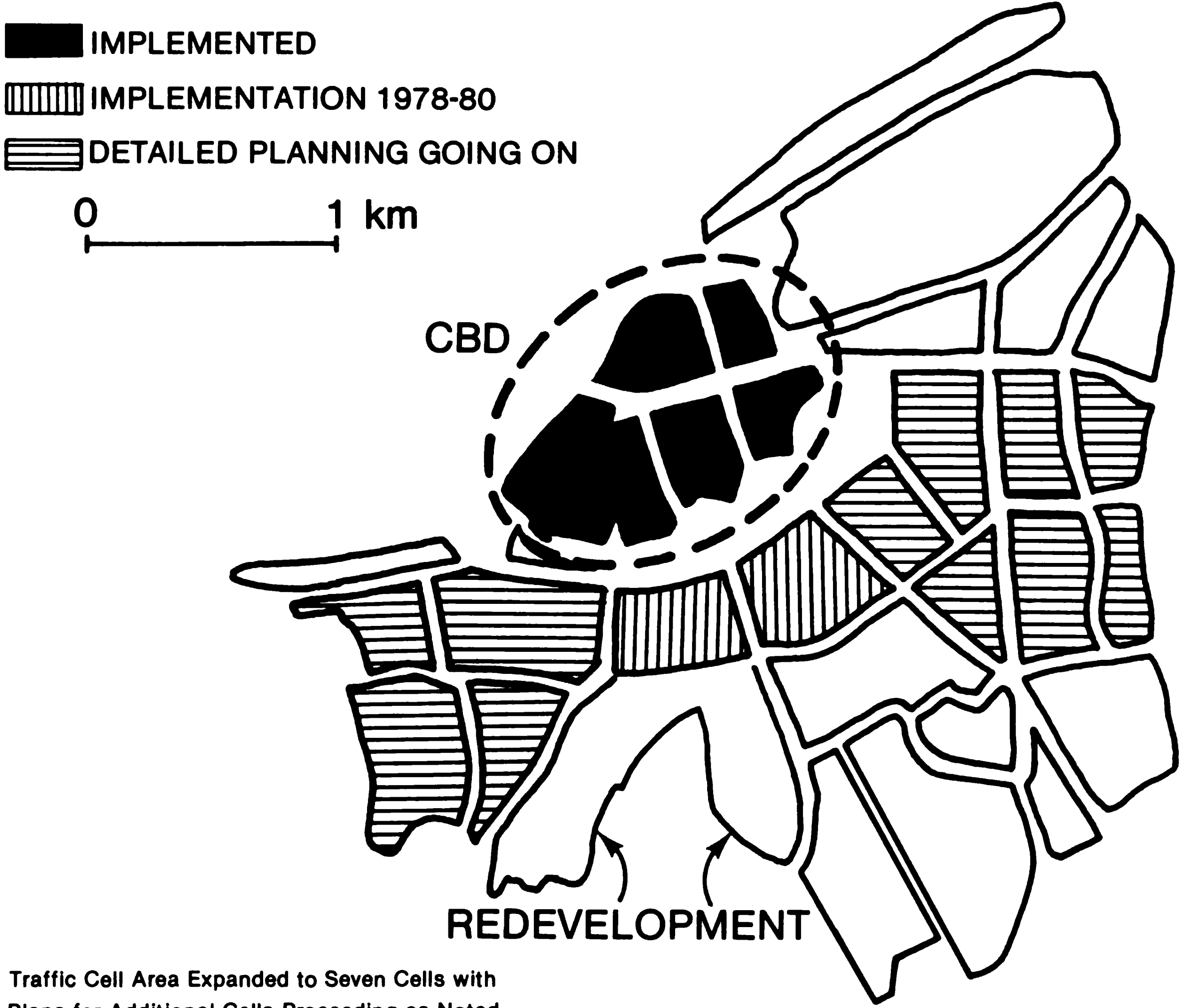
These changes were made permanent in 1973.

Early studies of the cell system indicated that traffic in the area was simply being rerouted. The City's goals of reducing traffic volume and inducing a shift to public transit were not being met. Consequently, a restrictive cell parking policy was developed and put into effect within the cells. At the same time transit improvements were made to make the public system a more attractive transportation alternative (see page 40).

Parking Policy

- Inside a cell there were originally no changes in parking policy and no additional street closures. One-way streets were unaffected, and traffic moved in and out of the cell directly to the ring road. Three months after implementation of the cell system, the parking fee was doubled to 50¢ an hour. The increase, coupled with the other changes, resulted in a 10% decline in the use of municipal parking facilities within the central business district at the end of five months. To reduce automobile volume further, a current proposal that favors residents and visitors would reduce commuter parking from 21,000 to 17,000 spaces and visitor parking from 10,500 to 9,500 spaces. Remaining parking spaces would be relocated from the center towards the periphery of the

CENTRAL URBAN AREA (CUA)
TRAFFIC CELLS



Traffic Cell Area Expanded to Seven Cells with Plans for Additional Cells Proceeding as Noted cell zones. Carpool parking and park and ride lots will be tested to determine their effect on reducing automobile use in the cell area.

Public Relations

Good public information was as important to the success of the cell system in Gothenburg as it would be in any U.S. city.

Two information pamphlets were developed by a local advertising firm. One and one-half months prior to the conversion, 16,000 copies of the first pamphlet were sent to all apartments, offices, shops, and cinemas within the central business district explaining the objectives and procedures of the cell system. Three weeks later, 300,000 copies of the second pamphlet were distributed to every household in the metropolitan area and were widely displayed in public establishments. The second pamphlet provided general information on the cell system and changes in public transit operations and specific route information. Finally, advertisements were placed in the local Gothenburg newspaper for the three days preceding the change, and a special program was aired by both television and radio stations, starting early in the morning of the first day, giving advice on route selections for motorists.

Throughout 1970, special information had been given to and consultations held with various groups, including taxi drivers, police officers, and the Retail Merchants Association. Particular attention was given to the police who, once they were thoroughly informed about the system and how it was supposed to work, were convinced of its advantages. This was particularly important because the police played a key role in the first days after the conversion by directing and informing confused motorists.

Benefits of the Cell System

The specific benefits of the cell system include:

- a markedly improved environment for people living, working, or walking in the central business district. Noise levels on the main shopping street fell to an appreciably lower level (from 74 to 67 decibels). Carbon monoxide levels fell from 65 to 55 parts per million in the traffic free area.
- a 50% reduction in accidents with injuries in the cell areas and a 25% reduction on the ring road during the first five years of the system. An estimated 20 to 30 policemen were thus freed for duty elsewhere.
- an increase in transit ridership and a 40% reduction in vehicle traffic on streets that had previously been through routes. Transit travel time remained the same, but regularity was improved, producing 2% operational savings for the system. The continuing decline in transit ridership was reversed, and ridership increased 8% between 1970 and 1975.
- an increase in travel speeds on the ring road from about 16km/hr to 23km/hr because reduced traffic volume on radial feeder routes allowed longer green lights for through traffic.

The cost of the original changes in 1970 was $1,250,000. The cell system has been highly successful and has enjoyed continuous popular support, including support from the retail merchants. In 1979 two additional cells were added so that the entire central business district is now included. Visitors and planners from around the world have studied Gothenburg's cell system. It has been replicated in several European cities including Stockholm and Delft (see page 25) and is being carefully examined by several U.S. cities.

Transit Improvements

To support the goals of reducing automobile usage in the central business area and encouraging public transit ridership increases, the existing light rail (tram) system is being continually upgraded.

Nine tram routes totalling 128 kilometers (80 miles) serve Gothenburg. About 80% of these routes are now separated from other traffic by grade, curb, or striping. Reserved rights of way are designed for any extensions of the light rail system. Signals giving priority to light rail vehicles have been installed at 70 intersections. Each tram car is equipped with automatic ticket cancelling machines, so all two or four-car trains need only one operator. New light rail cars are in the design stage.

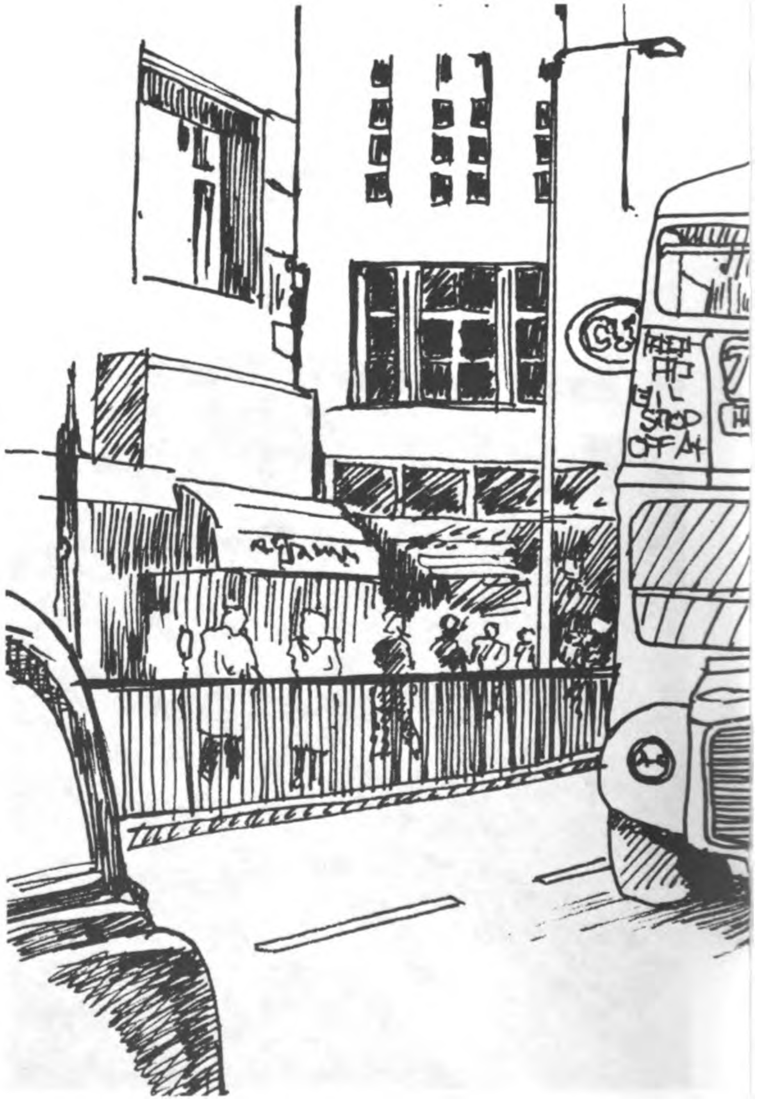
New buses, both articulated and standard, are on order. Twenty intersections are equipped for bus signal priority, and in the suburbs there are bus-only streets with access by controlled gates.

Zone and monthly fare cards are available. Transit tickets may be purchased at many shops and stores or, at additional cost, from the driver.

Financing

In addition to farebox revenues, city income and property tax revenues are used to support public transit. The national government funds only limited road bed construction for the light rail portion of the system.

Tram About to Cross Cell Border (center right)—
Truck Must Follow Exit Road to Far Right


STOP
OFF A4

London, England

Effective coordination between transportation and land use planning has enabled London to develop an impressive, low cost traffic management and transit service improvement program.

Greater London has a population of seven million people. Its land area of 1,561 square kilometers (610 square miles) encompasses three concentric rings, each with its particular traffic problems. Central London, which roughly corresponds to the central business district of U.S. cities, is highly congested throughout the day because it has a very large, daytime working population and heavy through traffic, as well as some residential neighborhoods. Inner London, the second ring, consists primarily of industry and older housing, while the outer ring developed largely in this century around previously existing towns. Both Inner and Outer London contain employment centers and residential areas that function like independent towns in terms of their transportation impacts.

London, like older U.S. cities, such as New York and Boston, was faced with serious transportation problems in the postwar decades. As automobile ownership and use increased dramatically, acute congestion and serious pollution problems followed inevitably. London had had, for many years, an excellent public transportation system, but transit deficits continued to grow as the costs of operating the system

CITY: LONDON

Population Per Car: 3.9

City Population: 330,000
Regional Population: 7 million
City Area: 10 Square miles
Regional Area: 610 Square miles

City Population Density per square mile: 11,475

● Outstanding Use
◐ Utilized
○ Not Implemented

TSM Measures	
Improved Signalling	●
One Way Streets	◐
Parking Controls	●
Peripheral Parking Facilities	●
Traffic Channelization	●
Auto Restricted Zone (Traffic Cells)	○
CBD Pedestrian Zones	◐
HOV Reserved Lanes	◐
HOV Signal Preemption	○
Bikeways	○
Integrated Fare Policies	○
Modal Coordination	○
Payroll Tax	○

soared. The results were that severe financial restrictions were placed on capital outlays for transit improvements, and equipment maintenance was neglected to cut costs. Public mobility needs were not being met. Automobile traffic in London was slowed to a crawl by congestion, and the public transportation system was inadequately funded to expand to meet the increased mobility demand or to relieve surface congestion.

In an attempt to remedy this situation, the British government, in the Transport Act of 1969, chartered the Greater London Council (GLC) and charged it with the responsibility of developing and organizing policies and measures to promote "integrated, efficient, and economic transport facilities for Greater London." [1] This Act provides for close coordination of land use and transportation planning in London and the development of an integrated, low cost traffic management system. The program emphasizes parking restrictions and improving traffic and transit flow to move people from residential to work centers as efficiently as possible. Expensive capital improvements to the existing transportation system are undertaken only when land use planning assures that public costs will be offset by tax revenue from private development.

Planning

In the GLC, London has a centralized planning body with enforcement powers. From the outset, transport and land use planning have been performed by the same department within the Council. In addition, the GLC dispenses block grants from the central government to the 33 borough governments and to the London Transport Executive, the transit operating agency. It also has the power to make grants to British Rail, the national railway system. British Rail, in return for grants from the GLC, must work with the Council and consult with it regarding fare structures within Greater London. To ensure local participation and support, the boroughs have final say over all traffic and development plans and controls and must be persuaded to take action on a GLC plan.

The transportation policy of the GLC has been to facilitate the efficient movement of the greatest possible number of people by means of an integrated surface and underground transport system. The primary objectives of this policy have been to discourage low occupancy vehicle operation in congested areas, primarily through parking controls, to give preferential treatment to high occupancy vehicles, to improve public transportation, and to improve traffic flow generally. The policy has been reinforced by a decision to complete only one of several planned ring motorways around Greater London. The existing roadway system, however, is to be maintained.

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[1] London Transport Act, 1969, Chapter 35.

Parking Policy

The principal means of restraining automobile traffic utilized by the GLC has been a coordinated parking policy. In Central London, the number of free, on-street parking spaces has been reduced from 48,000 to 4,000 since 1962. In recent years, further restrictions have been placed on automobiles to discourage driving in Central London.

- There are now more than 50 streets in Central London with all-day parking bans in effect.
- Approximately 400 kilometers (250 miles) of streets are "urban clearways" on which no parking is allowed during peak hours.
- Parking rates in four Central London car parks have been changed to discourage all-day parking and encourage short-term parking. Peak hour arrivals fell by 81%, and off-peak arrivals increased by 94% as a result.
- Residents who live in restricted parking areas are provided with reduced price, on-street resident parking tags to allow them to park near their homes.
- Park and ride lots have been established at outlying mass transit stations. Today there are 60,000 spaces available at lots adjacent to London Transport (Underground) and British Rail (commuter rail) stations.
- Total non-residential parking spaces have been reduced from 122,000 to 100,000 since 1962. The number of public non-residential spaces has been reduced from 82,000 to 49,000. However, at the same time, private parking spaces, primarily off-street, have increased from 40,000 to 51,000. Because private parking facilities are not controlled by the strategic parking policy, the success of the program is lessened accordingly.

Although parking restraints have been imposed over a 102.4 square kilometer (40 square mile) area, parking has, to some degree, simply shifted from on-street to off-street facilities, and traffic congestion is still a serious problem. The parking restraint policy has, however, changed some commuter habits; in fact, 90% of work-related trips within Central London are now made by public transportation. In addition, the reduction in on-street parking has improved traffic flow downtown, paradoxically making downtown driving more attractive.

The parking policy has not succeeded in improving environmental quality, pedestrian conditions, or bus operations. Total traffic volume has, in fact, increased because the reduction in public parking has been negated by increased through traffic and privately provided parking. Stronger restrictive measures are under consideration, including imposing a fee upon cars entering Central London streets during daytime hours.

London: Queue-jumper lane to bypass auto traffic

Bus Preferential Treatment

The GLC has implemented a number of low cost measures to improve the efficiency of its extensive bus fleet.

- New bus routes radiating from Central London complement the London Underground (which primarily serves north London) and British Rail routes (which cover the area to the south). Other new bus routes serve employment and residential centers in the outer ring of London and provide feeder service to rail stations.
- Bus lanes have been provided where more than 35 buses an hour use a given route. There are now 150 individual, discontinuous bus lanes, covering a total of 42 kilometers (26 miles), in use in London, with additional lanes planned. Most are concurrent flow curbside lanes, less than one kilometer in length, which serve as queue-jumper lanes rather than long distance busways. (Queue-jumper lanes are short, extra lanes which allow buses to pass cars waiting at intersections.) Enforcement of the parking ban in these lanes is strict. Traffic wardens are equipped with nearly universal keys which will open and start more than 75% of all automobiles. They simply drive the offending cars away. If none of the master keys will work, a special flatbed truck equipped with a pneumatic lift is summoned. Cars parked in bus lanes are lifted, unopened and undamaged, onto the truck and carried away.

The lanes are also used by taxis, cyclists, and sometimes, turning motorists. The lanes have improved bus trip times from half a minute on the Park Lane route to seven minutes on Vauxhall Bridge. There has also been a small time saving for non-priority traffic on streets with bus lanes.

- Oxford Street, London's busiest shopping street, was permanently converted to a transit and pedestrian mall in 1975. Sidewalks were widened, benches and crosswalks provided, and traffic lanes reduced to two. Only buses, taxicabs, bicycles, and emergency vehicles are now permitted to use the entire length of the street. Delivery vehicles may use short segments of the street to service stores and shops. Three thousand

Oxford Street Transit Mall

Oxford Street Transit Mall

vehicles an hour had used the four-lane street prior to its conversion. After the conversion, traffic volume dropped 50% during the daytime hours. Bus travel times have improved by one to two minutes, and bus reliability has improved markedly. Air pollution and noise levels have been somewhat reduced. Eighty-five percent of residents and shopkeepers approve of the transit mall and feel it has been a success.

Traffic Management

Parking and transit policies have been coordinated with intensive traffic management efforts.

- A large number of one-way street pairs have been designated to handle heavy through traffic. Effective street markings that make channelization requirements clear are extensively utilized.
- Computerized signaling has been implemented on a large scale; 800 intersections in Central and Inner London are tied into a centralized coordinated system which is programmed to maximize traffic flow. It does not, however, give priority to buses.
- Truck control measures have been imposed in Central London. Several large department stores have constructed warehouses outside Central London where freight shipments for their stores are consolidated for delivery. The government is encouraging cooperative warehouses for smaller businesses.
- A "Black Spot" computerized accident reporting system was installed to identify areas with higher than normal accident rates. New markings, signal changes, or other remedial actions are taken at these locations.
- Streets have been closed to traffic where warranted by pedestrian volume and supported by local residents or merchants. As a result, several major shopping areas, such as the Carnaby Street pedestrian mall, are enjoying increased business and pedestrian activity. Elaborate improvements have proven to be unnecessary. Foot traffic has increased, often by 50%, while vehicular traffic on adjoining roads has either decreased or increased only slightly. Most people arrive at these pedestrian areas either by transit or on foot. Planners have found, however, that where pedestrian volume is not high, closing a street to traffic will not necessarily attract new visitors.
- Residential streets in several neighborhoods have been organized into traffic cells. One-way streets and narrowing entrance roads to a neighborhood are devices used to prevent or discourage through traffic. Through vehicles are routed to peripheral streets which are more suited to heavier traffic volumes. The Pimlico area, where a 30-acre neighborhood eliminated through traffic by prohibiting entry at all but four points by the use of one way streets, provides an example of a successful restraint scheme.

Transportation Improvements and Coordination with Land Use

The Underground is gradually being extended to serve the most severely congested areas and to provide access to new developments. Joint development between the private and public sectors is being pursued to minimize public sector costs and to ensure mutually beneficial land use. Two examples of this policy are the Barbican and Hammersmith developments.

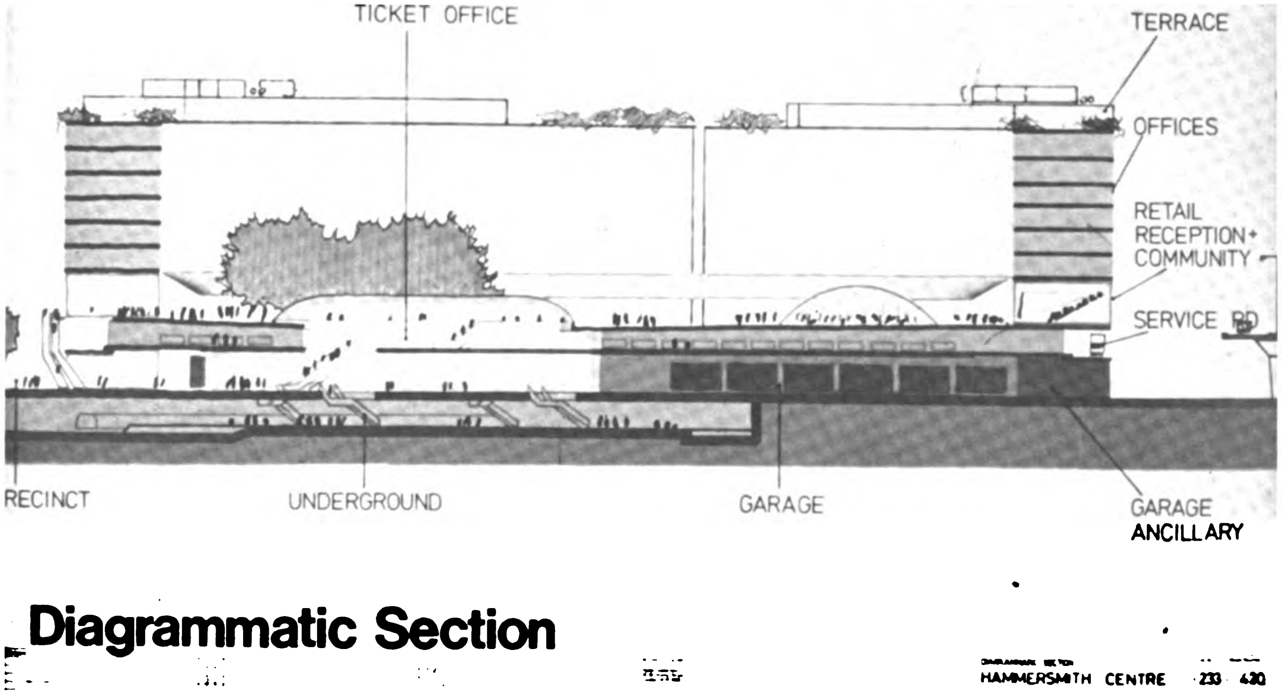
The Barbican development is located on the northern edge of Central London, in an area destroyed during World War II. Built in the early 1960's, it includes three apartment towers and a series of 11-story apartment buildings housing 6,500 people, all of which are grouped around squares, courts, and gardens. Roadways and parking areas are located on a separate lower level. In 1971, a cultural center, including a theater, concert hall, and drama and conference center, was added. Several bus routes and two subway stations serve this entire complex.

Unlike the Barbican development, the Hammersmith project represents an attempt to revitalize an aging, decaying residential and employment center. London Transport owns a large tract of land in the center of the Hammersmith area which it plans to redevelop. The revenues generated by privately developed, non-transport facilities, such as offices, theaters, and restaurants, will be used to pay for transit facilities including a bus garage, a bus terminal, and underground platform extensions.

Fare Policies

Fare policies in London provide a striking contrast to those of Paris. London Transport has deliberately set fares at high levels on both the Underground and buses. Because travel on the Underground is generally faster and more direct than travel by bus, higher fares are charged. Over 70% of the cost of combined bus and subway operations is recovered from the farebox in London, as compared to 33% in Paris.

London illustrates the potential for a large city to provide good public transportation on an almost self-sustaining basis.



Diagrammatic Section of Hammersmith
Joint Development Centre

Notes

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