The Urban Transportation Planning System (UTPS)

An Introduction for Management
June 1980

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

Urban Consortium for Technology Initiatives

Member Jurisdictions

ATLANTA, GEORGIA
BALTIMORE, MARYLAND
BOSTON, MASSACHUSETTS
CHICAGO, ILLINOIS
CLEVELAND, OHIO
COLUMBUS, OHIO
DADE COUNTY, FLORIDA
DALLAS, TEXAS
DENVER, COLORADO
DETROIT, MICHIGAN
HENNEPIN COUNTY, MINNESOTA
HILLSBOROUGH COUNTY, FLORIDA
HOUSTON, TEXAS
INDIANAPOLIS, INDIANA
JACKSONVILLE, FLORIDA
JEFFERSON COUNTY, KENTUCKY
KANSAS CITY, MISSOURI
KING COUNTY, WASHINGTON
LOS ANGELES, CALIFORNIA
MARICOPA COUNTY, ARIZONA
MEMPHIS, TENNESSEE
MILWAUKEE, WISCONSIN
MONTGOMERY COUNTY, MARYLAND
NEW ORLEANS, LOUISIANA
NEW YORK CITY, NEW YORK
PHILADELPHIA, PENNSYLVANIA
PHOENIX, ARIZONA
PITTSBURGH, PENNSYLVANIA
PRINCE GEORGE'S COUNTY, MARYLAND
ST. LOUIS, MISSOURI
SAN ANTONIO, TEXAS
SAN DIEGO, CALIFORNIA
SAN DIEGO COUNTY, CALIFORNIA
SAN FRANCISCO, CALIFORNIA
SAN JOSE, CALIFORNIA
SEATTLE, WASHINGTON
WASHINGTON, D.C.

The Urban Consortium for Technology Initiatives was formed to pursue technological solutions to pressing urban problems. The Urban Consortium is a coalition of major urban governments, cities and counties, with populations over 500,000. These 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 unifield 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 ten task forces: Community and Economic Development; Energy; Fire Safety and Disaster Preparedness; Health; Human Resources, Management, Finance and Personnel; Public Works and Public Utilities; and Transportation.

Public Technology, Inc. (PTI), a non-profit, public interest organization serves as Secretariat to the Urban Consortium. PTI was established in December 1971 by several public interest groups, including the International Cities Management Association and the National League of Cities. Its purpose is to help local governments improve services and cut costs through practical use of applied science and technology. PTI sponsors the largest local government cooperative research, development, and technology transfer effort in the nation. The staff of PTI provides both technical and organizational services to the Urban Consortium and its Task Forces.

The Urban Transportation Planning System (UTPS)

An Introduction for Management

Prepared by Public Technology, Inc.
1301 Pennsylvania Avenue, N.W.
Washington, D.C. 20006

Secretariat to the
Urban Consortium for
Technology Initiatives

Supported by:
U.S. Department of Transportation
Urban Mass Transportation Administration
Office of Federal Highway Administration

June 1980

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Table of Contents

Introduction

Local administrators facing complex transportation or land use issues frequently have little time to choose between alternative courses of action. Analytical support for decision making is often crucial; most decisions are reviewed by elected officials and the public, and may have to conform to State and Federal regulations.

Information demands of decision makers are rapidly outpacing the ability of local planning staffs to produce answers. The Urban Transportation Planning System (UTPS) provides planning and impact forecasting tools to meet many of these demands.

UTPS manual and computer methods can help to answer a wide variety of questions, such as:

- Will present roads accommodate future travel demands?
- How will traffic circulation be affected by a proposed pedestrian mall?
- What road improvements should have highest priority?
- What ridership should be expected on a proposed express bus route?
- Are lower income groups adequately served by transit?

Maps, graphs, and tables generated by UTPS help local officials compare alternative solutions.

UTPS was developed jointly by the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA). The entire system includes the UTPS computer package, supporting manuals, and technical guides to non-computer methods.

Originally developed to assist in long-range transit planning, UTPS has been expanded to include a roadway planning capability with many of the features of FHWA's highway planning battery PLANPAC.

This management document is designed to help officials make decisions about the potential utility of UTPS in their jurisdiction. The first chapter describes UTPS in light of local needs and constraints. The second chapter discusses a number of actual UTPS applications, including simple, nonconventional applications of particular interest to local officials. The third chapter addresses more technical questions about the operation of the UTPS package.

The appendices provide technical information about the operation and contents of the UTPS computer package.

Chapter 1

The Urban Transportation Planning System

UTPS consists of manual and computerized planning procedures which provide decision makers with information at the desired level of detail. The manual procedures -- UTPS Simplified Aids for Transportation Analysis -- provide quick, rough answers to questions like, "can fixed route bus service be justified in a particular travel corridor?" Some Aids describe methods combining hand techniques with simple computer manipulations. The UTPS computer package* addresses problems requiring more detail.

Manual Procedures: UTPS Simplified Aids for Transportation Analysis

When decision makers want answers fast, planners often lack time for detailed analyses. Short range transportation problems, like should the developer of a new shopping center agree to finance increased roadway capacity before approval of a zoning variance?, call for quick, back-of-the-envelope analyses. The UTPS Simplified Aids are designed to fill this need. These desk-top techniques consist of equations, graphs, and curves used to forecast or estimate project or policy impacts. The Aids include methods for site planning, transit route planning, analysis of dial-a-ride systems and others. (See appendix D).

The Simplified Aids provide the policy-level official with valuable ballpark estimates and reduce the options requiring detailed analysis to a manageable number.

The UTPS Computer Package

The UTPS computer-based package allows planners to simulate the operation of a transportation system to determine what would happen if changes were made in the roadway or transit networks. The package was originally designed for transit planning -- to help identify transit modes and route alignments appropriate for different urban areas. Subsequent additions to UTPS have made it possible to conduct roadway and short-term transit

*In this management document, *package* refers to the computer-based portion of UTPS.

studies. The computer package is broader in scope and detail than the Simplified Aids, and it is also more complicated to use. The package consists of a number of programs which parallel steps in the standard transportation planning process described in Appendix A (the individual programs are described in Appendix B).

This process involves four major steps: (1) representation of the roadway or transit system, (2) estimation of the number of future drivers and transit riders and their origins and destinations, (3) assignment of trips to appropriate roads and transit routes, and (4) preparation of maps, tables, and graphs to display results and compare different transportation alternatives.

Capabilities of the package include estimation of long-range land development impacts, transportation system costs, travel demand, major facility and corridor travel volumes, energy use, air pollution and traffic accidents. The package may also be employed to answer questions at a detailed, street-by-street level for short-range problems -- this requires a greater level of effort with an associated increase in cost.

A recent addition to the UTPS package is the Community Aggregate Planning Model (CAPM). CAPM is a large-scale, or sketch planning, tool that generates a broad array of region-wide system performance measures such as vehicle miles of travel, energy consumption, and pollution levels. It offers quick results, but sacrifices the detail provided by most other UTPS programs. Currently, CAPM is operative for land use and highway applications, and soon will be expanded to include transit.

UTPS is usually used to test different roadway or transit configurations and operating strategies (alternatives) to compare resulting levels of traffic congestion, transit ridership, air pollution, energy use, and numerous other factors. For example, to determine how best to reduce congestion on a certain road, one might test alternatives including adding lanes, building a new road, relocating a proposed public building, or reducing the zoned density of an undeveloped parcel. For each of the alternatives, UTPS could provide information about traffic accident levels, travel time reductions (or increases) and the geographic distribution of mobility improvements.

Who Should Use the UTPS Package?

An important first step in determining whether to use the UTPS package is an evaluation of local information needs. To accomplish this, some current UTPS users have listed transportation issues faced during a previous year, and questions arising in connection with those issues. For example, questions relating to a proposed road improvement project might include:

- What are current congestion levels on the road?
- What are expected future congestion levels?
- How much will the improvement cost per user?
- Are other roads in greater need of improvement?
- Will the improvement stimulate new development?

Comparable questions regarding a proposed new bus route might be:

- How many riders will use the line?
- Who will benefit?
- By how much will travel time be reduced for current transit users?
- How will fare changes affect ridership?
- How many auto trips can be eliminated?

Knowing how often these questions occur, how important they are to elected officials and the public, how detailed the answer must be, and how well UTPS can answer them, helps local officials determine the utility of the package. The benefits of UTPS-generated information must be weighed against the staff effort required to operate the package, and the ease or difficulty with which needed planning information is currently obtained.

Two factors tend to be important in a city's determination of the usefulness of the computer portion of UTPS -- population and growth rate. Cities with a population over 200,000 usually have a large number of highway and transit problems --enough to justify the cost and effort of implementing the package. The same justification can be made for medium-size cities experiencing a growth rate in excess of 5% per year. Under these circumstances, even a small city with 30,000 residents and a projected growth rate in excess of 10% per year will probably require extensive transportation planning to accommodate the rapid growth. Likewise, a city planning major changes to existing roadway or transit systems will benefit from implementation of the computer package. The following table depicts the circumstances that ordinarily justify the use of UTPS for the simulation of travel under changing land use or transportation conditions.

General Circumstances for Use of UTPS Computer Package

	ANNUAL GROWTH RATE			
POPULATION	0%	0 - 2%	2 - 5%	5% +
30,000 - 50,000	No	No	No	Yes
50,000 - 200,000	No	No	Yes	Yes
200,000 - 500,000	No	Yes	Yes	Yes
Over 500,000	Yes	Yes	Yes	Yes

Further, while UTPS can facilitate better informed decision making, implementing the computer package can be expensive, requiring substantial resources and expertise. Consequently, planning officials should explore opportunities for cooperative use of UTPS with other agencies (see Chapter 3).

Implementing the UTPS Package

While the UTPS package can contribute greatly to the decision-making process, its effectiveness depends upon the substantial involvement of management-level officials and transportation planners. Decision-makers should be appraised of the policy implications of all aspects of the analyses, including data inputs.

The package has been characterized as "data hungry." For most applications, planners must prepare a description of the roadway and/or transit networks, as well as detailed demographic and economic forecasts (see Appendix A), and policy-makers must agree on transportation alternatives to be tested and identify the impacts in which they are interested.

Depending upon the complexity of problems to be addressed, the availability of raw data, and the experience of the analytical staff, preparing initial inputs for UTPS can take from two months to two years. This system start-up effort is only required once, however, and subsequent analyses can often be completed very quickly. This task has been made much easier since the introduction of UTPS programs that can read and manipulate census tapes.

UTPS itself does not make decisions -- the output must be analyzed by knowledgeable transportation professionals in light of local policy. Sometimes UTPS output must be maniuplated by planners to obtain estimates of impacts that are outside the existing capabilities of the package, like intersection turning movements. UTPS users who have installed the package have found it essential to have at least one staff member experienced in computer system operations as well as transportation modeling.

Funding Transportation Studies

There are three common sources of funding available for transportation studies through the Federal government. Unfortunately, none of these monies are directly available to local governments. Section 8 (formerly Section 9) of the Urban Mass Transportation Act of 1964, as amended, authorized funds for states and local public bodies for--

1. Studies relating to management, operations, capital requirements, and economic feasibility.

2. Preparation of engineering and architectural surveys, plans, and specifications.

3. Evaluation of previously funded projects.

4. Other similar or related activities preliminary to and in preparation for the construction, acquisition, or improved operation of mass transportation systems facilities and equipment.

Subsequent legislation required that Section 8 grants go to the States and be passed (in part) to regional transit planning bodies.

States are also eligible for Highway Planning and Research Funds (HP&R) not to exceed one and one-half percent of the highway construction funds apportioned to the State each year. These funds may be passed to the Metropolitan Planning Organization (MPO) or the local agency.

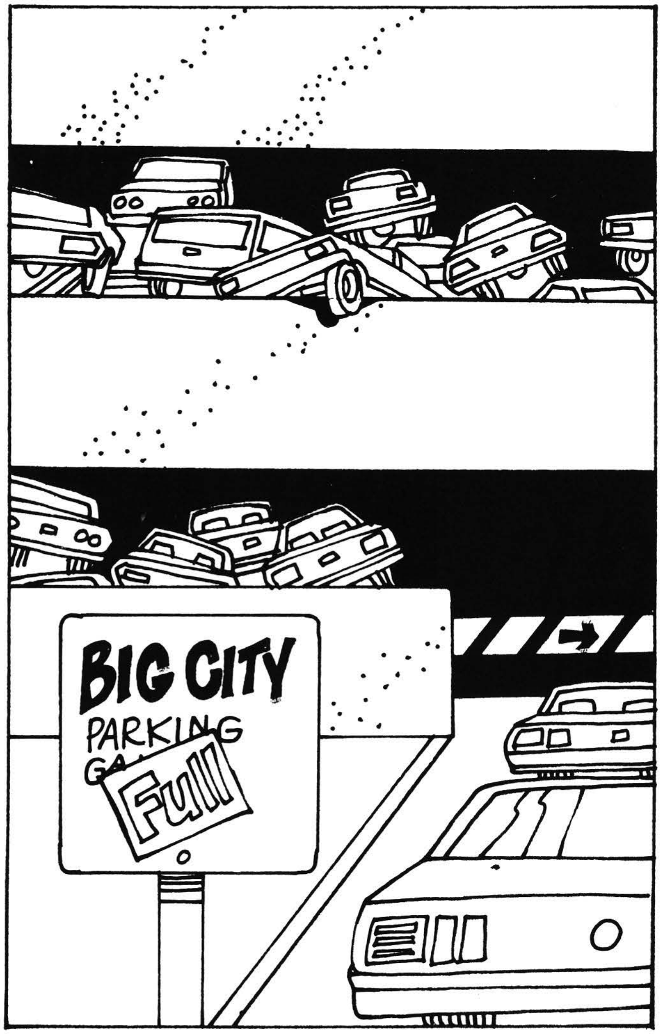
As a third source, the Federal Highway Administration is authorized to provide assistance, often called Public Law (PL) funds, which must be made available to urbanized areas through the MPO. In some locations, local governments have had funds passed to them from the regional or State agencies.

Chapter 2

UTPS Applications

This chapter presents a number of actual UTPS applications addressing local policy issues. The examples are not detailed case studies, but rather demonstrate the flexibility UTPS gives planners in responding to a variety of transportation-related problems.

Downtown Parking Needs



Problem:
Officials in an urban county wanted to know how many parking spaces would be needed for a future year.

Solution:
The county used one of the UTPS Simplified Aids. The technique works best when a forecast of future automobile trips to the downtown is already available, but a method for estimating future downtown trips is provided. Curves relating parking demand to the number of downtown trips were employed to estimate total required parking spaces.

Inputs:
- Future highway and transit trips to downtown
- An inventory of currently available parking spaces

Products:
- Number of parking spaces needed

Confidence:
Useful for a first-cut analysis only

Effort:
One to two person weeks, which includes some data preparation time.

Bus Ridership and Operating Costs

Problem:
A fixed-route bus service was proposed for a small urban area. Elected officials wanted to know the potential ridership and operating costs.

Solution:
Since only rough estimates were required, a quick desk-top method, included as one of the UTPS Simplified Aids was used. Simple equations provided estimates of annual ridership and operating costs.

Inputs:
- Service area population
- Percentage of households without automobiles
- Fare
- Bus service miles

Product:
- Annual transit ridership
- Annual operating cost

Confidence:
Useful for a first-cut analysis only

Effort:
Two days, including data collection.

Hospital Location

Problem:
Health authorities wanted to know which of three proposed hospital locations would best serve the needs of out-patients dependent upon public transportation.

Solution:
The city had already developed a detailed UTPS transit network. One type of information easily obtained from the network was the transit travel time from different parts of the hospital service area to each of the proposed hospital sites. The planners averaged travel times to each of the sites, and obtained information on the average fare and number of required transfers.

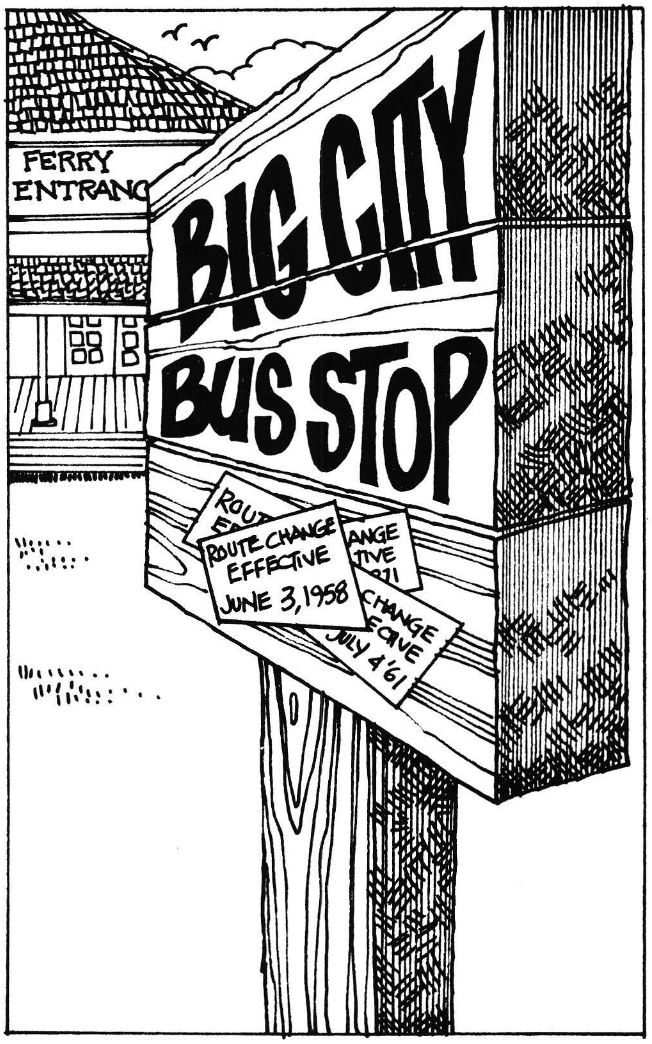
Inputs:
- Hospital service areas and locations
- A detailed UTPS transit network

Products:
- Average travel time to each hospital site
- Average fare to each hospital site
- Average number of transfers required to reach hospital sites

Confidence:
Since the network was very detailed, results were very reliable.

Effort:
About two days, using an existing UTPS transit network.

Bus Rerouting



Problem:

In one section of a large Eastern city, bus routes had not been changed substantially for over 20 years. For example, a major transfer point occurred at a ferry terminal where service had been discontinued in the 1940's. Planners felt they could improve average travel times by realigning transit routes to serve present day activity centers. The planners had to demonstrate this to the transit authority, where officials were concerned that some areas would suffer in an attempt to improve service to others.

Solution:

Planners used UTPS to simulate major bus service and route changes. New transit passenger travel times and bus use statistics were obtained and then plotted against current figures. The plots showed, by geographical area, which transit users would experience changes in travel time and the number of required transfers.

Inputs:

- A detailed UTPS transit network
- Data on current transit trips (origin and destination)

Products:

- Average transit passenger travel time
- Average bus miles per passenger
- Average number of transfers

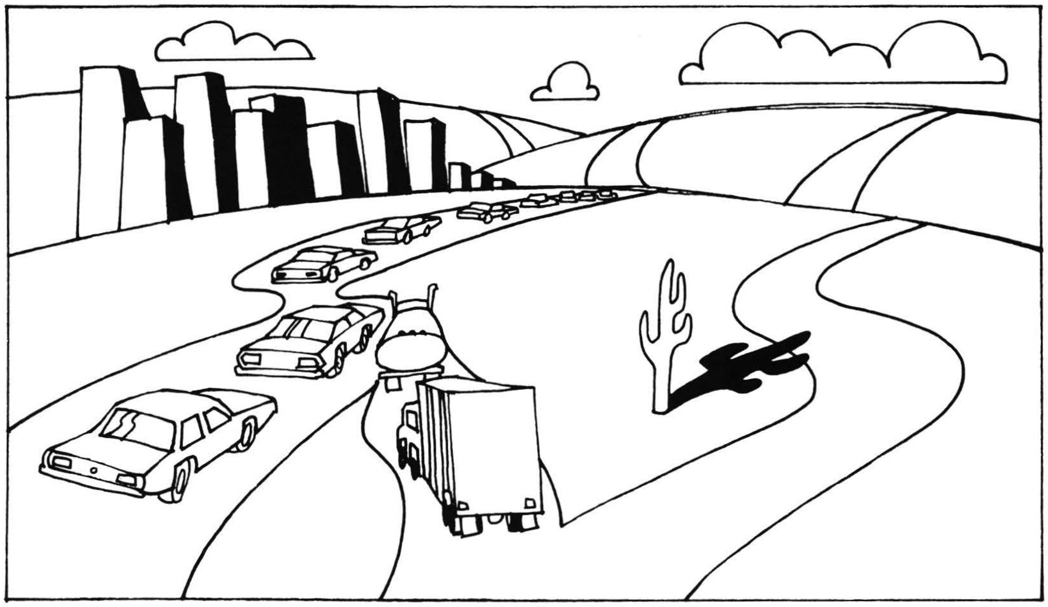
Confidence:

The accuracy of both the trip data and the network resulted in very reliable estimates which were adequate for the decisions made.

Effort:

Due to the large number of bus routes that were changed and simulated, the project required a month's time, using an existing base transit network and trip data.

Future Transportation Alternatives



Problem:

Local government officials in an urban area of around 1 million population wanted to know the relative impact of a large number of long-range transportation and land-use alternatives. Alternatives included different combinations of 3 land-use plans, 3 highway plans, 3 transit plans, and 3 Transportation System Management strategies.

Solution:

Planners employed the UTPS Community Aggregate Planning Model (CAPM) to provide rough estimates of a wide variety of cost, performance and impact measures for each alternative. These estimates enabled local officials to narrow their options and select a small number of alternatives for in-depth analysis.

Inputs:

For the future, each of the following:

- Population and employment for the region
- Regional freeway and arterial lane miles
- Estimated number of vehicle trips in the region
- Average trip time in the region

Products:

- Vehicle miles of travel (VMT) [CAPM estimates most other impact measures using this figure]
- Regional air pollution levels [Carbon Monoxide (CO), Hydrocarbons (HC), Nitrous Oxides (NO)]
- Fuel consumption
- Freeway maintenance costs

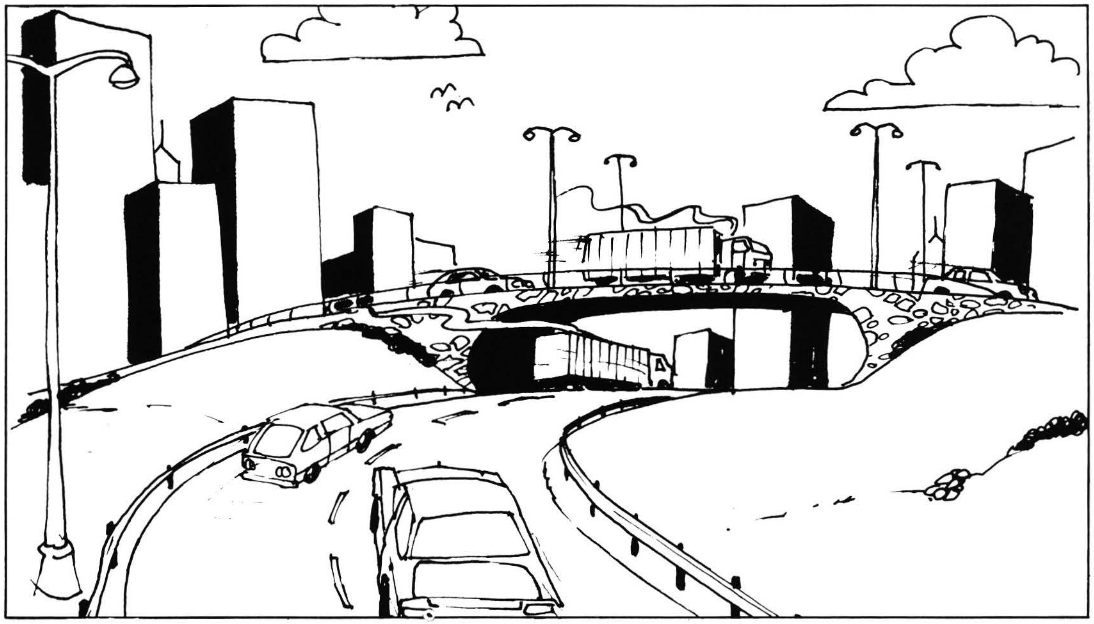
Confidence:

The results were adequate for eliminating all but a few alternatives from consideration.

Effort:

Two people for two months, to test 70 different alternatives.

Allocation of Major Facility Improvement Costs



Problem:

A freeway overpass was to be built to serve a small area of commercial and industrial users in a growing city. While the entire city would benefit to some degree, officials felt that those near the overpass would benefit the most and should be assessed a larger proportion of the costs. Elected officials wanted to know how to allocate the cost to those who would benefit.

Solution:

The city alredy had a UTPS highway network, to which they added the new overpass. Using UTPS, planners determined which areas would use the facility and how frequently they were likely to use it. Local costs were allocated to residents and establishments according to the predicted use of the overpass.

Inputs:

- A UTPS highway network

Products:

- A count, by geographical area, of how many trips would use the overpass

Confidence:

UTPS usually selects the roads used to get between an origin and destination on the basis of the shortest travel time; some drivers, however, do not select the shortest route. Consequently these estimates are not absolutely correct, but they were considered reliable by decision makers.

Effort:

About two days using an existing network

Removing a Planned Freeway

Problem:
Several years ago the State Department of Transportation had planned a freeway through a large Eastern city. The city felt the freeway was unnecessary, but had to prove this to the State.

Solution:
Using the same networks developed by the State, the city removed freeway links and assigned auto trips for a future year. The local roads showed heavy congestion. The traffic engineers proposed a number of intersection improvements, and a road-widening, which were reflected in the network. Several iterations of assigning trips and improving the network made it possible for the city to show the State how they could adequately meet future traffic demand without the freeway.

Inputs:
- A UTPS highway network
- Auto trips for a future year

Products:
Traffic flows on local street network

Confidence:
The results were reliable, although there were no tests of transit ridership changes as a result of changing road conditions.

Chapter 3

UTPS Resource Requirements and Support

Chapter 2 emphasized a number of the benefits of UTPS in providing quick response to some policy questions. This chapter examines the costs and also discusses analyses for which UTPS is not well suited or where the development time is excessive.

Development of a comprehensive highway or transit planning capability, using the UTPS computer package, requires a major investment on the order of at least $80,000 to $100,000 (including staff and data collection costs) for the first year. Costs may be lower for a less ambitious project. Expenses can be reduced dramatically by sharing the package with another agency that has already completed the start-up effort, or by using some of the individual UTPS computer programs to supplement the Simplified Aids and other manual techniques.

The U.S. Department of Transportation is committed to helping implement the package, providing technical assistance, and training users. The package is regularly updated with improvements and several new, short-range planning modules are under development.

Computer Operations

At the present time, UTPS programs operate only on IBM computers. The programs can be installed and tested in a few weeks. Someone thoroughly familiar with computer operations should supervise the installation.

All UTPS programs will be converted to run on non-IBM computers by the early 1980's, and a proposed feature of this new version of the package is that it will also operate on mini-computers and, in some cases, on micro computers.

Local governments may obtain a copy of the installation manual and computer readable programs, as well as a variety of manual planning method handbooks, free from UMTA by writing to:

Gran Paules, Chief Technology Transfer
Office of Planning Methods and Support
UMTA, UPM-20
U.S. Department of Transportation
400 7th Street, S.W.
Washington, D.C. 20590

Public agencies requesting the UTPS computer program must provide a 2400 foot magnetic tape on which the programs will be copied.

Costs

Costs of using UTPS may be broken down in several ways:

- Start-up Costs
- Major Study Costs
- Individual Analysis Costs
- Computer Costs

Start-up costs include activities in coding highway or transit networks, data collection, and development of mathematical models that predict future travel patterns (travel models). Costs of these activities will vary depending on the level of detail desired in subsequent analyses.

The time and cost of network coding can vary widely depending upon network size, level of detail, existence of other coded networks, experience of the analytical staff, and other factors. It may require as few as three to four person-months to code a highway network for a medium-size city. If a highway network already exists, a transit network for a medium-size city may be coded with as few as six to eight person-weeks of effort. This work can usually be accomplished by entry level planners supervised by a transportation professional.

A number of analyses can be performed with only a transit or highway network; however, extensive raw data collection and development of travel models are necessary for a comprehensive planning capability. Most transportation analyses rely on land use and related socioeconomic data (for example, number of households, income, auto ownership and employment) to forecast travel in a region. If this land use information is not available in a convenient form, gathering it can be an expensive component of UTPS start-up costs.

Fortunately, new Census programs included in UTPS allow much of this data to be obtained easily from census tapes, using already developed geographic data base files (DIME Files). Local data records can also be matched to census records using these new programs, with many transportation and general planning applications.

Like raw data collection, the development of travel models, based on previously collected data is expensive. Travel models range from the very simple, like one which multiplies the number of households by a trip making rate, to the very complex—requiring households, number of automobiles by households, age, income, and distance to work. Depending upon the level of effort, developing a complex travel model and its inputs can easily escalate the cost to well over $100,000 for a large region. Sometimes, however, these activities will have already been completed by another agency or consultants, in which case start-up time and costs are considerably reduced.

Start-up costs are usually incurred in the course of a major study, such as might be involved in the development of a long-range capital improvement transportation plan. This type of undertaking is usually the most expensive application of UTPS. A recent study—using UTPS to produce system demand estimates for a 1990 transit plan—cost almost two million dollars over a three-year period. The study assessed system, financial, and environmental impacts for 75 transit system alternatives.

Most medium-sized cities should expect to spend at least $80,000 to $100,000 over one year to conduct a long-range highway and transit study. This rough estimate includes the costs of model development, simple data collection, and computer and staff time. If both UTPS capability and suitable travel models are already available at another agency, an analysis of this magnitude would cost around $50,000.

Once a system has been implemented, individual analyses can be performed quickly and inexpensively. Chapter 2 illustrates several studies that were completed in two to four days, costing from about $200 to $1,000.

Recent advances in UTPS design will reduce local computing costs. Once UTPS is converted to operate on mini- and micro-computers, user costs will be further reduced. Computers costs are almost impossible to estimate due to the different billing procedures used by computer facilities. In most analyses, computer charges will represent a small portion of the overall transportation planning costs. A large city with a very active UTPS based planning process could spend more than $30,000 a year using a non-governmental computer service bureau.

Sharing the UTPS Package

Current Federal legislation and planning philosophy implies that regional planning agencies should assist cities and counties in their planning activities. Ideally, a local government transportation official should have a good understanding of UTPS capabilities and be able to request UTPS generated information from the appropriate regional agency. Often, however, city requests do not have priority, and the delay in obtaining results is unacceptable.

More commonly, regional networks and data cannot provide information at the level of detail required by the city. As an alternative to relying entirely upon a regional agency, a local jurisdiction can code its own transportation networks, and then use the facilities of the regional agency to perform remaining computer operations. Since coding changes to the transportation network constitute most of the work (the remaining computer steps often require little human intervention), regional agencies are more receptive to this arrangement.

Some cities and counties have retained consultants to prepare long-range transportation plans. The consultants often have completed a substantial part of the UTPS start-up effort, and local governments can take advantage of their work to avoid most of the start-up costs.

UTPS Assistance

The U.S. Department of Transportation is committed to providing technical assistance to UTPS users. UMTA and FHWA staff members teach week-long UTPS training sessions throughout the country. These are augmented by one-day information exchange seminars and Advanced Workshops for experienced UTPS users and a UTPS newsletter which highlights new developments and problems.

Users who experience problems with operation of the package can get help directly from DOT by using a 24-hour, toll free, telephone line. Messages can be sent by a teletype or remote terminal and answers are usually typed back the next day. If access to the toll free service is not available, problems may be discussed over the telephone with the DOT staff in Washington.

Staff Requirements

Officials from jurisdictions that maintain their own UTPS capability say it takes at least one person full-time to maintain the system. Typically, this person has extensive computer and transportation modeling experience. Most large cities also have two or three other people familiar with UTPS inputs and analytical reports, and capable of designing studies using the UTPS package.

Several cities have found it difficult to find a person experienced in using UTPS. Often it is necessary to train the person to use UTPS after he or she has been hired. Unfortunately, UTPS-trained staff are in demand and often are hired-away by MPO's or larger transportation agencies, requiring the city to retrain new staff frequently.

Staffing requirements are drastically reduced when the city is able to share the UTPS operation and data collection responsibility with another agency. Under these circumstances, a minimum of one person must understand the way the system works so that specific analyses and reports can be requested. Actual staff commitment, beyond the initial learning period, is limited to time spent on specific projects and gathering of special data when necessary.

Response Time

Some local planners have cited their ability to respond quickly to policy issues as the single most important element in their successful use of UTPS. Conversely, others say the long response time is why they avoid using the package. The key determinants of time required are the complexity of a given problem, technical staff experience, and the commitment by supervisors to dedicate staff to the project.

A major transportation facility analysis—from network changes to the generation of comparative analytic reports—can take from as little as one week to as long as one month. Shorter analyses, similar to the hospital location problem described in Chapter 2, can be accomplished in two days or less. The table in Appendix C shows the time required to do several typical analyses. Staff proficiency in the use of the package will increase with experience.

The time needed to complete certain analyses, especially when substantial new data must be gathered, may sometimes approach the time needed to experiment in the real world. For example, for a study to identify service areas for vehicles providing services for elderly or handicapped persons, gathering and analyzing information on the locations of elderly and handicapped passengers and coding new routes might take longer than changing the routes and counting the riders.

A UTPS study would, however, provide more information about the service, including estimated average access times to activity centers, vehicle demand, and costs. While in some cases it may take longer to analyze a problem using UTPS than it would with other approaches, UTPS permits examination of a wider range of alternatives and can provide more detailed analyses, often leading to better decision-making.

The Future of UTPS

The U.S. Department of Transportation continues to upgrade existing UTPS programs and add new capabilities for short-range planning. Additions under development include:

- Methods for quickly estimating the costs of transit route changes. These will link directly with detailed schedule-making techniques.
- Programs that will tie together transit system cost analysis and financial and cash flow planning methods.
- Computerized methods for simulating street and intersection movements and for better evaluating the shared use of streets by automobiles and transit.

In the near-term future it will be possible to use UTPS with low-cost micro- and mini-computers. Considerable emphasis is being given to providing a highly responsive, interactive, user-oriented system.

What UTPS Will Not Do

UTPS provides a broad range of planning capabilities and is well suited to the evaluation of multiple alternatives. It permits consideration of many transportation system related factors including levels of service, capacity, usage patterns, environmental and economic impacts, and system costs.

UTPS cannot provide highly detailed final engineering design information, detailed transit schedule plans, or highly reliable micro-level data. It cannot make decisions or interpret data. It contains a set of powerful analytical tools, but the quality of its output information is dependent on the quality of input data and the reasonableness of assumptions made in analysis. Outputs must be interpreted in light of these factors.

Use of UTPS by local agencies often facilitates better technical communications between transportation planning and operating organizations. However, it cannnot guarantee compatability of assumptions or analytical results unless agencies commit themselves to effective cooperation and coordination.

Conclusion

The numbers developed through the use of UTPS can help answer a great number of transportation problems facing local governments. Problems cannot be resolved, however, until the decision makers combine UTPS-developed information with other information that cannot be quantified. The solution using UTPS can be better because it offers an opportunity to test various solutions, and, ultimately, to be better prepared for likely impacts of the final decision.

UTPS provides an ability to analyze a wide range of local transportation problems, but an initial commitment to the computerized system can demand substantial staff time. In some cities and counties, installation of the computer package may not be warrented—especially if transportation issues are being resolved in a satisfactory manner with existing tools. Local governments that need the package should consider staged implementation, first undertaking basic data manipulation and reporting chores, then simplified network modeling and testing, and subsequently more complicated procedures. Whenever possible, local governments should try to share a regional agency's or consultant's programs to avoid some of the start-up costs.

The U.S. Department of Transportation and PTI would be pleased to respond to requests for additional information regarding UTPS use. The potential user should consider attending either the technical one-week UTPS Training Session. These courses are held several times a year throughout the country. Course announcements are available from:

> Gran Paules, Chief Technology Transfer
> Office of Planning Methods and Support
> UMTA, UPM-20
> U.S. Department of Transportation
> 400 7th Street, S.W.
> Washington, D.C. 20590

Appendix A

UTPS and the Transportation Planning Process

UTPS allows planners to simulate the operation of the transportation system. Working with an appropriate data base, the steps outlined below create a model of the actual operating environment. Changes in that environment can be simulated, and the effects of those changes calculated.

Development of a general travel model requires considerable effort for its few immediate benefits. However, it ultimately provides the ability to test alternative solutions to transportation problems—a significant aid to the decision maker.

Coding a Network

The realistic abstraction of a highway or transit network is the most time consuming step required to implement UTPS.

A *network* describes the characteristics of roads or transit lines to the computer in the same way a map describes roads to a driver. For computer input the network is made up of *links*--each link is a stretch of roadway. Links have *nodes* at either end, and these nodes usually represent intersections or transfer points. The study area is divided up into *zones*, where trips start and end. *Paths* are created by UTPS to represent the links travelers use to get from their origin zone to their destination zone. *Lines* show the sequence of links used in each transit route.

Figures A-1 through A-4 illustrate network development. Figure A-1 is an aerial view of a sample area. Figure A-2 is a road or transit map, Figure A-3 shows the zones, Figure A-4 illustrates the links. If the network is to be plotted later, grid coordinates must be added for every node (as shown).

First the area under study is divided into zones. External stations--where vehicles enter or exit the study area--are identified as well. Usually zones conform to census boundaries as well as natural barriers--such as rivers, political boundaries, city limits, socio-economic areas, and neighborhoods. Small zones are drawn where there is a lot of activity--like central business districts--and larger zones are created for rural or outlying areas.

To a great extent the number of zones determines computing time, so there should be no more

Figure A-1

Transit Map

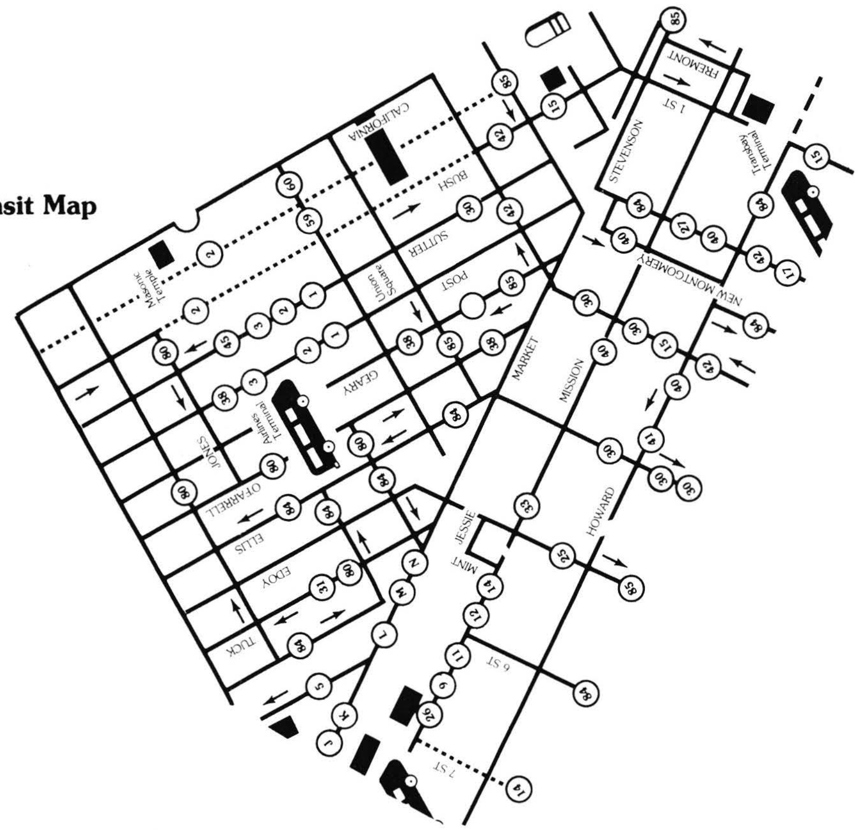
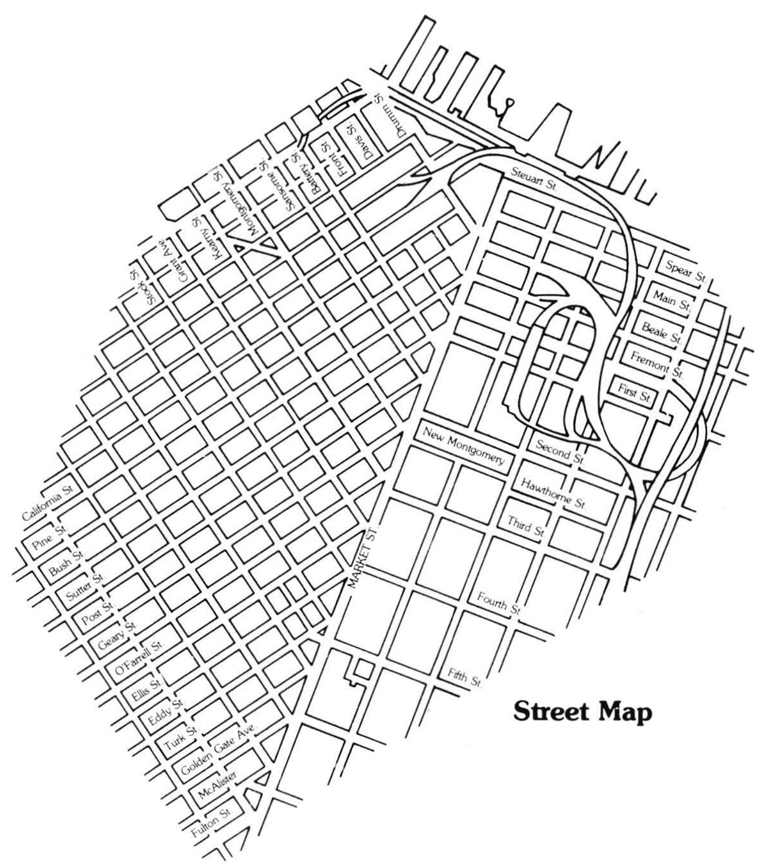


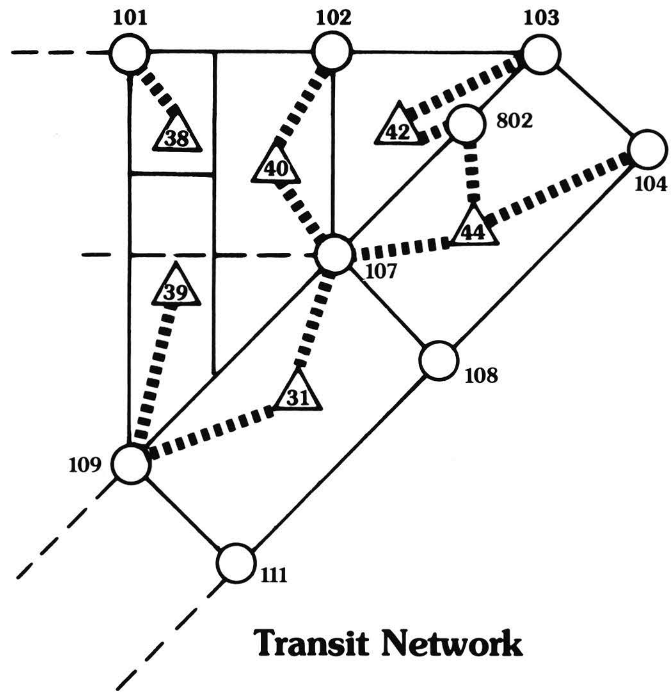
Figure A-2



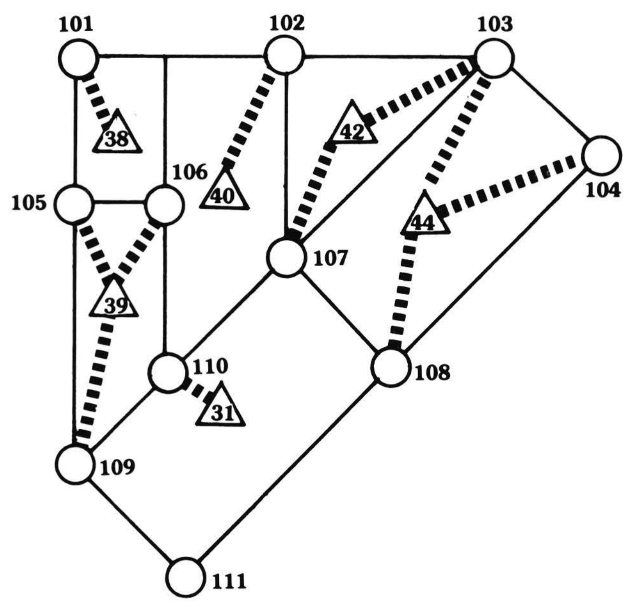
Street Map

Transportation Zones

Figure A-3



Transit Network



Highway Network

△ Centroid

○ Node

▮▮▮▮ Access Link

Figure A-4

zones than necessary. Many analyses can be performed at a sketch planning level, using larger zones, thus reducing computing time as well as the need for detailed zonal data.

Each zone must have a *centroid*, representing the approximate travel center of the zone. For the purposes of the computer, all trips begin or end at the centroid, and are connected to the road or transit network by access links. *Access time*--the time it takes to go from the centroid to the network--must be determined manually for every zone in the study area. Auto access time usually includes an average driving time to the network for all locations in the zone plus a *terminal time*--the time it takes to walk to the car, start it, and pay parking charges (if any).

One final task in the network building phase remains. The characteristics of the roads must be described on a link-by-link basis. Each link is defined by nodes at the start and end. For a highway network, the user must provide the link distance, average vehicle speed or travel time over the link, and number of lanes. Several other optional pieces of data may also be provided. The computer automatically determines the roadway capacity.

A recent program addition to UTPS allows planners to build a transit network directly from the already coded highway network. This makes it relatively quick and easy to code new network alternatives. The user merely must specify the nodes through which each transit line travels, the frequency of service for each line, and a few mode-specific variables. This UTPS program then gets other pertinent shared right-of-way data from the existing highway network. Exclusive guideway data is added as part of the same process.

The information described above is enough to construct a useful base network which may be modified to simulate alternatives. The *base network* usually represents a "no-build" or "null case" to which all alternatives are compared.

Note that the programs can accommodate more information, such as additional intersection movement data, time of day, tolls, etc., to increase the flexibility of the package.

Building a network is more tedious than it is difficult. Depending upon how many roads or transit lines are included, gathering what amounts to a roadway inventory can be a time consuming process. The planner should also realize that, regardless of the care the staff takes in building the network, there will be errors that will require correction. UTPS programs are designed to reveal many of these errors. A very positive spinoff of transit network coding is that the process itself often provides valuable insights about existing and proposed service.

Subsequent Steps

Network development is the first step of the typical transportation planning process. Subsequent steps include:

- *Path Selection* - A medium-sized study area could have over 10,000 ways for a traveler to get from each zone to all other zones. Only a few are direct enough to make sense. UTPS has a program that selects the shortest path between each zone pair.

- *Trip Generation* - The total number of trips that will be made in and through the study area must be determined, usually by relating a trip rate to some land use value, such as 15 trips per household. UTPS does not have a built-in trip generator, since the generation rate can vary dramatically by city. A trip generation method, however, can be specified by the user for operation in a UTPS program.

- *Trip Distribution* - The trips that were generated for each zone in the previous step must be distributed to destinations. UTPS has a program that does this based on the gravity modeling technique. The result is a trip table, which lists, for each zone, trips from that zone to all other zones.

- *Mode Split* - To study a transit system, a *transit trip table* is usually required. Ordinarily, the total trip table is separated (split) into different modes--automobile and transit. Like trip generation rates, the modal split varies between cities. Therefore, a mode split forecasting technique must be designed or selected and tested for local conditions by the user. This step produces an *auto trip table*, after considering auto occupancy, and a *transit trip table*.

- *Trip Assignment* - In this step, trips are assigned to the network. In transit analysis, trips are assigned to the shortest combination of transit lines. For auto trips, highway assignment techniques usually consider congestion, for the shortest path may not have the capacity to carry all of the vehicles that want to use it. UTPS has a program that assigns trips to the shortest path and the best reasonable (less congested) alternative.

Analysis

The ability to compare and display information is an important part of the UTPS package. Computer-drawn maps of the highway system and transit lines illustrate the volumes for each link. Tables and graphs comparing alternatives can easily be generated. Results at the zonal level can be aggregated for larger districts, and the resulting data and tables can be manipulated very easily. Except for the maps (which require a high speed printer or mechanical plotter), all reports can be printed on a desk top computer terminal.

Figure A-5
Link and Line Information

Highway Links

A-Node	B-Node	Link Distance	Time or Speed	Capacity	Number of Lanes	Functional Classification*	Area Type**
38	101	.5	5 min.		1	1	1
39	105	.5	5 min.		1	1	1
101	102	.25	20 mph		4	2	2

*Where functional classification:
1 = access link
2 = local street

**Where area type:
1 = downtown
2 = residential

Transit Links

A-Node	B-Node	Modes***	Link Distance	Time or Speed
38	101	1	.5	4 min.
109	107	4,5,8	.7	5 mph
107	108	4,5	.4	10 mph

***Where mode:
1 = walk access link
2 = auto access link
4 = local bus
5 = express bus
8 = BART

Line Information

Line	Headway	Node	Node	Node	Node	Node	Node	Node
1	10.0	103	802	107	109	111	131	133
2	5.0	103	104	131	142	148		

Appendix B

UTPS Programs

The programs described here constitute the UTPS package (April 1980 release) as delivered on magnetic tape to the potential users. All UTPS documentation is contained on the tape and may be printed by the user. A brief description of the UTPS programs follows:

1. Network Analysis - Transit

INET, the integrated network program, reads highway network and transit line data and writes a transit network description for use by the path building program (UPATH) and the passenger loading program (ULOAD), which can further analyze transit service options. INET greatly simplifies transit network coding by using the coded highway network developed by the highway network builder (HR). Outputs include transit service characteristics such as route miles, travel times, required number of vehicles, vehicle hours, energy consumption, and pollution emissions. In addition, INET can be used in the determination of headways, construction of route schedules, and estimation of operating costs. INET supersedes the old program UNET.

UPATH, the transit path builder, reads the network description from INET and outputs a description of shortest paths between all or selected zone pairs in the study area. The criteria for determining the shortest path include fare, distance, waiting times, and transfer penalties. Output includes matrices of zone-to-zone fares, distances, or a combination of these, and a transit paths file for input to the minimum path summary program *(UPSUM)*.

UPSUM, is the transit path analyzer which reads each minimum path from *UPATH* and outputs matrices providing information about trips on the minimum paths between all zone pairs in the system. This information includes transit running times by mode, walk time, total out-of-vehicle time, transfers, and total travel time, which are used as input to demand models in *UMODEL*.

ULOAD, the transit passenger loading program, loads trips (described in trip tables output by *UMODEL*) on the transit network using minimum paths. ULOAD summarizes, reports, and plots the results. Outputs include a description of the origin destination demand for selected segments of the transit network.

USTOS, the station-to-station transit volume analyzer, reports passenger flows between selected stations in the system. Based on transit paths and trip tables, outputs include station-to-station volumes as well as summaries of access and egress volumes by mode for each station.

2. Network Analysis - Highway

HR, the highway network data collection program, creates or updates a highway network from link data cards. These data include link distances, travel times, facility type, number of lanes, and other characteristics for input to the highway assignment program, *UROAD*. Outputs include a data file describing the highway network for other programs, (e.g., UROAD, NAG, and INET) and printer plots of the network and its associated attributes.

UROAD, the highway analyzer and assignment program, finds shortest (and other) paths based on any combination of time, distance, or tolls. It also assigns trips to the highway network, using one of a variety of techniques selected by the user. Its inputs include the network (from *HR*) and highway trip tables, such as those output by *UMODEL* or *AGM*. Besides an updated historical record with link and turn volumes, *UROAD* outputs origin-destination trip matrices for selected links, impedance matrices, selected paths, link loadings and speeds, VMT, VHT, pollution emission and energy consumption estimates, and plots describing any of the above.

NAG, the network aggregation program, extracts network and travel demand information for a subarea of a region. Called "windowing", this process facilitates micro-level planning, allowing for the creation of a fine-grained network and smaller origin and destination zones. Inputs include *HR* and trip tables, and outputs include an updated (more detailed) network and reports similar to those in *UROAD*.

3. Demand Estimation

UMODEL, the demand model program, accommodates virtually any user-specified travel demand model. A "default" direct demand model is available in *UMODEL* for users who require first-cut estimates and lack the time to construct and calibrate their own model. Inputs include user-provided FORTRAN-coded subroutines, as well as zonal and matrix data. Outputs consist of trip tables or calibration files that can be used by programs *ULOGIT* and *UREGRE*.

UREGRE, the regression program, reads either raw data or calibration files (as output from *UMODEL*) and performs linear multiple regressions according to a set of user specifications. Outputs include regression parameters, goodness-of-fit measures, and other analyses.

ULOGIT, the logit calibration program, calibrates models of the linear logit form, which are particularly useful for mode choice forecasting. Using a calibration file produced from *UMODEL*, it uses a maximum likelihood estimation technique to estimate parameters. Outputs include parameter estimates, plots, and goodness-of-fit statistics.

AGM, the gravity model program, is used to forecast trip distributions. Inputs may include trip tables, zonal production and attraction factors, zone-to-zone friction factors, and other adjustment factors. Outputs may include calibration and forecasting results, with comparison plots of estimated and observed trip tables and trip length frequency distributions.

4. Matrix Operations and Evaluation

MBUILD, the matrix building program, constructs matrices from origin-destination survey records or from calibration files, as output from *UMODEL*. The detection of erroneous and illogical values is accomplished through extensive editing and screening. Trip factoring or data recoding is accomplished through the use of user-specified lookup tables. Output consists of trip tables and edit summaries as well as detailed raw data.

UMATRIX, the matrix manipulation program, performs arithmetic and functional operations on matrix data. Capabilities such as multiplication, division, addition and subtraction, as well as special functions, such as transposition and square roots, are available. The use of logical expressions (if A then B else C) allows for matrix cell modification and facilitates a variety of system evaluation and data preparation activities. A plotting feature enables the posting of data at zonal centroid coordinates.

USQUEX, the matrix expander and compressor, is used to aggregate or disaggregate zonal data. By combining, breaking down, or rearranging matrix data, zones can be consolidated into districts, or new, smaller zones can be created. Inputs are matrices, and outputs include matrices and cards readable by other programs.

UFMTR, the matrix formatting program has the capability to print or to plot the contents of matrices. Outputs are reports and include row-by-row listings of table contents, selected row displays, plots of trip length frequency distributions, and scattergrams comparing two matrices.

5. Sketch Planning

CAPM, the community aggregate planning model, is a highway sketch planning tool designed for the rapid estimation of impacts of various policy alternatives. It can address several issues including the location, magnitude, and functional type of urban highway investments; highway operating strategies; and future land development policies. Inputs include trip-ends and lane miles of freeways and surface arterials. Default values and functions distribute trips, resulting in such system performance measures as construction and maintenance costs, volumes, speeds, fuel consumption, and pollutants.

6. Data Development

UCEN70, a census data processing program, summarizes and converts publicly available U.S. Bureau of Census tapes from census geography to user-defined transportation geography. It is capable of extracting data from 1970 census tapes for first, third, and fourth counts. Simple software modifications will permit this program to process 1980 census tapes when these are available.

UGEN,* the program for accessing the most recent U.S. Census programs in UTPS, automatically translates simple UTPS program statements into computer operating language. It allows users to process, manipulate, and format U.S. Census data, taken from computer tapes, with ease. It is designed for 1980 census tapes.

UGEO,* the address matching program which accesses two other programs (UNIMATCH and ZIPSTAN), allows the user to link up separate data records automatically. For example, a transportation planner can match a file of trip origin-destination addresses to a geographic base file (e.g. GBF/DIME) to determine the transportation zones where all trips start and end. Alternately, local data records (e.g. tax assessor files) can be linked to census records and then be processed and analyzed by other UTPS programs.

*Available in separate release upon request to USDOT, UPM-20.

Appendix D

Transportation Planning Guides

The documents described in this section are especially useful for transportation problems requiring quick responses.

"Land Use and Arterial Spacing in Suburban Areas," FHWA, May 1977. A quick method of analyzing land use arterial capacity relationships. Available from FHWA, HHP-22, Washington, D.C. 20590.

"Characteristics of Urban Travel Demand," (also on UTPS tape). This manual presents demographic and travel demand data from numerous urban areas and transportation systems. Good for making quick estimates or checking travel demand outputs. Available from UMTA, U.S. DOT, UPM-20, Washington, D.C. 20590

"Characteristics of Urban Transportation Systems," (also on UTPS tape). This is a manual for planners giving parameters of cost, speed, capacity, emissions, energy use, etc. For conventional auto and transit modes. A very useful, continuously updated handbook. Also available from NTIS, PS#245-809, $7.00.

"Traveler Response to Transportation System Changes: A Handbook for Transportation Planners", FHWA and UMTA, Feb. 1977. An excellent guide to past experience with system changes such as carpooling, auto free zones, transit route changes, and use of TSM type options. Available from FHWA, HHP-22, Washington, D.C. 20590.

"Analyzing Transit Options for Small Urban Communities" UMTA, January, 1978. A three volume manual providing a framework and supporting analytical techniques to assist in the analysis of transit systems in small urban areas. Comprehensive coverage of service types, setting objectives, patronage and cost estimation, and operations planning is included. Manual procedures are emphasized. Available from UMTA, UPM-20, Washington, D.C. 20590.

"Simplified Aids for Transportation Analysis" UMTA, January, 1979. A continuing series of technical reports, each of which documents a step by step procedure for adressing a particular planning problem. The first six of these are titled:

1. Annotated Bibliography
2. Forecasting Auto Availability and Travel
3. Estimating Ridership and Cost
4. Transit Route Evaluation
5. Estimating Parking Accumulation
6. Fringe Parking Site Requirements

The Simplified Aids are based on methods developed by State and local transportation planners that are not fully documented elsewhere. Available from UMTA, UPM-20, Washington, D.C. 20590.

"Quick-Response Urban Travel Estimation-Manual Techniques for Transferrable Parameters," NCHRP Special Report 187, 1978. A comprehensive manual approach to the traditional urban transportation planning process, including trip generation, distribution, mode choice, auto occupancy, time-of-day, traffic assignments, capacity analysis, and development of density and highway spacing relationships are included. Available from Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. Cost: $10.20.

"Modeling Demand-Responsive Feeder Systems in the UTPS Framework", Transportation Systems Center and UMTA, July 1978. A set of previously developed DRT supply models, representing many-to-many service, many-to-one cycled service, and many-to-one subscription service has been adapted and refined for feeder service analysis. These services are discussed, and general guidelines for designing feeder services offered. The models themselves are described, and program listing provided. In addition, a series of nomographs based on model results have been developed to enable the analyst to predict the service levels of DRT feeder systems under a range of conditions without actually exercising the models themselves. Available from UMTA, UPM-20, Washington, D.C. 20590.

"DPM: Planning for Downtown People Movers," Transportation Systems Center and UMTA, April 1978. A three-volume manual providing state-of-the-art methods and case study examples. Leads the planner from concept stage through crude feasibility studies and refinements leading to engineering design. Manual techniques are emphasized. Available from UMTA, UPM-20, Washington, D.C. 20590.

"Transit Corridor Analysis: A Manual Sketch-Planning Technique," UMTA, April 1979. A quick, first evaluation of short and long range plans for urban line-haul transit systems. The manual computational process relies heavily on graphical aids. Available from UMTA, UPM-20, Washington, D.C. 20590.

"Transit Network Analysis: INET," UMTA, July 1979. A collection of five documents concerning the UTPS Program INET, including a technical introduction, lecture guide, coding hints, case studies, and operating instructions. Available from UMTA, UPM-20, Washington, D.C. 20590.

"Transportation Planning and Impact Forecasting Tools," Urban Consortium, October 1978. A brief overview of issues and problems pertaining to local government use of transportation planning and impact forecasting tools, including UTPS. Available from Public Technology, Inc., 1301 Pennsylvania Avenue, NW, Transportation Section, Washington, D.C. 20004.

This management document was developed with the assistance of many people. Some of those include:

Warren Anderson, Chief, Transportation Planning, City of Baltimore

Gary Barrett, Transportation Director, PTI

Alinda Burke, Vice President, PTI

Fred Burke, Consultant

Les Card, Manager, Transportation Services, City of Irvine

James Clark, Acting Director, Department of Transportation, District of Columbia

Kent Dewell, Deputy Director, Department of Public Works, City of San Jose

Leon Eplan, Commissioner, Budget and Planning, City of Atlanta

Stewart Fischer, Director, Traffic and Transportation Department, City of San Antonio

Edward Hall, Street Transportation Administrator, City of Phoenix

Thomas Hillegass, Chief, Office of Planning Methods and Assistance Division, UMTA, US DOT

Daniel Hoyt, Traffic Commissioner, City of Buffalo

William Hurd, Consultant

Lee Jones, Program Evaluation Specialist, UMTA, US DOT

Gary Kruger, Transportation Planner, City of Seattle

Harvey Lyon, Transportation Division, City of New York

Woodrow Moore, Director, Division of Planning and Programming, Dade County, Florida

Ed Mueller, Executive Director, Jacksonville Transportation Authority

Manuel Padron, Director of Planning, Metropolitan Atlanta Rapid Transit Authority

Granville Paules, Chief, Technology Transfer Division Office of Planning Methods and Support

Norm Paulhus, Technical Coordinator, Technology Sharing Division, OST, US DOT

David Pearl, Transportation Analyst, PTI

Lawrence Quillian, Economist, Office of Planning Methods and Support Division, UMTA, US DOT

Michael Replogle, Transportation Engineer, PTI

S.E. (Ed) Rowe, Principal Traffic Engineer, City of Los Angeles

Deborah Rudolph, DOT/ISETAP Staff Director, Technology Sharing Division, OST, US DOT

Andrew Schlaefli, Supervising Planner, City of San Diego

Robert Selsam, Director, Transportation Division, New York City

Garrison Smith, Deputy Director of Transportation, North Central Texas Council of Governments

William Volk, Managing Director, Champaign-Urban Mass Transit District

Special Acknowledgements

Public Technology, Inc.

PUBLIC
TECHNOLOGY
INC

Public Technology acts as Secretariat to the Urban Consortium. The UC/PTI Transportation Project consists of the following PTI staff and consultants:

- PTI Project Staff:

Gary Barrett,
Director
Doris Ballenger
Rosalyn Dortch
Lisa Jully
Lynn Mitwol
Helene Overly
Edith Page
David Perry
Kathy Perry
Michael Replogle
Peggy Schwartz
Carolene Smith
Leigh Stokes
Erwin Young

Public Technology, Inc.
1301 Pennsylvania Avenue, N.W.
Washington, D.C. 20004
202/626-2400

Department of Transportation

DEPARTMENT OF TRANSPORTATION ★ UNITED STATES OF AMERICA ★

Special acknowledgement is due the following people and offices of the U.S. Department of Transportation for their invaluable support of this project:

Al Linhares, Director
Norm Paulhus, Technical Coordinator
John Hohl, Staff Support
Office of Technology Sharing
Office of the Assistant Secretary for Governmental Affairs

Gran Paules, Division Chief
Office of Planning Methods and Support
Urban Mass Transportation Administration
U.S. Department of Transportation
400 7th Street, S.W.
Washington, D.C. 20590