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Assessment of Transit Passenger Information Systems

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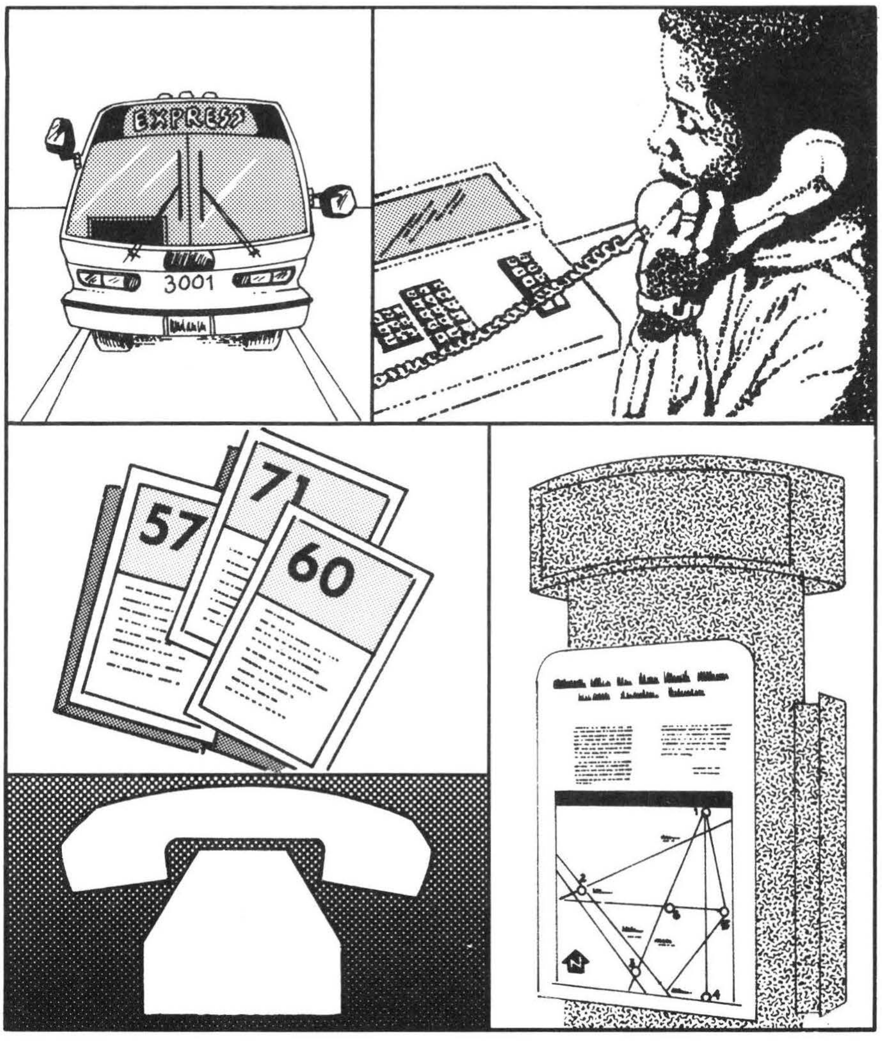

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16. Abstract This report presents the results of an examination of transit passenger information systems (TIS) with particular emphasis on the technology and operations necessary for delivering information to transit passengers over the telephone. The study examined the telephone information systems at three transit authorities, representing three categories of TIS: (1) simple, labor-intensive manual telephone system (Nashville-Davidson County Metropolitan Transit Authority); (2) computer-assisted manual system (Washington Metropolitan Area Transit Authority); and (3) automated system (Hamburg, Germany). Each of these systems is designed to provide transit users with answers to their inquiries regarding transit system schedules, routes and itineraries. A description of how each of these systems works is presented together with information on system performance and system costs.

In addition, descriptions of automated transit passenger information system installations in Ottawa, Ontario, Canada and Columbus, Ohio and of a computerized data storage and retrieval system in Minneapolis-St.Paul are presented. Other current developments in passenger and related information systems are reviewed.

The information and data presented in this report was collected through a comprehensive process involving literature review, telephone interviews, site visits, and discussions with operating personnel. A draft of this report was reviewed by each of the persons contacted for primary data in the study and by the Urban Mass Transportation Administration. Their comments have been incorporated into the final report in a manner which ensures that the objectivity of the assessment is not compromised.

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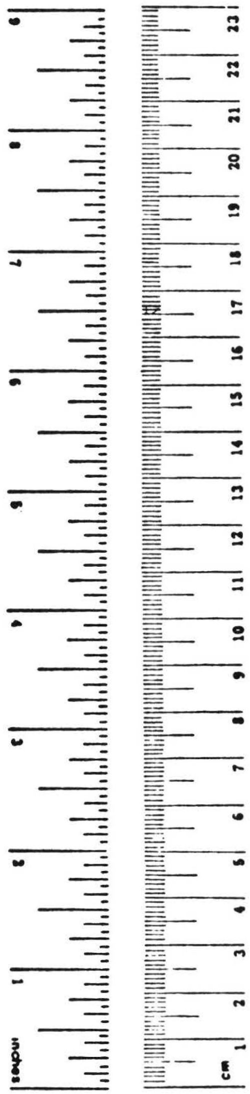
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

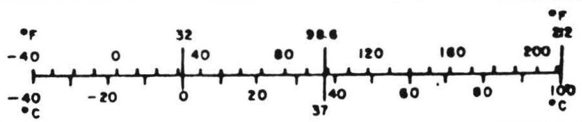
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10.286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	oun	
kg	kilograms	2.2	pou	
t	tonnes (1000 kg)	1.1	sho	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This report presents the results of an examination of transit passenger information systems with particular emphasis on the technology and operations necessary for delivering information to transit passengers over the telephone. The study examined three categories of telephone information systems: (1) simple, labor-intensive manual telephone systems; (2) computer-assisted manual systems; and (3) automated systems designed to provide transit users with answers to their inquiries regarding transit system schedules, routes and itineraries.

This assessment was conducted as part of a project entitled Assessment of Transit Technologies, which emphasizes newly developed technology. The project is funded by the U.S. Department of Transportation, Urban Mass Transportation Administration (UMTA) through its Office of Technical Assistance. The work was carried out by N.D. Lea & Associates, Inc.

The cooperation of many professionals was essential to the success of this effort and their assistance and support was gratifying. The following people in particular contributed significantly to this study:

Mr. Michael Noonchester	Washington Metropolitan Area Transportation Authority (WMATA)
Mrs. Frances Gray	Washington Metropolitan Area Transportation Authority (WMATA)
Mr. Bob Brooks	Nashville Davidson County Metropolitan Transit Authority (MTA)
Mrs. Estella Williams	Nashville Davidson County Metropolitan Transit Authority (MTA)
Mr. William Morris	Teleride Corp.
Mr. James Ahlstrom	Central Ohio Transit Authority (COTA)
Mr. William Bownas	Central Ohio Transit Authority (COTA)
Mrs. Carol Armstrong	Metropolitan Transit Commission (Minneapolis-St. Paul)
Mrs. Mary Whelan	OC Transpo (Ottawa-Carlton, Ontario)
Mr. Fritz Pasquay	Hamburger Verkehrsverbund (HVV)
Mr. Horst Gerland	Friedrichshafen, West Germany
Dr. Heino Nuppnau	SNV Studiengesellschaft Nahverkehr mbH, Hamburg, West Germany

In addition, considerable assistance was obtained from staff members of the Bell System, Mitel Corporation, Rolm Corporation, Communications Group Inc. and Dornier System GmbH (West Germany).

The project staff consisted of Dr. Walter Diewald, the assessment team leader, and Mr. William Frost and Mr. Wolfgang Bamberg, assessment team members. Dr. Diewald managed the project effort and was responsible for the planning and organization of the system assessments and the system performance evaluation efforts. Mr. Frost researched and prepared the sections describing the passenger information systems and the WMATA AIDS system description. Mr. Bamberg prepared the section on the Hamburg AFI system. Mr. John Barber, UMTA Program Manager and Contracting Officer's Technical Representative (COTR), and Mr. John Durham of the UMTA Office of Technical Assistance, provided valuable support and guidance.

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1.0 EXECUTIVE SUMMARY

1.1 DESCRIPTION OF PASSENGER INFORMATION SYSTEMS

Passenger information services represent a major marketing activity and are organizationally located within the marketing group of most transit agencies. Recognition that transit is in the business of selling a service to its customers has led to increased efforts toward understanding and using marketing tools and devices to promote transit. Passenger information consists of maps, schedules, signs, and other components used to educate the potential rider on the use of the transit system and is a significant element of the marketing effort.

1.2 TRANSIT MARKETING ACTIVITIES

The marketing activities of a transit agency are aimed at tailoring services to potential customers and meeting their transportation needs. Working with the transit planner the marketing group attempts to locate the market by establishing the nature of the travel demand of the service area; market segmentation efforts are aimed at identifying specific market segments and examining how appropriate services can be provided. A marketing mix is developed which combines various services, fares and promotions to meet the needs of as many market segments as possible.

Transit advertising is used to inform the public, to stimulate demand, and to promote positive attitudes toward transit. Transit advertising is accomplished through various media and, if appropriately targeted, can provide useful passenger information messages.

A transit marketing component which has become an essential source of passenger information is the telephone information system. Telephone information systems have, in many cases, evolved from a single receptionist or secretary answering inquiries regarding schedules, routes, or fares to highly complex telephone switching systems serving numerous information agents whose sole responsibility is to answer system-related questions from callers desirous of using the transit system.

1.3 FUNCTIONS OF A PASSENGER INFORMATION SYSTEM

The passenger information system has two main functions to perform. It provides general information about how to make a trip and where to get more specific information; it also provides specific trip information on how to use the transit system. General information about services relates to the type and extent of the transit network, i.e., hours, fares and special services. It includes information about how to use the system and about routes.

Specific information includes more detailed routing information, station/stop locations, schedules, transfer locations and the like.

1.4 COMPONENTS OF A PASSENGER INFORMATION SYSTEM

The following provides a listing and brief explanation of the major components of a passenger information system.

- Comprehensive system map - presents a complete map of the service area and coverage, showing all the transit routes and transfer points; often includes information on hours of service, fare structure, and special services.

- Station orientation map - consists of a local street map with the location of station entrances marked to help passengers orient themselves.

- Route map/timetable - prepared and distributed for each bus or transit route; timetable gives departure times for 24-hour period.

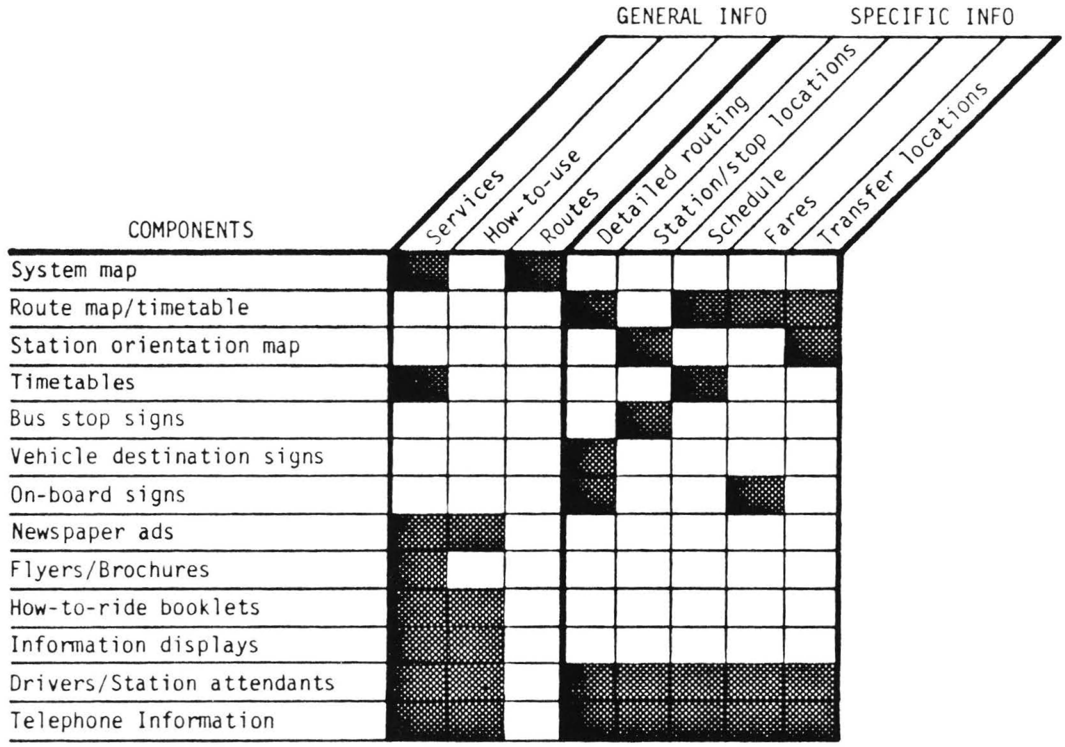
- System schedule - book of schedules for every route in the system; not often distributed in U.S. transit systems.

- Station and stop signs - identify places where riders board vehicles to enter system and indicate routes which serve each stop.

- Vehicle destination signs - located on front and, possibly, sides of vehicles.
- On-board signs - provide additional route, station, schedule, and/or fare information.
- Newspaper advertising - used to encourage ridership, introduce new services, publicize system changes, etc.
- Flyers and brochures - used like newspaper advertising but often focussed at a particular market segment.
- How-to-ride booklets - generally a direct-mail item used to promote transit services.
- Information displays - made up of much of the above information and usually set up at a conspicuous location in a public place.
- Drivers - provide an important and immediate source of often much-needed information.
- Station attendants - provide an important function much like drivers.
- Telephone information systems - usually comprised of a group of information agents who answer queries about transit services.

1.5 FUNCTIONAL CAPABILITY OF COMPONENTS

With regard to the functions and components of passenger information systems, the following illustrates which functions each component of the information system performs:



1.6 DESCRIPTION OF TELEPHONE INFORMATION SYSTEMS

1.6.1 Purpose of Telephone Information Systems

In North America, a telephone information system (TIS) is generally accepted as an essential means for delivering specific information about transit service and is the most complete single source of detailed transit information. The objectives of a TIS are threefold:

(1) Personalized service. Through a dialogue with an information agent, the prospective rider can obtain all the information needed to make a specific transit trip, including route, schedule, fare, and travel time information.

(2) Convenience. Telephone information can be obtained via any telephone during information system operating hours.

(3) Special information. The transit agency can disseminate information about service interruptions, special services, or new routes and schedules via their telephone information systems.

1.6.2 Functional Analysis

A TIS must be capable of performing the following functions:

(1) Call intercept. Calls are answered or put on hold, or given a busy signal.

(2) Call routing. Calls are assigned to an information-handling component such as an information agent.

(3) Information request. The caller is asked to provide essential information regarding the trip involved.

(4) Data input. The caller's information is fed into the information-handling system.

(5) Information handling. Storage, retrieval, and calculations related to transit system route and schedule information.

(6) Data output. Information regarding stations and stops, routes and transfers, departure time, arrival time, and fares is generated for use by the information agent.

(7) Dissemination to caller. The information which has been calculated and read out is given to the caller.

1.6.3 System Components

In order for an exchange of information to take place the TIS requires both communications and information-handling components. Information systems use different combinations of components depending upon the needs and level of sophistication of the system. The complexity of the information system usually reflects call-demand upon the system and the size and complexity of the transit system. The system components include the following:

(1) Telephone equipment. The telephone equipment is the communications link between the caller and the information-handling system or the information agent. The types of telephone equipment on the market vary a great deal in cost and capability. A simple call director gives every telephone receiver (information agent station) direct access to all incoming trunk lines. Each agent has the capability to answer outside calls by depressing a lighted key. A call sequencer is used to separate the trunk lines from the agents' phones and places all incoming calls in a holding queue; voice recordings and music can be featured until an agent answers the call. An automatic call distributor (ACD) handles calls similarly to the call sequencer and has the added feature of routing calls to available agents in a predetermined queuing strategy. A Private Branch Exchange (PBX) or Private Automatic Branch Exchange (PABX) is a user-owned internal telephone switch. The newest generation of PABX equipment is computerized with capability to customize service to each receiver in the system. A Centrex system is similar to a PABX but is owned and operated by the local telephone company. A management information system known as Station Message Detail Recording (SMDR), is a sophisticated form of traffic reporting and performance measurement for the telephone systems described above; it is one of the major features of a computerized ACD or a PABX. The SMDR provides reports on agent performance, traffic information, and trunk usage.

(2) Microfiche readers. Microfiche is a medium of information storage whereby hard-copy data is filmed and the microfiche film is then projected via microfiche readers for use by information agents. Transit

schedule and route information, which changes often, is not economically treated by microfiche systems.

(3) Computers. Computers can be used for storage and information retrieval as well as performing elaborate search and comparison endeavors regarding transit information. As the computer electronics field continues to grow, system hardware of increased size should be more readily affordable. Computer software, the programs which process data, will be written for each application, since each transit system has a different route and schedule configuration, as well as different management and marketing philosophies. Custom software for a TIS is an expensive item.

(4) Video display terminals (VDT). VDTs, also known as CRT (cathode ray tube) terminals, are the most common method of communicating with a computer. Information agents can use the VDT to retrieve all the necessary information from the computer, as needed, and then they can erase the display once they have passed the information on to the caller.

(5) Information agents. The information agent is the most important element in all but totally automated telephone information systems; the agent has a key role in communications and, in simpler systems, is responsible for all information retrieval and calculation as well. Experienced agents can work twice as fast as novices and with better accuracy. Capabilities of information agents depend in large part on their experience and training.

1.6.4 Categorization of Telephone Information Systems

Four broad categories which encompass all functions and equipment of a Telephone Information System (TIS) have been chosen as follows:

(1) Manual systems. A manual TIS utilizes an information agent for communications with the caller and for determining the response to the caller based upon some type of "hard copy" data base. The data base can consist of route maps, local street maps, headway sheets, drivers'

schedules, timetables, notes and memos the agent uses as memory aids, daily bulletins on service interruptions or street closings, and other such information.

(2) Microfiche-assisted manual systems. Microfiche-based systems operate on much the same way as manual systems, except that the system data and information are stored on microfilm which is accessed via an automatic retrieval reader. Each agent is provided with microfiche reader and a full set of microfilmed data.

(3) Computer-assisted manual systems. Computer-assisted systems can be used as a simple electronic data storage device or they can, through appropriate software development, be used to calculate itineraries, transfers, and fares for the caller based upon inputs regarding origin, destination, and time of travel. Each agent is provided with a video display terminal (VDT) which enables the agent to query and access data from the computer.

(4) Automated systems. Automated systems are the most technologically sophisticated of the information systems and each system which has been developed thus far is unique, both in capabilities and in hardware. A system has been developed which provides an automatic response to a call to each specially designated telephone number, the response being information about the next arriving bus or buses at a stop. Another system permits some dialogue with a computer data base via the telephone dialing mechanism and a predetermined logic sequence. In this way, automated systems, i.e., those without an information agent, provide an answer to preset questions or require additional (dialing) activities by the caller.

1.7 EVALUATION OF PERFORMANCE

The operation of a TIS can be costly; but at a time when transit agencies are trying to increase ridership and improve service the TIS is an important asset. It is often the first connection between prospective customer and transit agency.

Besides providing personalized information service, customer convenience, and emergency information, the TIS is recognized as a necessity for an accessible public transit system. In addition, the TIS enables the transit agency to make schedule and route changes which it might otherwise delay if it were solely dependent upon printed information materials. This aspect is discussed in more detail below in view of current operational settings. Following this are findings regarding the indicators currently being used to measure performance in terms of operations, technology, labor productivity and system costs.

The value of a TIS cannot be expressed solely in terms of the generation of fare-box revenues. It must be seen in terms of the current needs of transit management and the tools that are being used. For example, RUCUS provides the transit operator with the ability to change schedules more quickly and efficiently than ever before. But, it also poses a problem of getting schedule and route information to the transit user (and others wishing to use transit) quickly, efficiently, and more often than in the past when routes and schedules were seldom changed. OC Transpo of Ottawa-Carleton in Canada states this as the primary reason for initiating its "560" automated telephone information system.

Another new tool being examined and used by many transit operators is the automatic passenger counting device. The data obtained with these devices enables the transit operator to more quickly respond to actual passenger demand through the adjustment of schedules and/or routes aimed at increasing ridership improving farebox revenues. Coupled with RUCUS the transit passenger information system provides the transit operator with the data and procedures he needs to optimize his transit operations. However, the task remains to inform the transit user or potential user. Today this is accomplished with a TIS. The TIS is easily promoted as the source of information and it does not incur the printing and distribution delays of a system based solely on print media. (Printed materials nevertheless remain a necessity, complementing or supplementing the telephone-based system.)

The TIS thus can be seen to be part of an evolving process which includes automatic passenger counters, RUCUS as well as the telephone information system. Without the TIS the other two elements of the process would not be nearly as effective.

1.7.1 Operations

With regard to TIS operations, data have been collected at a number of transit agencies which are helpful in understanding TIS functions and in examining what is being accomplished in TIS operations. The available data are very limited, represent only a small number of transit agencies, and have been collected for very short time periods at these agencies. Information which has been gathered thus far is presented below:

(1) Number of calls arriving during selected time periods. The number of calls into a TIS has hourly and daily distributions which vary among systems. The data suggest that incoming calls tend to have two peaks during the day, one in the morning and another during or just after the noon lunch period. The daily call data indicate that the call demand is highest on Monday, tapering rather uniformly through the week with, possibly, a slight increase on Friday.

(2) Time required per call. The total time required per call (for manual systems) averages about two minutes and appears to be consistent among the properties for which data was gathered.

(3) Time required for information retrieval. For manual systems, it is the search and retrieval components which, for a given set of questions, can be reduced through improved equipment and techniques. From the available data it appears that the communication time is fairly constant and is more than half the total time required per call.

(4) Calls per agent. The number of calls per agent (per unit time) varies as a function of the complexity of the TIS, the nature of the inquiries, and other factors. The data suggest that although an average rate of 30 calls per hour (and maybe higher) is achievable, particularly over short time periods, 20 calls per hour is a more likely rate at which information agents can be expected to function throughout the working day.

(5) Percent lost calls. A lost call represents a caller who is put on hold by an information agent or by automatic answering equipment, because all agents are busy, and who hangs up before ever reaching an agent or receiving any information. Such a caller may call again. Lost call rates range from 10 to 43 percent.

(6) Queue-related measures. Average time in the queue or average wait time and average queue length, though closely related to the queuing model analysis approach to the representation of the (transit) telephone information process, have not been subjected to a data-gathering effort with regard to a TIS.

(7) Percent time lines are busy. No evidence was found that data on the percent of time that a caller gets a busy signal when he calls the TIS have been collected. The Hamburg AFI system is sized so that no more than 3 percent of all calls get a busy signal.

1.7.2 Technology

In evaluating performance there is a need to examine the various equipment components, their individual reliability/maintainability characteristics and the impact which these characteristics have upon performance of a TIS. The TIS equipment has specific performance characteristics and, when used in combination with other equipment and information agents, results in specific service attributes. There is little evidence that performance studies have been carried out or that studies of the trade-offs which exist in equipment, personnel, and service have been conducted. This is an area which requires further investigation, both in terms of selecting appropriate technology for specific tasks and in terms of evaluating technology performance.

1.7.3 Labor Productivity

Labor productivity is an important issue in evaluating the performance of a TIS because labor represents a major cost element for any TIS. Labor productivity can be examined in terms of the following: calls per agent per time period; time per call; and time for information retrieval. Response quality is another important agent-related indicator; it does not directly relate to labor productivity but it is of major importance with regard to customer relations. These indicators, together with the information available on typical observed values, have been discussed with regard to TIS operations above (see Section 1.7.1).

1.7.4 System Costs

The major elements of total cost for a TIS include the following:

(1) information agents (for all but completely automated systems)
(2) furniture
(3) space preparation
(4) telephone equipment
(5) physical plant overhead
(6) information agent training
(7) data base management
(8) computer space preparation (for automated systems)
(9) computer software development (for automated systems)
(10) computer hardware (for automated systems)
(11) computer operations (for automated systems)
(12) computer terminals (for automated systems)

A previous study has noted that the cost associated with a particular element category may vary in magnitude between different systems. A TIS is largely tailored for each transit system application and reflects the size and preferences of the transit agency involved.

Available data on costs of a TIS are limited. From a survey taken in 1979, data indicated that for a sample of 19 TIS systems, estimates ranged from $0.12 per call to $1.00 per call. (The mean was $0.40 per call.) These numbers do not take account of variations in transit system size, TIS service provided, TIS equipment involved, etc.

1.7.5 Value of a Call

One of the more difficult aspects of assessing a TIS is estimating the value of a call into the system. It is generally assumed that a telephone call into the TIS is initiated by a prospective transit user and that by providing the appropriate information the TIS will enable the caller to become a revenue passenger. No study has yet assessed the actual revenue-producing capability of a TIS call although WMATA is currently undertaking such an effort. Attendees at an UMTA-sponsored TIS workshop estimated in an informal survey that one call can generate from one-third to one-half an average fare. Discussions with transit marketing specialists indicate that these estimates may be high for small-to-medium-sized transit agencies. Nevertheless, the consensus of opinion among transit marketing experts is that a TIS is a valuable tool. More discussion concerning the value of a call can be found relating to the cost of a call in Section 1.8.1.4.

1.8 ASSESSMENTS OF THREE REPRESENTATIVE TELEPHONE INFORMATION SYSTEMS

Three representative TISs which range in technical complexity from a labor-intensive, manual system to a fully-automated, computerized system were examined. The three consisted of the manual system at the Nashville-Davidson County Metropolitan Transit Authority (MTA); the computerized Automated Information Directory System (AIDS) at WMATA in Washington, D.C.; and the fully-automated, computerized AFI system in Hamburg, Germany.

1.8.1 Nashville-Davidson County MTA Manual System Assessment

1.8.1.1 General Information

The Nashville-Davidson County (Tennessee) Metropolitan Transit Authority (MTA) operates approximately 120 buses on 32 routes over an area of 1,377 km^2. The system had 9,763,500 passengers (7,355,200 revenue passengers) in 1981. Revenue passengers have declined 37 percent from 1964 to 1981, while vehicle miles have decreased 5 percent during the same period. The typical MTA frequent rider uses MTA three days per week for one of five almost equally important reasons, i.e., to go downtown, to save money, because no car is available, to get to work, and for convenience.

MTA's information dissemination program focuses on the telephone information center and the distribution and display of printed materials. Printed materials include timetables with maps for each route, a system map with "how-to-ride" advice, ridesharing promotion brochures and "flyers". Newly installed bus stop signs (in the downtown area) provide the number and name of each route serving that stop; they also provide the TIS access number as do all printed materials distributed by the MTA.

1.8.1.2 MTA Telephone Information System Description

The MTA telephone information center operates from 6:00 a.m. to 7:00 p.m., Monday through Friday, and from 8:00 a.m. to 5:00 p.m. on Saturday. The number of information agents on duty varies during the day and during the week, the maximum being seven. The average number of calls handled per day is 1,400, the maximum about 4,500. An information agent handles an average of 250 calls per day, a maximum of about 500 calls per day. Available data indicate a pattern of a call demand peak on Monday with a daily decrease until demand increases again on Thursday and Friday.

The information agents are located in a single office with six desks for the information agents and a partitioned space and desk for the Director of Information; no additional dividers or sound-deadening materials are used.

The system hardware consists of six call directors with a rotary system. Seven incoming lines are used by the information center; an eighth line, dedicated to ridesharing information, is also manned by the information agents. An automatic answering device is used when the phones are not being manned. There is a TTY system for the hearing-impaired at a specially designated number.

The TIS is manual, utilizing hard-copy data storage. The MTA information agents respond to inquiries from memory and/or through the use of printed schedules, route maps, and route descriptions which they keep at their desks. The caller is generally asked to provide information regarding his location, destination, and arrival and/or departure times. Once these inputs are established, the agent can determine the appropriate response and convey it to the caller.

The telephone information center is perceived by the MTA as a public service operation provided for customers seeking any information about MTA service. Telephone information agents respond to all calls, including those which are not related to MTA business. Agents are encouraged to intercept all calls and to put callers on hold if necessary; this is believed to make the agents more aware of the waiting caller and encourages them to get back to the waiting caller as soon as possible. An automatic system which puts the caller on hold and provides an informative message or provides background music is considered to be too impersonal.

The MTA information agents are high school graduates who must have a good knowledge of the city. There are no training manuals; rather, the MTA relies on individualized instruction and on-the-job training. Agent training lasts from four to six weeks. As necessary, the agents are sent out to ride the bus routes with which they are unfamiliar.

1.8.1.3 Performance Characteristics and Measures

Individual agent call data are not routinely collected but agent performance is examined via direct observation. It was estimated that the average time per call is less than two minutes and that 60 percent of all calls are one minute or less. An internal study of agent activities revealed that there are very few lost calls and that a call is usually answered within three rings. No lost call information is available although it would be possible to request that it be collected by the local phone company.

1.8.1.4 Telephone System Costs

Annual cost of operating the MTA telephone information system is approximately $138,200. Based upon the weekly call records the annual number of calls is between 300,000 and 400,000 calls. The per-call cost therefore ranges between $0.30 and $0.37.

1.8.1.5 Telephone System Evaluation

The Nashville-Davidson County MTA telephone information system appears to be typical for a transit system and an urban area of this size. The MTA system has evolved from a single receptionist answering inquiries into the transit system and is currently organized to provide responses to all inquiries; it is strongly oriented to the public relations objectives of a TIS and of transit marketing.

The average number of calls handled per day is 1,400, the maximum about 4,500. An information agent can handle an average of 250 calls per day, a maximum of about 500 calls per day. No information is available regarding time required per call, time required for information retrieval, or percent lost calls.

The MTA plans no major changes in equipment or operation in the foreseeable future. The orietation toward public service will be retained.

1.8.2 WMATA AIDS System Assessment

1.8.2.1 General Information

The Washington Metropolitan Area Transit Authority (WMATA) serves a metropolitan Washington, D.C. population of more than three million. WMATA operates about 1,767 buses over 775 bus routes (143 bus lines), and four rail lines which cover 67.8 km. The 1981 system ridership was 182,532,237.

WMATA was created in January 1973 from four private transit companies. Since that time marketing has always been considered one of the most important functions of the organization. Since rail system operation was initiated in 1976, the public information system has been the focus of much attention and effort because of the need to provide customers with current information about the new system and about changes in the bus system. In 1982 there were 57 information agents with up to 30 on duty at one time.

By 1974 WMATA identified a need for an information storage and retrieval system which was more efficient than both hard copy and microfiche systems; a report set forth the basic requirements for the Automated Information Directory System (AIDS) and compared it with other generic system types. Since that time, work on the AIDS system has progressed through the development of system specifications (July 1977) to the implementation of AIDS in March 1981.

1.8.2.2 WMATA Telephone Information System Description

The WMATA telephone information system is in operation from 6:00 a.m. to 11:30 p.m. daily. It receives 200,000 calls in a typical month, between 5,000 and 9,000 calls per day. Peak calling days during the week are Mondays and Tuesdays. Specific daily peaks are 9:00 a.m. to 11:00 a.m. and 2:30 p.m. to 5:00 p.m. The average call load per agent is 180 calls per day; the maximum is approximately 300 calls per day. The information agent staff consists of 57 agents and seven supervisors with one trainer and an AIDS data base coordinator.

WMATA currently uses a Stromberg-Carlson Automatic Call Distributor (ACD) Telephone System. It has the capacity for 50 trunks, 30 lines, and 30 receivers. Calls are answered and put on hold automatically, then routed to an agent. Calls are queued and released on the basis of first-in and first-out. The system has provision for recorded announcements, which callers intercept in a recorded loop. Three basic recordings are used: one which operates during the attended period, a second which operates at night when there is no one to answer the calls, and a third for holiday service. The ACD system is equipped with a peg counter which counts the number of calls received and the number of calls answered. It also maintains a count of the number of calls handled at each work station.

WMATA utilizes Hazeltine 1510 video display terminals (VDT) and two identical Hewlett-Packard HP 3000 Series II computers for fail-safe operation. The computers are dedicated to the TIS during the hours it is in operation; in the off-hours they are used for related activities, including generation of bus stop files, landmark files, and lists of routes for cost allocation.

The applications program for the AIDS system was custom written for the system. It includes data base search, retrieval, and handling. The geographic data base was constructed by overlaying a grid of squares 25 ft (7.6 m) on a side on the Washington region. Thirteen thousand bus stops, 700 routes, 26,000 streets, 40,000 intersections, and other landmarks are located by coordinates on the grid.

The AIDS system provides agents with a prompting method of data entry. The system displays (on the VDT) a series of statements and blanks to be filled in by the agent. When all entries are completed, the system evaluates the entries to determine the type of query and selection ranking and then performs the necessary calculations. If there is an input error the system displays a prompting message so the agent can reenter the data. Once the entry has been made properly, the system continues handling the transaction normally.

The AIDS system has a specific set of calculations and a display for the four major types of queries upon which the data retrieval system is based, i.e., trip itinerary, boarding time, bus/rail stop location, and service information. The system retains information in response to any or all of the preceding query types and then permits follow-on queries. Route calculations can be made on the basis of bus only or rail only travel, for a particular day of the week, for arrival or departure times, and for current information or for information that will be correct after an upcoming schedule change.

Information agents at WMATA are given a five-week training course in the transit system and the TIS before they are put to work full time. An extensive training manual emphasizes the sales aspects of the job. Attitude and courtesy are stressed; agents are trained to treat callers as important customers at all times. Agent training involves all information sources at hand, i.e., AIDS, printed schedules and route maps, and their own knowledge of the system. System familiarization involves learning the routes and schedules from maps and headway sheets, and learning the routes and route surroundings from riding trains and buses.

1.8.2.3 AIDS Performance Characteristics and Measures

In 1982 the average information agent at WMATA handled 22 calls per hour and 179 calls per day. Choice of information materials is left up to each agent, so these figures include use of AIDS, manual information retrieval, and answers from memory. Lost calls range from 10% to 20% of calls received.

1.8.2.4 Telephone Information System Costs

Operating costs are estimated at approximately $1,743,950 annually, while the total capital cost of the AIDS system was approximately $1,258,000. Daily call counts are approximately 6,000 calls resulting in an annual total of 2,190,000 calls. The operating cost per call is on the order of $0.80. If the AIDS development costs are amortized over a ten-year period, the resulting TIS cost per call is estimated at $0.86.

1.8.2.5 Telephone Information System Evaluation

The implementation of AIDS at WMATA was originally an UMTA-sponsored demonstration of new technology rather than the application of existing technology. UMTA's goal was to determine if a computer system could be developed which would provide for automation of the telephone information function. An evaluation of AIDS must take account of this first-of-a-kind application.

Careful examination of AIDS indicates that UMTA's goal of demonstrating computer technology for a TIS has been met satisfactorily. The system is workable, useful, and, after the initial debugging period, has not required an inordinate amount of maintenance and repair.

The AIDS demonstration has resulted in a working system which operates successfully every day in a real-world environment. The AIDS system has become an essential tool for the WMATA information agents; it has not replaced agent memory or the hard-copy data base used in the past, but it complements them as a data and information source. The fact that the agents use AIDS and rely on it for certain types of inquiries is important evidence of its technological success.

The AIDS system has shown that automated information retrieval and calculation is a substitute for a portion of inquiries, but not all. Information agents have shown that they can answer certain inquiries faster and as effectively as the computer. AIDS-only calls are most likely to be itinerary requests which is not surprising in view of the complexity of these types of calls. On the other hand, agent familiarity with certain data or responses will result in AIDS being bypassed ir order to provide the caller with a quicker response.

1.8.3 Hamburg Automated System Assessment

1.8.3.1 General Information

The Hamburg Transport Association (Hamburger Verkehrsverbund-HVV), which consists of nine member organizations, serves a metropolitan area of about 3,000 km^2 and a population of 2,440,000. The multi-modal transit system in Hamburg includes rapid rail, subway, bus, and waterborne transit.

Hamburg's transit marketing has two major thrusts, the local press and advertising. Press releases are regularly prepared for local papers, publications, radio and television. Advertisements in local papers emphasize the service and special fares which show transit to be attractive compared to private automobile trips.

The conventional central telephone information service has been in operation since 1980. It is completely manual and concentrates previously decentralized functions under one published telephone number at the Hamburg Transit Association (HVV). Total staff for the system is five. It operates on weekdays from 7:00 a.m. to 10:00 p.m. In the absence of the automated telephone information service, approximately 500 to 600 calls per weekday were serviced by the manual system. Of these calls, about 60 percent are related to schedule information, about 28 percent to fares, and about 12 percent are classified as other.

1.8.3.2 Automated Telephone Information System Description

The automated telephone information system (AFI-Automatische Fahrplan Information) in Hamburg provides 24-hour access to full, vocal schedule information for a limited user group. AFI, which uses no human information agents, is capable of user-machine dialogue utilizing synthetic voice generation.

The AFI system resulted after the need for a TIS was recognized by HVV and after it was decided that an automated system was needed in order to keep personnel costs to a minimum. Major design and development work was performed during an 18-month period in 1978 and 1979 with funding provided by the Federal Ministry for Research and Development (Bundesministerium fur Forschung und Technologie). From June 1979 until May 1981 the AFI automated telephone was operated as a demonstration and test system in Hamburg. At the completion of this demonstration, work was continued on development of final modifications to the hardware, software, and operation of the system.

The AFI system consists of three main components;

(1) a central processor unit which stores all schedule data and which computes the "best" connection based upon trip request inputs;

(2) five automated auxiliary machines which provide hard-copy printouts for the trip information after user input of destination code numbers;

(3) the telephone interface system which includes the speech generation equipment.

A DEC PDP 11560-CD was used as the central processing computer. Nine CAMAC-Telephone Interface Modules, routed through a Multiple Call Director, were used for speech output. Nine Speech-Vocoders interface with the CAMAC controllers. An eight-channel multiplexer transmits signals between the central processor and the five automated auxiliary machines over hard-wired communications lines. The caller communicates with the system either over the keyboard on the automated auxiliary machines, or over a telephone at home or any public telephone in the local call area.

The system software is programmed in FORTRAN IV. The route search routine is designed to select the optimum route for the user from a large number of possible connections between the origin and destination points. The auxiliary machines provide a printout through a dispenser slot to the passenger.

The most widely used access to the system was via telephone. The caller uses code numbers for his origin and destination and inputs them by dialing the code numbers on the telephone. The dialogue sequence starts with the machine requesting the required inputs from the user. The caller then dials the code numbers in a predetermined sequence. Special note pads are available to help the caller. If the caller makes an input error, dialing 99 allows him to start the sequence again from the beginning without losing the connection.

1.8.3.3 AFI System Performance

The Hamburg AFI system application was a test and demonstration program. The distribution of directories for system codes and the number of automatic auxiliary machines which were installed was limited in number. Once system use stabilized the average demand upon the system was about 1,000 calls per day and 100 calls per peak hour. An extrapolation to the 750,000 households in Hamburg projects to approximately 10,000 to 12,000 calls per day with a projected peak hour frequency of 1,000 calls per hour.

It takes approximately three minutes to obtain a trip recommendation although experienced users require two minutes or less. The system is sized so that no more than three percent of incoming calls encounter a busy signal so lost calls are not a problem; this is according to national telephone system regulations.

1.8.3.4 AFI System Costs

Estimates for the cost of an expanded system (for approximately 2.4 million persons) with 80 incoming telephone lines and capacity for 10,000 to 12,000 calls per day have been made. Capital costs for such a system would be DM 2.5 million (approximately U.S. $1.25 million); annual costs including O&M would be DM 0.9 to 1.0 million, and approximately DM 0.5 million for annualized capital costs.

1.8.3.5 AFI System Evaluation

Most of the problems encountered with the AFI system during the demonstration were with the software and the automatic auxiliary information machines. The reliability of these machines was low and there are no plans to use them again. Improvements were made to the computer software and the computer-generated voice. The central processor performed well.

A potential limitation in some application areas is the lack of accessibility with some telephone systems when the caller is outside the local call area. Long distance call usage was not possible in Hamburg. Touchtone telephone systems, not the norm in Germany, provide unlimited access.

Surveys performed during the operation of the system indicated the following:

(1) user frequency stabilized at 10 percent of the test population using the system, an average of 1.4 calls per week per subject

(2) more than 75 percent of the callers also made a trip

(3) one-third of the test population made transit trips for which a private automobile would have otherwise been used

(4) most of the trips resulting from system use were nonwork or occasional trips, thereby increasing transit utilization.

1.9 ADDITIONAL TRANSIT TELEPHONE INFORMATION SYSTEM TECHNOLOGIES

1.9.1 Telerider* Systems

Telerider is an automated schedule information system which enables a caller, by dialing a special telephone number, to obtain information regarding the scheduled arrival of buses (usually the next two to arrive) at a particular stop, as well as preprogrammed status information and public service messages for the route and/or the transit system in general. Each bus stop can be assigned its own telephone number and the computerized Telerider data base and voice digitizer equipment provide the specific information desired within a short period of time and without the cost or delays of information agents. Telerider includes an automatic message-shortening capability which is activated when almost all the telephone trunk lines are busy. This provides an automatic capacity increase in the event of high demand without the cost of adding more capacity.

The Telerider computer (both DEC and IBM Series I hardware have been used) has two basic data bases, a stop file and a schedule file. An incoming call actuates the stop file first (since each telephone number identifies a unique bus stop location) and then a request is made to the schedule file for information. Additional messages can be accommodated. Informational inquiries other than those regarding schedules must be made to some other service and handled by an information agent.

1.9.1.1 Telerider in Ottawa, Ontario, Canada

In September 1980, OC Transpo (the regional transit authority in Ottawa-Carleton, Ontario, Canada) initiated operation of a Telerider system to handle the estimated 40 percent of all calls into its conventional telephone information system which request schedule information only. Telerider has enabled OC Transpo to accommodate the schedule information requirements which result from changes in schedules and routes. It was also installed in the hopes of increasing ridership during the off-peak period. OC Transpo assumed that the Telerider system would provide

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* Telerider is a registered trademark of the Teleride Corporation.

the off-peak rider with the information necessary to enable him to use the system without undue waiting and delays.

In two separate comparison evaluations each covering a total of four weeks, OC Transpo found that the automated schedule information had a favorable impact on both public perception of the transit system and transit ridership. Between April 1980 and January 1981, the increase in transit ridership in the neighborhood with Teleride service was greater in each period (peak, midday, and evening) than in the control neighborhood without Telerider.

1.9.1.2 Telerider in Columbus, Ohio

In April 1982 the Central Ohio Transit Authority (COTA) in Columbus, Ohio initiated service for a Telerider installation on three of its urban routes. The installation is designed as a one-year test of the Telerider automated telephone information system. Revenue and ridership as well as Telerider inquiries will be monitored for three Telerider routes and for three similar "control" routes during the test period. If comparative revenue increases on the three Telerider routes meet predetermined levels, Telerider will be expanded to include all routes served by COTA in Columbus. Initially Telerider was been found to be primarily a "foul weather" device whereby transit riders could better schedule their arrival at a bus stop to more closely coincide with the bus arrival. A comparison between four-week periods in January/February 1982 and 1983 did demonstrate a 7% better revenue performance on the Telerider routes vs. the control routes. As a result COTA has decided to expand Telerider to the entire service area.

1.9.2 Computerized Data Storage and Retrieval in Minneapolis-St. Paul

The Metropolitan Transit Commission (MTC) of Minneapolis-St. Paul has installed a computerized data storage and retrieval system for use by its Telephone Information Center (TIC) information agents. Data is stored according to the following classifications:

(1) RUCUS updates: headway files on all bus routes.
(2) Supervisor updates: headway and nonheadway revisions.

(3) Inquiry transactions: records regarding inquiries into the system.

The computer system does not perform any calculations or searches; it is designed to provide data which is normally in hard-copy form in quick and efficient manner on a VDT screen.

1.10 OTHER DEVELOPMENTS IN PASSENGER AND RELATED INFORMATION SYSTEMS

1.10.1 Automatic Passenger Information Machines in Germany

The German National Railway System has implemented an automated information system at many major station locations. The system consists of an automatic machine which passengers can use to obtain itinerary and schedule information for rail travel. Origin and destination information is input via three-digit location codes. Printed information is generated by a computer terminal and presented on special trilingual forms which are retained by the passenger. The information provided includes departure times and locations, train types, train arrival times, transfer information, and details on fares.

1.10.2 Computer-Generated Public Transport Information in Britain

The Transport and Road Research Laboratory (TRRL) in Great Britain has prepared a computerized system for determining optimum routings over the public transport network of bus, rail, and coach services within the country. The computer algorithms are based on the minimization of overall travel time but do not preclude the output of other optional routings that are not the quickest but are worthy of consideration. The system has been used experimentally thus far and may be given wider application in the future.

1.10.3 Federal Aviation Administration Voice Response System

The U.S. Federal Aviation Administration (FAA) is testing an automated weather information system for pilot preflight planning. By dialing via any push-button telephone a number of weather information products are made available. The Voice Response System (VRS) features a computer voice which provides the information. The 12-key telephone signalling system is used to request information from the computer based on a set of dialogue rules which utilize the three-letter combinations called location identifiers (LOCIDs) which uniquely identify weather reporting stations and airports.

1.10.4 Proposals Regarding AIDS and AIDS-Type Systems

Discussions indicated an interest in further development of the AIDS system to enable access to it by travelers via an automated device at transportation terminals such as the city's airports. The device would direct travelers to use the AIDS system in an interactive manner (somewhat like the Hamburg AFI system) to obtain route, schedule, and itinerary information for the public transportation system.

1.10.5 Interactive Cable Television

The use of interactive cable television systems, such as the Warner Qube system present a possible access mode for transit passenger information systems. This approach is only in the discussion stage at present in the U.S. A similar system is in the planning stage in Germany.

1.10.6 Other Research Needs

There is considerable opportunity for additional research and development with regard to transit passenger information systems. The AIDS and AFI systems have shown that computerized systems can be developed and used. Work needs to be done to determine the nature and type of system which is most appropriate for the majority of U.S. transit systems. Work needs to be directed toward determining the means for identifying the requirements and measuring cost-effectiveness of telephone information systems, as well.

2.0 INTRODUCTION

2.1 STUDY OBJECTIVES

This report is the result of an examination of transit passenger information systems with particular emphasis on their technology-related subsystems. The study was conducted as part of the project entitled Assessment of Transit Technologies carried out within the New Systems Alternatives Program for the Urban Mass Transportation Administration (UMTA).

The major objectives of this study were the following:

(1) the development of a classification system and definitions for the transit passenger information systems in operation or under development

(2) technical assessment of three selected systems ranging in technical complexity from labor-intensive manual systems to fully automated computerized systems

(3) an examination of the performance characteristics of transit passenger information systems, with particular reference to operations, technology, labor productivity, and system cost

(4) the compilation of information and data which will assist transit system operators in selecting appropriate telephone information system technology.

2.2 STUDY SCOPE AND METHODOLOGY

This study was accomplished in a number of stages. An initial literature review was carried out which provided the basis for system and subsystem identification and definition. Three systems to be assessed were chosen and initial contacts were made with local transit officials in Nashville, Tennessee; Washington, D.C.; and Hamburg, Germany, regarding their telephone information systems and their willingness to assist in this effort. Questionnaire booklets were prepared for each site and sent to a local contact person. Site visits were planned and carried out, using the questionnaire booklets as the basis for data and information gathering. As a result of these efforts and discussions with UMTA officials, it was concluded that additional information regarding the Teleride applications in Ottawa, Canada, and Columbus, Ohio and the computerized data storage and retrieval system used in Minneapolis-St. Paul would be useful to the study. Consequently, staff reports were obtained from Ottawa and from Minneapolis-St. Paul and questionnaire booklets were prepared for Columbus, Minneapolis-St. Paul, and for the Teleride Corporation. The data and information were compiled and examined and the draft report was prepared. This report was circulated to UMTA and to all other persons who provided primary data for the study for review and comments; the final report takes account of this material.

2.3 ORGANIZATION OF THE REPORT

The report is organized in the following manner: Section 3.0 presents a general description of transit passenger information systems with a discussion of their functional and system components. Section 4.0 examines the means whereby the performance of these systems can be evaluated and compared. Section 5.0 presents technical assessments of three system applications: the Nashville-Davidson County Metropolitan Transit Authority manual system; the Washington Metropolitan Area Transit Authority (WMATA) computerized system, known as AIDS - Automated Information Directory System; and the Hamburg (Germany) fully automated AFI (Automatische Fahrplan Information) system. Section 6.0 describes the automated Teleride System in application in Ottawa, Canada and Columbus, Ohio and the computerized data base used by the Metropolitan Transit Commission in Minneapolis-St. Paul, Minnesota. Section 7.0 presents information about ongoing research and development efforts which can impact future improvements to transit passenger information systems.

3.0 GENERAL DESCRIPTION OF PASSENGER INFORMATION SYSTEMS

3.1 TRANSIT MARKETING ACTIVITIES

Passenger information systems are generally part of a broader transit marketing effort which includes everything involved with making a transit system attractive and effective for the transit users in an area. Since passenger information systems in general, and telephone information systems in particular, are part of the overall transit marketing effort, it is important to examine briefly what transit marketing entails and how it fits into the activities of the transit system. The following sections provide background information regarding transit marketing and transit advertising.

3.1.1 Marketing

Passenger information services represent a major transit marketing activity and are organizationally located within the marketing group of most transit agencies. In recent years, it has become more clear that transit, like any other industry, is in the business of selling a service to its customers. The marketing activities of a transit agency are aimed at tailoring services to potential customers and meeting their transportation needs. Serving the transit consumer is at the heart of the transit business.

The transit planner works closely with the marketing group to locate the market by establishing the nature of the travel demand of the service area. Origin-destination studies and other related planning activities are helpful in market identification because they can be used to identify the travel patterns of potential customers. Further market research is aimed at identifying specific market segments and examining how the various services can be best provided; this is known as market segmentation. Some riders need express service and are willing to pay for it; others, without access to cars, need fine-grained routes and easy transfers. The purpose of market research and planning studies is to identify the various segments of the market defined by travel characteristics and ability to pay.

Finally, a marketing mix should be developed which combines various services, fares, and promotions to meet the needs of as many of the market segments as possible.

3.1.2 Advertising

The purpose of advertising is to inform the public, to stimulate demand, and to change attitudes towards the product advertised. Changing attitudes is particularly important to the transit agency, because of the need to make the public aware of the range of services being provided. Replacement of obsolete equipment and improved service can change the face of transit in a region, but the attitude of the public must also be changed accordingly. Advertising must bring the change in the system and its services to the public's attention.

The image of the transit agency is most important. The system must be visible: riders must be aware that it exists or they will not consider using it. Visibility can be accomplished as a part of selling the service to the public. Transit vehicles are the most visible part of a transit system. The appearance and condition of an agency's rolling stock tells the potential rider a lot about transit, and may be the most important conveyor of the image of the transit agency.

Advertising is also accomplished through the mass media: radio and TV, for example. They are useful for broadcasting a message throughout a region, but they have drawbacks. They do not target the transit market well. Many of the people receiving the advertising may be out of reach of the transit system, so that no matter how well the campaign is put together, these people cannot be enticed into using transit, and the money spent on reaching them with advertising is wasted. There is a better chance that advertisements in the local newspaper, rather than on radio or TV, will reach those within range of transit service. It can also be used for delivering passenger information.

3.2 PASSENGER INFORMATION SYSTEMS

In every transportation system, users need information. They must be confident that they will be routed through the system and arrive at their destination at a desired and specified time.

Different transportation systems have different information requirements. System complexity is one determinant of the need for information. A simple system can be described easily. With few choices of routes or schedules and a limited number of stations, a passenger needs very little information to negotiate the system. More complex systems require much more information, and more complex information, which must be easily understood.

Although the transit user must have information about the system in order to travel, his requirements are not as high as those of an auto driver, for example. The rider needs only to know which bus takes him to his destination and when and where to board and exit. To some extent, he must know the route network if it has an impact on his trip.

The transit user must place himself in the system, do his own routing, and exit at his destination without any control by the transit agency. Passenger information systems are the means whereby the transit agency informs and educates its customers to guarantee they get the most direct and speedy service possible.

Passenger information consists primarily of maps, schedules and signs. It is used to educate the potential rider on the use of the transit system and to turn potential users into riders. It helps people use the service by answering some basic questions that they may have. Typical questions and the information aids used to respond to them include the following[(1)*]:

WHAT KIND OF SERVICE IS OFFERED?	Information on regular route service, special service (dial-a-ride, subscription, charter, contract, and so forth)
WHERE DOES THE SYSTEM GO?	Maps
WHEN CAN I USE THE SYSTEM?	Schedules
WHERE CAN I CATCH THE BUS?	Shelters and bus stop signs
HOW MUCH ARE THE FARES?	Fare schedules and promotions
HOW CAN I USE IT?	Schedules, maps, signs, promotional materials

* Numbers in raised parentheses refer to references.

3.2.1 Functions of the Passenger Information System

The passenger information system has two main functions to perform. It provides general information which tells the potential passenger how to make a trip and where to get more specific information and it provides specific trip information so the passenger can find his way through the system, as illustrated by the following:

General Information	Specific Information
Types of Transit Service	Detailed Routing
How-to-use	Station/Stop Location
Routes	Schedule
	Fare
	Transfer Location

General Information

General information about services relates to the type and extent of the transit network: hours, fare zones, discount fares for particular groups, and special services such as commuter park-and-ride facilities or shopper's specials. It enables potential riders to decide if their travels could be made using the transit system.

How-to information tells passengers how to use the system. For example, it includes detail on paying fares, and describes special fare gates which might be unfamiliar. Bus designations and route numbering can be called how-to information, if they help a passenger learn the system.

Route information tells the rider if the transit system goes near his origin and destination. Such information is important in deciding to use transit; without an idea of the route structure and size of the system, the potential passenger cannot tell if the system will take him where he wants to go.

Specific Information

Specific service information is essential to, and used by, all transit users. The transit user needs to know where to enter the system, how much it will cost to ride, which streets it travels along, where to exit, and where to transfer if that is necessary. He also needs to know when to be at a bus stop or station in order to arrive at his destination on time.

3.2.2 Components of a Passenger Information System

Table 3.2-1 lists major components and sub-components of a transit passenger information system. Maps are found in virtually every passenger information system. A system map gives a clear understanding of the service area and coverage, showing all the transit routes and transfer points. The system map is often displayed at terminals, bus stops, and within vehicles; it is also distributed folded to pocket size, and it may carry information on hours of service, fare structure, and special services such as wheelchair lifts on particular routes.

Subway or rail stations may have local street maps with the location of station entrances marked to help passengers orient themselves when they return to street level. These maps are large and are permanently fixed to the station wall.

Route maps are distributed, frequently with an accompanying timetable, for each bus or transit route. They are pocket sized, folded, and show a simple schematic strip-map for the route in question. Transfer points are frequently marked with the numbers or other designations for the routes for transfer. Occasionally parallel service will be marked on the map as well. The timetable gives departure times over 24 hours, along with scheduled stops for several prominent stops. If service is significantly different on Sundays or holidays, separate timetables for it will be included.

Timetables come in two basic forms. One is a book of schedules for every route in the system. This is a bulky document, rarely disseminated for passenger use in American systems, although common in most European cities; for example in Copenhagen, it is direct-mailed along with a system map to every household in the region twice a year. The other form is the route map/timetable mentioned above.

Signs are a basic part of the information system. They are located at bus stops and stations throughout the system, and used for a number of purposes. Bus stop and subway station signs identify places where riders board the vehicles to

TABLE 3.2-1: COMPONENTS OF THE PASSENGER INFORMATION SYSTEM

Maps

Comprehensive System Map

Station Orientation Maps

Route Map/Timetable*

Timetables

System Schedule

Route Map/Timetable*

Signs

Station and Stop Signs

Vehicle Destination Signs

On-board Signs

Distributed Information

Media Advertising

Flyers and Brochures

How-to-Ride Books

Information Displays

People

Drivers

Station Attendants

Telephone Information Systems

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* These are the same.

enter the system. They may be a simple sign that reads "Bus Stop" or a larger one to show route maps of the services at the stop, schedule information, or fare information. Stop signs usually list the lines which serve the stop.

Each vehicle in the transit system carries a destination sign on the front of the vehicle and/or on the side facing the entering passengers so prospective passengers can identify the correct vehicle. Routes with multiple destinations depending on time of day, or express routes, are labeled primarily through the destination signs on the vehicle.

Other signs on board the transit vehicle also help the passenger find his way. Rapid transit cars frequently show a simple strip-map of stations, placed near the doors. Buses may list fare information by the doors so that riders can have the exact amount ready without having to ask the driver and cause delays.

A rather broad category of information components is distributed information. This consists of information meant to reach the general public, and includes advertising, brochures, and flyers. How-to-ride booklets are an example of direct-mailed information. These tell the public what the stop signs look like, how to tell which buses serve the stop, how the fare is paid, and so on. An important piece of information is the address of the transit agency and the telephone number to call if further information is desired.

Information displays can be made up of all these components. They may display a large-scale system map with the information in the how-to book. They are usually set up in public places: post offices, libraries, and shopping centers, or at fairs and festivals. Although the information is not distributed as are advertisements and flyers, the intended audience and the scope of the information disseminated are quite similar.

People are an important source of transit information. The two groups of employees that passengers come into contact with, drivers and station attendants, answer most of the questions regarding transit service. Drivers can be an important source of detailed route information for the first-time passenger who may be nervous about missing a stop or making a transfer.

The last major component consists of telephone information systems. Basically a telephone system is comprised of a group of information agents who answer queries about detailed transit service. They use other information aids, such as route maps, timetables, headway sheets, and landmark identifiers to find the caller's origin and destination, place it in relation to the transit system, and plot a routing on the system to send the passenger on his way. More complex systems make use of computerized information aids, microfiche files, specialized telephone equipment, or combinations of them.

3.2.3 Functional Capability of Each Component

Figure 3.2-1 illustrates which of the functions each component of the information system performs. The darkened squares indicate the type of information listed at the top of the column that each component is capable of delivering. A newspaper ad, for example, can include basic information about the transit system and the service it offers, or sell a particular service such as express buses for baseball games. How-to-ride information may fit into the ad as well.

Newspaper ads are too small to include a map of the system's routes or schedules and stops for more than one simple service. Other components, such as the pocket-sized route map/timetable can perform this function much better.

3.3 TELEPHONE INFORMATION SYSTEMS

3.3.1 Objectives and Capabilities

Telephone information systems are most effective when used for delivering specific information. They are used by passengers who have a general idea of where the system goes and how to use transit (a first-time rider knowing nothing about the system calls to find out if he can use it to reach his destination). Telephone systems are the most complete single source of detailed transit information.

Useful as it is, though, a telephone system cannot stand alone as a passenger information system. Because telephone information is not printed, it has a short life. Unlike a timetable, it cannot be referred to again en route. The information it

COMPONENTS	GENERAL INFO			SPECIFIC INFO				
	Services	How-to-use	Routes	Detailed routing	Station/stop locations	Schedule	Fares	Transfer locations
System map	■		■					
Route map/timetable				■		■	■	■
Station orientation map					■			■
Timetables	■					■		
Bus stop signs					■			
Vehicle destination signs				■				
On-board signs				■			■	
Newspaper ads	■	■						
Flyers/Brochures	■							
How-to-ride booklets	■	■						
Information displays	■	■						
Drivers/Station attendants	■	■		■	■	■	■	■
Telephone Information	■	■		■	■	■	■	■

FIGURE 3.2-1: FUNCTIONS OF TELEPHONE INFORMATION SYSTEM COMPONENTS

conveys is extremely specific; normally it is used for only one itinerary. Any time the rider wants to change his destination or his travel time he must make another call.

The objectives of a telephone information system can be summarized as follows:

1. Personalized service. The telephone gives the prospective rider the exact information needed to make his particular trip. An information agent can tell the caller where and when to catch a bus or train, where to transfer if necessary, and where to get off. Walking distances to and from the stop locations and stations can be given over the phone. The caller's route, schedule, fare, and travel time are given to him, and he needs to know very little else in order to make his trip.

2. Convenience. The telephone provides a method of giving out transit information when it is convenient for the rider. Every other information component requires the rider to obtain some form of printed information from the agency. This means he will have to plan to use transit well in advance of the time he actually needs it, in order to be ready with maps and timetables for planning a particular itinerary. With telephone service, an entire transit trip can be planned very near to the time when it is needed. Moreover, since telephones are accessible to nearly everyone, it is easier for users to call.

3. Special information. The telephone information system is a good means for the transit agency to disseminate information about service interruptions, special services, or new routes and schedules. Accurate information can be passed along to the passengers in less time than it takes to print new schedules and maps. Temporary changes can be disseminated without the necessity of printing the information at all. Because of this feature, even experienced passengers who have route maps and timetables may call to verify that their information is up to date.

3.3.2 Functional Analysis

Any telephone information system must be capable of performing several functions. Incoming calls must be answered, information must be received from the caller and used to determine an itinerary, routes and schedules must be given to the caller. The general functions are discussed in greater detail in the following paragraphs.

Call intercept. This refers to the first action taken within the system. Calls must be answered, put on hold, or given a busy signal.

Call routing. After calls are answered or taken off hold they must be routed. The call is assigned to one of the information-handling components, or to an information agent to have his question answered.

Information request. The caller is asked to put his travel question into a form most suitable for the system. Generally, this is a request to the caller for his origin, destination, and the time he wishes to travel. Other information, such as special routes or multiple stops, are requested from the caller at this time.

Data input. The caller's information is fed into the information-handling system.

Information handling. Information handling actually consists of three separate steps: storage, retrieval, and calculations.

-- Storage. In every telephone information system there must be some component that stores all the route and schedule information for the entire transit system. This is the data base from which callers' requests are answered. (Information agents do not add to or subtract from the data base; they utilize the data.)

-- Retrieval. This is the function of searching the stored information files to match it against the request that has been fed into the system.

-- Calculations. Once route and schedule information has been retrieved, it is necessary to calculate the optimum itinerary for the caller. This can be based on shortest travel time, shortest waiting time, least number of transfers, or some special routing.

Data output. The determined itinerary must be read from the information-handling subsystem back to the component that is dealing with the caller. There are five pieces of information that must be read out so that the caller can make use of the transit system. These are:

-- Station and stops. Where he will enter the system and where he will exit.

-- Routes and transfers. How he will travel from his origin to his destination.

-- Departure time. What time he must be at the bus stop or transit station.

-- Arrival time. What time he will arrive at the stop closest to his final destination.

-- Fares. The cost of using the transit system.

Dissemination to caller. The information which has been calculated and read out is given to the caller.

3.3.3 System Components

All of the above functions must be available in order for the exchange of information to take place over the telephone. In general, equipment used for communications is not used for information handling, and vice versa. These are two separate branches of engineering, although in recent years with the advent of microprocessor computer technology, the branches have been merging. So, although it is not far-fetched to imagine one piece of equipment able to perform all of these functions, it is not on the market yet.

This section describes and defines the major components used to provide telephone information, examines the features available in each type, and discusses performance for this application. Although not commonly thought of as "equipment" or "components", the information agents themselves are an essential part of most information systems. They are discussed as well.

The components covered in this section are:

- o Telephone equipment
- o Microfiche readers
- o Computers
- o Video display terminals
- o Information agents

Sophisticated telephone information systems may use a different component or piece of equipment for every function; in simpler systems one component may take care of several functions. The simplest telephone information system consists of only three components: a telephone, an information agent, and a schedule book. In combination these three can perform all the functions to make the system work.

In addition to the components listed above, there is other equipment used in automated or semi-automated systems which enables the caller to communicate directly with a computer through the telephone. These (touch-tone decoder, voice decoder, speech synthesizer) are usually an integral part of some larger system and would not be purchased separately. Other equipment, such as telephone switchgear, is similarly an integral part of each manufacturer's product line.

3.3.3.1 Telephone Equipment

Telephone equipment is the communications link between the caller and the information-handling system or the information agent. There are several types of equipment of varying levels of sophistication which may be used to connect the caller. For very small transit systems, the information group may use the same telephone system or number as the transit agency. Calls for information are handled by the receptionist or routed to the information agents.

For larger transit systems, telephone equipment first answers the ring and then connects the caller to an information agent; if all lines are busy it gives a busy signal. The more sophisticated equipment can put the caller on hold automatically if no agents are available, releasing the caller to the system as soon as possible. There are capabilities for recorded announcements on hold, music on hold, consecutive announcements, and other features which will help keep the caller occupied while holding.

The types of telephone equipment on the market vary a great deal in cost and capability. They are available from several manufacturers, including the Bell System. The types of equipment available are described below in order of complexity:

Call Director

A call director gives every telephone receiver direct access to all incoming trunk lines. Each information agent has the capability to answer outside calls by depressing a lighted key. These keysets include a hold button so that each receiver can be used to put callers on hold. There is no priority queuing on this system; calls are taken off hold at random, with no relation to how long each caller has been waiting. Agents select which call to answer and how long to take before answering calls.

Call Sequencer

A call sequencer can be used with a call director or with a PABX (see below). It is an interface between incoming calls and agents' receivers, separating trunks from the agent positions. All incoming trunks connect to the call sequencer and calls cannot go through without being intercepted by the sequencer. It places incoming calls in a holding queue, then signals all the receivers which call is the oldest (first in line) with a light that flashes faster than the others. It is designed to be used with keysets, but because it is an interface between trunks and receivers, it can accommodate more trunks, and therefore more callers, than a straight call director. Agents can select which call to answer and how long they will wait to answer, but a signal indicates the oldest call in line and agents are trained to answer that call first. In addition, call sequencers are available with additional features such as voice recordings and music.

Automatic Call Distributor (ACD)

An Automatic Call Distributor (ACD) takes incoming calls and puts them on hold if necessary. In this respect an ACD incorporates some of the same features as the call sequencer. Where they differ is a feature called Call Forcing. An ACD will automatically route calls to available agents, instead of allowing agents to connect themselves to incoming calls by pushing a button. An agent's receiver in an ACD system can be a single-line set. Receivers do not have any access to trunks unless routed by the ACD, which acts as a sequencer and an automatic switch.

There are several ways to route calls to agents, all of which can be specified by the purchaser for a custom-designed installation. The first consideration is the way calls enter the holding queue. In most cases, calls enter and leave in a first-in first-out (FIFO) pattern. This ensures that all calls are served with an approximately equal wait, and none are lost by being accidentally ignored.

Priority queuing allows certain calls to enter at the front of the queue rather than the end of it. This is a desirable feature for users who pay for 800 numbers (incoming WATS lines). To keep long-distance charges down, it is desirable to answer these calls before any local calls, so they are given priority. Since transit information systems deal primarily with local calls, this may not be an important feature.

Dynamic, or caller-signalled queuing, is a feature of some of the sophisticated computer-based ACD systems. Using a recording and a touch-tone decoder, the system allows the caller to respond to questions about the nature of his call (what kind of information is desired) by pushing the buttons on a touch-tone telephone, enabling him to be switched to another recording or a group of agents who specialize in that type of information handling.

Once in a queue, calls can be routed to a group of agents in a number of ways. A computer-based ACD can vary the routing depending on traffic load or other factors. Methods of routing are:

- o First available agent
- o Uniform call distribution
- o Longest available agent
- o Terminal hunting
- o Circular hunting

At peak traffic periods, it is desirable to connect incoming calls to information agents as rapidly as possible. In this case, as soon as an agent becomes available, another call should be routed to him. As a result, the speediest and most efficient agents will end up taking the most calls, thus increasing their workload.

The option called Uniform Call Distribution is a means to level the workload when the traffic permits it. The ACD keeps track of how many calls each agent has handled and routes new calls in order to keep the number spread uniformly among all agents. Faster workers get longer periods of slack time between calls than slower ones. Because of this, at peak times, Uniform Call Distribution slows the rate of call handling to that of the slowest agent, resulting in longer wait times and more lost calls.

Another means of spreading the workload is to route calls to the agent who has been available for the longest period of time. This is, in effect, a FIFO routing for the agents.

Terminal hunting is a routing procedure that treats a group of information agents as a line. When a call comes in, the ACD will start at the agent at the head of the line. If that agent is busy, it tries to route the call to the agent second in line, and so on. During times of peak traffic, when there is a queue, this procedure will route calls to the first available agent, by working through the line over and over until an available agent is found. However, during slower periods when there is no queue, the agent at the head of the line takes most of the calls, and the agents at the end take few or none. This result is sometimes known as a "hot seat", since it assigns work unevenly to the agents.

Circular hunting is a variation which closes the head and tail of the line to treat the agents as a circle. Instead of returning to one agent each time a new call comes in and beginning the hunt for an available agent from there, this procedure starts where it left off, at the agent behind the last one assigned a call. It then hunts through the group, and assigns the call to the first available agent it "sees". The next call starts the hunt again from there. This is a simpler method of routing calls uniformly.

PBX/PABX

A Private Branch Exchange (PBX) or Private Automatic Branch Exchange (PABX), is a user-owned internal telephone switch. The PBX uses a switch-board with an operator and is all but extinct, having been replaced by the PABX, which uses an automated switch. A PABX allows all in-house phones to dial each other, to receive incoming calls, and to dial outside. All calls to or from the outside go through the PABX switch. Trunks terminate in the PABX which switches them among users as required.

The newest generation of PABX equipment is computerized. While the switch itself may be electromechanical, analog electronic, or digital, the computer control gives it much greater capabilities. Among these are call forwarding, transfers, conference calls, call parking, etc.

Hardware is usually modular, with a set number of ports (for trunks, receivers, and features like recordings and music) which can be expanded 2, 4, or 8 at a time. Generally the electronics are rack mounted with pull-out printed circuit boards (cards) that determine the configuration of lines and trunks.

Software is used to refine the capabilities of the system, allowing features to be tailored to particular receivers. This is generally done by removing capabilities: taking away the ability to transfer calls from a particular receiver, or blocking a group of receivers from dialing out.

An ACD installation which is based on a computerized PABX, as most of them are today, can be easily tailored to meet individual transit authority requirements, by simply adding or removing specific features.

PABX equipment which does not have Automatic Call Distribution built in may be available with Uniform Call Distribution. A separate telephone number is assigned to a particular group of receivers, called a hunt group. As calls come in, they are routed within the hunt group from one receiver to another until one is found that is not busy. The PABX will not put a caller on hold automatically if all the extensions in the hunt group are busy. It can be programmed to (1) give the caller a busy signal, or (2) send the call to the switchboard operator, who can answer the call and put the caller on hold. Calls on hold will not be answered in the order received, however.

Centrex

This is a system owned and operated by the local telephone company that performs the same function as a PABX. The only difference is that the switch is located in the telephone company central office instead of on user property.

Management Information Systems

The Management Information System (MIS), also known as Station Message Detail Recording (SMDR), is a sophisticated form of traffic reporting and performance measurement for the telephone systems described above. MIS is one of the major features of a computerized ACD or a PABX. In these systems, it is software oriented. No additional hardware is necessary; the only task is to write and integrate the programs that will read the data generated by the PABX and organize it into reports that are valuable for the user.

Most older ACDs have a peg counter, which keeps call counts and lost call counts, but which must be read manually and reset. An MIS system does this automatically. MIS equipment can be added to any ACD or call sequencer, including the older electromechanical technologies. An MIS system reports on agent performance, traffic information, and trunk usage.

Agent performance shows how well each information agent uses his time, and how productive he is. Agent performance reports indicate the following:

- Number of calls routed to the agent
- Calls handled
- Average length of calls

The reports also show the time spent by the agent in the following categories:

- Available
- Unavailable
- Handling calls
- Wrap-up work after a call

This gives the supervisor information about how the agents use their time and a basis for improved control over this time. Without this kind of information, agents must be watched or monitored over the phone, and there are no detailed statistics giving proof of the supervisor's observations.

Traffic reports show how the telephone system deals with the callers entering the system. They can show hourly or half-hourly summaries, updated several times a minute, of the calls handled by the system. These reports show:

- Calls offered (incoming)
- Calls handled
- Calls overflowed (placed in queue)
- Calls abandoned
- Average waiting time
- Average talking time

Other traffic reports deal with the calls waiting in each queue for any group of agents that have been set up with a different set of callers. These reports for the waiting calls show:

- o Calls offered
- o Calls handled
- o Handling time
- o Average delay for waiting calls
- o Longest delay within each queue
- o Calls abandoned
- o Number of calls abandoned in less than a user-specified length of time

Trunk usage reports give information on the trunk lines coming into the system from the local telephone company. These reports can be used to help analyze the cost-effectiveness of the service bought from the telephone company. The following information is summarized for each trunk:

- o Calls handled
- o Total calls by line or by trunk group
- o Call seconds of usage
- o Number of busy signals
- o Percent of time all trunks are busy
- o Trunk condition

All these MIS reports can be summarized over a user-specified period for historical information: monthly, annually, or otherwise. Some systems have the additional capability to forecast trunk or agent manpower requirements based on these historical data.

An ACD system with an MIS offers four possibilities for increasing productivity and improving the performance of the telephone information system. They are: (1) improving agent productivity; (2) decreasing the time between calls; (3) increasing the number of callers; and (4) improving the utilization of trunk lines.

Agent productivity is improved with an MIS because the agents' work becomes more visible to supervisors. The agent's choice of being available or unavailable for work is uncontrolled and invisible without MIS reports. The performance reporting possible with these systems increases the time each agent will key in as available, making it possible to handle more calls with the same work force.

Some systems have devices to assist in motivation, by signalling how many callers are in the queue, or how long they have been waiting. It is presumed that this information will spur an information agent to take less time answering calls, in order to reduce the length of the queue.

An ACD can shorten the amount of time between calls handled by automatically putting the callers on hold instead of requiring the agents to answer all the callers manually. With an ACD, agents are free to answer questions, and the mechanics of handling the calls are done automatically.

The more sophisticated ACDs and PABXs may be able to increase the call capture for the information system by helping to keep callers on the line. The use of recorded announcements, particularly those informing the caller that he has reached the right number and will be attended to, and the use of music on hold, can make the wait for an agent much less onerous for a caller. Reducing the lost call rate increases the number of people who can access the system, resulting in more calls answered with the same number of personnel. The aim is to increase the caller's acceptance of waiting in line, keeping him connected until an agent is free to answer.

Trunk information, available with MIS, can help the telephone information staff to determine the effectiveness of the trunk lines purchased from the local telephone company. Analysis of trunk usage can point out if there are too many trunks, resulting in idle trunks, too few, resulting in too many callers receiving busy signals, or problems such as static on particular lines. The number of trunks affects the time in queue for callers; if there are many more trunks than information agents, several callers can stack up in the system, waiting a long time for an agent to become available. Too few trunks may result in idle time for agents as callers, frustrated by busy signals, decide not to try calling anymore.

Table 3.3-1 summarizes the major characteristics of available telephone equipment and related management information systems with regard to telephone information systems.

3.3.3.2 Microfiche Readers

Microfiche is a medium of information storage which makes it possible to put all the route and schedule information for a single bus route on a 4 x 6-inch (photographic negative film) card. The card can be filmed directly from paper copy source documents, or from a computer tape, in which case it is known as Computer Output Microfiche (COM). Most microfiche readers are sized to project COM microfiche to full screen size without cutting off the edges, which is why screen sizes are occasionally referred to as "full-COM" or "3/4-COM" sized.

There are two basic types of microfiche readers: manual, for which the operator must locate and insert the microfiche card himself; and automatic retrieval, which will load the card with a typewriter keyboard. The operator types the index code for the fiche desired, and in a few seconds it will be projected on the screen. When there are a large number of microfiche in use, search and retrieval time can be cut down considerably with a reader that automatically retrieves selected cards. Cartridges which are easily inserted and removed hold the fiches, which are accessed by coded push buttons. When a fiche is selected, the index is displayed. Another push button selects the exact frame required. There is a significant difference in cost and complexity between these two kinds of machines.

Manually operated microfiche readers are quite simple. They consist of a lamp, a mirror, a microfiche carrier and a screen. There are minor differences among the models available, which make some readers more suitable for particular applications. In general, any reader is capable of the same tasks as any other reader. More information on microfiche reader features is presented on Table 3.3-2.

3.3.3.3 Computers

Computer technology has been evolving so rapidly that studies done just a few years ago comparing manual telephone information systems with computer-assisted

TABLE 3.3-1: CHARACTERISTICS OF TELEPHONE SYSTEMS WITH REGARD TO TELEPHONE INFORMATION SYSTEMS

EQUIPMENT	PRIMARY TELEPHONE CHARACTERISTICS	MANAGEMENT INFORMATION CAPABILITY
Call Director	Every agent has a telephone receiver with direct access to all incoming trunk lines; hold button to put calls in queue; no priority queuing.	No automatic capability.
Call Sequencer	Can be used with key system or PABX; interface between trunks and agents' receivers; accommodates more trunks than key system; indicates call longest in queue.	No automatic capability; an MIS can be added to provide data described below.
Automatic Call Distributor	Features same as call sequencer plus capability to route calls to available agents according to a desired routing method, i.e., first available agent, uniform call distribution, etc.	Peg counter provides call counts and lost call counts; and MIS can be added to provide data described below. An MIS is a major feature of a computerized ACD.
PBX/PABX	Provides a user-owned internal telephone switch; computer control on PABX permits call forwarding, transfers, conference call, call parking, etc., modular design permits user-determined combinations of capabilities.	An MIS is a major feature of a PABX.
Centrex	Similar to PABX but system owned.	See PABX description.

TABLE 3.3-2: MICROFICHE READER FEATURES

FEATURE	OPTIONS AVAILABLE
Screen Size	Screen sizes are referred to in terms of COM. A full-COM screen is 11 x 14 inches (27.9 x 35.6 cm); a 3/4-COM screen is 11 x 11 inches (27.9 x27.9 cm) . These are the most popular sizes. An 8½ x 11-inch (21.6 x 27.9 cm) size is available, as are smaller-sized machines suitable for use on the corner of a desk.
Image Rotation	When source documents are microfilmed, they may be placed sideways or upside-down in relation to others on the same microfiche card. With image rotation, it is easy to turn the image around with a dial or a crank so it can be read without removing and reinserting the fiche.
Projection	The image can be front- or rear-projected. The main difference is the angle of the screen, and the effect of ambient light. A rear-projected michrofiche screen is at the reader's eye-level and vertical. A front-projected screen is inside the hood, slanting away from the viewer at an angle. It is more comfortable to use for viewers with bifocals or contact lenses, and because the image is inside the machine, it is better protected from the glare of ambient light.
Lenses	Every reader offers the user a choice of magnification at the point of sale. Some have easily interchangeable lenses so the user can change magnification while the machine is in use. The most interesting feature, however, is dual-lens capability. With the flip of a lever, the reader can change magnification from low to high and back. This can be helpful when searching a fiche.
Carrier	The microfiche carrier itself is the part of the machine most users will come into contact with. It should be designed for smooth operation, gliding from one corner of a fiche to another without sticking, to make the job of searching information easier. Carriers are available which will hold two cards at the same time (dual-carrier). These make it possible to switch between two sources of information, or between an index and an information card without continually removing and reinserting microfiche in the machine.
Lamp	Lamps come in various wattages, rated for different lifetimes. Some machines come with a high-low intensity feature, which lengthens the life of the lamp.
Cooling	The microfiche carrier must be protected from the high temperatures generated by the lamp. It can be fan-cooled, or cooled by convection current formed by the heat of the lamp itself. Convection cooling is quieter, but fan cooling is more effective.

ones do not apply today. A study in 1977 showed, with findings based on the rental cost of an IBM 370 mainframe computer, that the computer system was not cost-effective.(2) Today's smaller minicomputers can do the same job at a purchase price of less than one month's rental of the IBM computer at that time.

Any installation of a computer system, for any purpose, must take into account the two elements needed to make it work: hardware and software. In the burgeoning computer field hardware of any size is readily available. However, the type of tasks a computer must do in relation to telephone information is not available in pre-written packages, and is probably not amenable to easy modification of packaged software. Programs for telephone information systems will have to be customized to the particular application, i.e., for each transit authority wishing to install such a system. This is because the market for these programs is small and each transit agency, with different management and marketing philosophies, has different operational requirements as well.

Custom software has two drawbacks to balance the benefit of getting exactly the program features needed. One drawback is that it is expensive. A typical installation will incur equal costs for software and hardware. The other drawback is the necessity to debug the programs before they are usable. During this period reliability will suffer. Essentially, the user is buying a prototype piece of software rather than a finished product.

The experiences of two of the users of computer-assisted information systems, SCRTD in Los Angeles and WMATA in Washington, D.C., illustrate that the custom software is a prototype piece of software, rather than a finished product and, therefore, expensive. In both cities, according to the evaluations performed for UMTA, there was a necessary period of debugging.(3,4) During this period the information agents became actively involved, pointing out to the software people the problems they were having with the system, the erroneous results the computer was giving from their queries, and providing suggestions for better formats and answers.

The total grant amount which WMATA received for AIDS was $1,110,000. Approximately one-half the amount was required for computer hardware and one-half was required for software and data base development. Room construction, excluding some furniture (approximately $24,000) cost about $224,000.

The selection and procurement of computer hardware does not take place until something is known about the system requirements. Initially, a decision must be made regarding what the system will be expected to do, and how much data it will have to manage to do this. The size of the data base is dependent upon this decision; using only transit system data (routes and schedules only) requires much less data storage capability than using a geographic data base which incorporates this as well as streets, addresses, and landmarks.

The capabilities of the information system and the software used to achieve them ultimately force many of the decisions on the size and performance of the computer hardware which will be used. System response time and number of terminals are two of the most important requirements to be considered when sizing or specifying the hardware.

Rapid, even immediate, response is of major importance to the function of the computer-assisted information system. The average call involves three activities of approximately equal duration: information request, information search and handling, and information dissemination. Response times longer than 20 or 30 seconds will negate any advantage of the computer system in regard to speeding call handling, at least with respect to all but the most complex itinerary calculations. Observation of WMATA's information agents has indicated the necessity for quick response times. On the occasions when the computer took more than 10 or 15 seconds to come up with an answer, the agents became restless. Some gave up on the system and went to their maps and headway sheets in order to satisfy the caller.

Continual input and output is the main task of the information agents. Response time should be short enough to make the job easier, and to make it visibly faster than manual techniques.

Each agent position should have a dedicated terminal. This is a factor in the speed of call handling and on the capacity of each agent to do his work properly without interference. Doubling up on terminals in order to save on a small computer is false economy.

The rapid response required and the large number of terminals in use indicate there will be a very high level of transactions going on in the Central Processing Unit at any one time. This affects at least two elements of the computer architecture (hardware) which is to be purchased: word length and main memory size.

Word length is measured in "bits" which stands for binary digits, and is the smallest measure of information. A bit is a signal of 1 or 0, on or off, reflecting a binary condition. A word is the typical unit of information the computer works with internally. Words range in length from 4 bits to 64 bits, the larger ones being used in the most powerful mainframe computers. Smaller computers typically have word lengths of 8, 16, 24, or 32 bits. The larger the word length, the more powerful the computer. More power means more speed and more capability for terminals.

Main memory size is the other hardware feature which has an impact on capability. Sometimes called RAM memory (Random Access Memory), this is the storage capacity of the computer for the transactions or tasks it is working on at any given time. It stores program instructions, input instructions, and whatever data is required from disk or tape memories. A larger memory means the computer is capable of processing more complicated programs and storing more data for immediate use. It is always faster to read data from the machine's internal RAM memory than from off-line storage such as disks. For an application such as telephone information, it will be necessary to have a memory which is sized large enough to store a large part of the data base. Otherwise, every time the computer is asked by an operator to find a route and a departure time, it will have to run its disk drive, find the information stored there, bring it to the central memory and then to the terminal. This time-consuming process is unacceptable for an application which demands response in a matter of seconds.

3.3.3.4 Video Display Terminals (VDTs)

Video display terminals, also known as CRT (cathode ray tube) terminals, have overtaken card readers and printers as the most common method of communicating with a computer. They are easy to use, and they allow the user to rapidly handle input and output operations. A feature that makes them ideal for applications such as telephone information is the transitory nature of the information display. Information agents need to retrieve a lot of information from the computer, but they do not need to save what is retrieved. Once the information has been communicated to the customer, it is no longer necessary. Because a VDT displays information and then erases the display, it is perfect for this application.

A VDT consists of only a few elements: A CRT screen, a keyboard, and enough memory and control functions to edit input and allow the terminal to "talk" to the computer. It must receive input from the keyboard, store it, convert it to the language used by the central processing unit (CPU), and send it whenever the CPU has time to process it (batch processing). It must do the same sequence of functions in reverse when displaying output for the user: receive information, translate, display on the screen. The major features important to the buyer of a VDT include the following:

Screen size. A full size screen is recommended, rather than the 5-inch screen available on smaller models. Although the same amount of data can be displayed on the smaller machine, the print is so small that an information agent will not be able to read it comfortably for an entire shift. For ease of use and the sake of health, a larger screen is better.

Line width. In order to display information manageably, it is recommended that the terminal have at least 24 lines of 80 characters each. Fewer lines mean the screen may "scroll" the first information received off the top while new information (alternate routes or schedules, for example) is received. Eighty-character lines are the standard for computer usage.

Keyboard. Keyboards are available with the keys placed as they are on a typewriter or a teletypewriter. Because the letters are not in the same position on these two keyboards, there is a choice of which to use. A VDT with the keys arranged like those on a typewriter is preferred. An agent with clerical experience or typing ability will be able to adjust rapidly to VDT usage. Otherwise, the level of errors and frustration will rise if a computer system is installed.

The specification document for the WMATA AIDS system contains two pages of more detailed features (both hardware and editing functions) to consider when buying a VDT. These two pages have been reproduced in Appendix A. The AIDS specification and sales information from manufacturers are sources of more information for those interested in the details of VDT equipment.

3.3.3.5 Information Agents

The information agent is the most important element in a simple, manual telephone information system, because so many of the functions necessary to transmit the correct information are the responsibility of the agent. All communications and information handling are the sole responsibility of the agent. Even in more sophisticated, computer-enhanced systems, the agent still has a key role in communications.

In a manual system, the agent answers the telephone, takes the request for information from the customer, then searches out the data required to answer the request; the data may be in the agent's memory or in the files of headway sheets and maps at his station. After determining a route and schedule that will satisfy the customer, the agent communicates it to the caller. For a complex transit system, data searches can take a long time.

Computer information handling can reduce the amount of information retrieval and calculation that the agent must perform. In this case, the agent must interpret the customer's question and formulate the request so that it can be keyed into the computer, key in a request, examine the computer response, interpret it, and relay the response to the caller. As in the simpler system, all the communication must be handled by the agent.

The measures of an agent's performance are the speed at which calls are handled, expressed as an average time for each call or a number of calls handled per hour, and the accuracy of the answer given to the caller. While speed is fairly easily measured by observation, accuracy is not measurable without controlled testing. Since there may be different routes and schedules to serve each caller, and each caller might weigh the parameters of a trip differently (walking distance, travel time, etc.) observation of a caller's questions and the agent's responses are not the sole method of judging the agent's accuracy.

Studies have shown that more than 75% of all calls have a duration of less than three minutes. A typical three-minute call involves about one minute of communication with the caller to understand his query, about one minute of information handling, and about one minute of communicating the results to the caller. At this rate information agents can handle about 20 calls per hour. There is ample evidence that the majority of calls can be answered in less than three minutes so that agents can be expected to handle more than 20 calls per hour. The performance of information agents is discussed in more detail in Section 4.0.

Most transit systems conduct formal training of the information agents with regard to the geography of the region and the transit routes that serve the region. Usually, they will be required to travel over most of the routes in the system, observing stops, transfers, and the streets covered by the route. Their notes and marked-up maps become part of the data base they use to answer callers.

This type of training is essential for the agents working with a manual system, and it has been found to improve the performance of those using computerized information handling as well. At both WMATA and SCRTD, it is reported that the fastest, more accurate agents are the ones who do not rely solely on the computer for their answers, but who have a good knowledge of the transit system and can answer easy questions from memory, and others, such as schedule questions, with a quick flip to the hard-copy data base.[3,4]

An experienced agent, with a good knowledge of the transit system, will be able to answer many questions without reference to any data, computerized or not. With smaller systems in particular, the routes are not so complex as to be beyond the capability of a person to memorize. In such a case, a skilled operator provides the best possible service to the callers.

For this reason, it makes sense to consider the skill level of the operators to be hired in a telephone information system along with the equipment and data base which will be used. It may be possible to use personnel such as retired or part-time bus drivers or office personnel to staff the information center instead of using new employees with no knowledge of the transit system routes and schedules. For some transit agencies such a use of skilled personnel may be more cost-effective than investment in information-handling equipment.

3.3.4 Categorization of Telephone Information Systems

The components of a telephone information system are determined by many factors including size and complexity of the transit system, marketing budget, number of incoming calls, etc. We have chosen four broad categories which encompass all the functions of the information systems, and which encompass the equipment discussed previously. These are manual systems, microfiche-assisted manual systems, computer-assisted manual systems, and automated systems.

3.3.4.1 Manual Systems

Manual systems are the least complex in terms of technology, and also the most common among North American transit systems. A manual telephone information system requires an information agent for all communication with the caller and for determining the response to the caller based upon some type of "hard-copy" data base. The data base can consist of route maps, local street maps, headway sheets, driver's schedules, timetables, notes and memos the agent uses as memory aids, daily bulletins on service interruptions or street closings, and other such information. The data base also includes the information the agent may have memorized over the course of his employment with the transit authority. Memorized information can be the most valuable, since it requires no retrieval time, and thus results in the fastest call handling. It is, of course, crucial that the information memorized be up to date.

3.3.4.2 Microfiche-Assisted Manual Systems

Microfiche systems operate in much the same way as manual systems, with the exception of information storage. Instead of using paper copies of maps and schedules, these data are microfilmed onto (typically) 4 x 6-inch films (10.2 x 15.2 cm). The amount of space needed to store the route and schedule information is reduced immensely. Sorting can also be improved, if some thought is given to the order of the pages as they are microfilmed.

Microfiche, with an automatic retrieval reader, may speed up the task of searching for information, changing the task from one of flipping through pages of schedules to keying in the route number on the reader. Bulletins, notes, and changes would still be kept on paper at each agent's station.

3.3.4.3 Computer-Assisted Manual Systems

Computer systems can give the information agent more capabilities than a microfiche system, or they can be used as a simple electronic data storage device. If used to project route and schedule information, computers have two advantages over microfiche. First, information retrieval is faster, and second, changes in the data base can be processed immediately, without need for refilming and printing microfiche for every agent station.

The computer can also be used to calculate itineraries, transfers, and fares for the caller, with appropriate inputs regarding origin, destination, and time of travel. The AIDS system in use at WMATA has this capability. For a complex system, the ability to calculate itineraries can save an agent a significant amount of time in the handling of difficult calls. Information agents at WMATA, including the more highly skilled agents, value the ability of the computer to calculate trips based on a desired time of arrival, complex suburban trips, and long distance trips. These are the most difficult questions to answer because of the necessity of backing up through successive timetables on different routes to determine the correct departure time.

The heart of a computer-assisted manual system is the computer. It can be time-shared with other departments of the transit authority, or dedicated for the use of the information section. The latter case is preferable, because it will be in use constantly as the agents search and retrieve data and time-sharing activities can delay the system retrieval time.

Each agent should have a VDT (video display terminal), along with a complete set of paper schedules and maps. Since the fastest method of call handling has proven to be a mix of memory, manual, and computerized information handling, it is important that all the materials required for a manual system be present for a computerized system.

There may not be any money saved in training or printing costs by switching to a computer-assisted system, but it can be expected that the overall call-handling rate of the information center will improve.

3.3.4.4 Automated Systems

Because they are the most technologically sophisticated of the four categories, automated systems are somewhat difficult to describe. Nearly every automated system is unique, both in capabilities and in hardware. Telerider systems are designed to answer one particular kind of question (arrival time of the next bus at a particular bus stop). Telerider uses a unique telephone hookup -- instead of a general information number, and having all callers answered by a central facility, each bus stop has an individual telephone number. The Telerider data base and voice synthesizer equipment provide the desired response. The act of calling to Telerider is also the information request; the automatic response is initiated by the telephone call.

The automated telephone information system in use in Hamburg (AFI-Automatische Fahrplan Information) is a fully automated operation with a user-machine dialogue utilizing synthetic voice generation. The caller "asks" a question by dialing a pre-selected sequence of numbers. AFI selects the optimum route for the caller from amongst the feasible connections between the origin and destination points and presents it via a speech synthesizer to the caller together with fare information.

3.3.5 Summary Comments

The vast majority of telephone information systems in use are manual systems. Few transit systems are of the size and complexity to require more sophisticated information handling than paper schedules and route maps. It has been suggested by some transit agencies that improved filing of these materials helped their information agents increase their speed, and that the main benefit of using microfiche was that it forced attention towards filing and information retrieval.

Communications technology, on the other hand, has changed so radically in recent years that there may be opportunities for all but the smallest transit authorities to make improvements. The cut-off at which a PABX or computerized ACD becomes economically feasible is not certain, but estimates indicated that it is somewhere between 10 and 25 information agents. Additional analysis needs to be carried out to determine equipment requirements.

4.0 EVALUATION OF PERFORMANCE

4.1 INTRODUCTION

The operation of a telephone information system (TIS) can be costly; it requires significant expense for both labor and equipment. Moreover, since most transit agencies are operating under reduced funding, efforts are increasingly directed toward determining the cost of providing a TIS and the effectiveness of systems already in place. The desire for changes or improvements in a TIS is being matched by the need to examine existing performance. Such examinations prove valuable in selecting changes and improvements, in determining if they are appropriate, and in justifying specific expenditures. Cost-effectiveness analysis and the development of system performance measures should also aid in the comparative assessment of TIS alternatives for specific transit agencies.

The concept of performance takes into account two distinct notions: effectiveness and efficiency. Effectiveness compares the results of a service with the objectives initially set; efficiency is more concerned with how well an action is carried out by comparing the results with the resources consumed. This section reviews the work which has been done with regard to telephone information systems relative to both effectiveness and efficiency. It draws upon studies which have been conducted as well as the information obtained in interviews and discussions carried out during the course of this project.

In Section 3.0, it was pointed out that the objectives of a TIS are threefold:

(1) personalized information service,
(2) customer convenience, and
(3) provision of special short-term information (for example, announcement of weather- or equipment-related delays).

In addition, many transit marketing people contend that, from a public relations standpoint, a TIS must be maintained; the TIS is considered to be an essential part of an accessible public service. The TIS may also be the primary means for people to "enter" the transit system. These latter objectives stem from other, possibly more general, objectives of the marketing effort. In any case, the actual objectives should be established and known before an attempt is made to evaluate actual system performance.

In addition, the requirement for a TIS results from the need for transit companies to improve route productivity by improving schedules and routes in response to demand changes. The concommitant need to provide accurate and timely information about these changes cannot be met for all customers solely by distributing printed materials. In this case, the telephone information system enables the transit authority to make changes which it might otherwise delay if it were totally dependent upon printed information materials. Interestingly enough, during the 1940s, when schedules and routes were much more stable than at present, but when there were significantly more transit users, few, if any, transit agencies had a telephone information system.

In assessing the cost-effectiveness of a TIS, one must be concerned with the measurement of performance and the identification of indicators which enable performance to be measured. The primary performance aspects of a TIS which would be desirable to measure include the following:

(1) the acceptance of the TIS by the transit-user population
(2) the influence on user behavior in terms of the TIS revenue-generating potential
(3) the cost-effectiveness of providing a TIS service
(4) the performance of information agents

In this study we have identified how these aspects of performance are measured and the indicators currently being used to measure the performance. The latter two performance aspects above have yielded a number of useful results; the first category is much more difficult to determine for all but a few applications. However, in those cases where revenue-generation capability has been calculated the outcome has proven to be quite significant.

In the following sections our findings with regard to performance indicators, operations, technology, and labor productivity are presented. Our findings regarding TIS costs and the value assigned to a call response follow.

4.2 OPERATIONS

The aim of the TIS is to provide the desired information to the caller upon request; in most cases the TIS information agents respond to all types of incoming questions. Ideally, it would be useful to take account of the market segmentation (of calls) and to evaluate how each segment is being served, i.e., how accurate the responses are, how much time is spent responding, how many calls are of each type, etc. In addition, it would be useful to determine the effect of the TIS upon revenue generation for each of the market segments. This would help in determining the information to be included in the data base, the inquiries which might best be channeled elsewhere, etc. At this time, however, there does not appear to be a method for either segmenting the incoming call market or for determining the effect of the TIS upon any of the market segments. There is currently no generalized method for determining the effect of the TIS upon the generation of transit revenue (revenue passengers). However, WMATA is currently examining this aspect of a TIS.

On the other hand, data has been collected at a number of transit agencies which is helpful in understanding the TIS functions and in examining what is being accomplished by the TIS. In particular, the following information has been gathered:

- number of calls arriving during selected time periods
- time required per call
- time required for information retrieval
- number of calls serviced by each information agent during selected time periods
- percent lost calls (callers on hold leave queue)
- average waiting time in the queue (on hold)
- average queue length (callers on hold)
- percent time that telephone lines are busy

In addition, there are examples of data collected on the types of inquiries, the average time per call for different types of calls, and the accuracy of responses. However, these data have only been gathered in limited efforts and are not generally available. The following describes the results of a number of studies and data collection efforts with regard to the various data described above.

4.2.1 Calls Per Hour

The number of calls into a telephone information system has an hourly distribution which varies among systems. For the month of December 1978 in Minneapolis-St. Paul (Metropolitan Transit Commission), the distribution of calls during the day (averaged through the month) was as illustrated in Figure 4.2-1.[11] For a single day in October 1980, the calls into eight different telephone information systems within the New York - New Jersey (NY-NJ) metropolitan area were as shown in Figure 4.2-2.[10] Figure 4.2-3 illustrates the hourly distribution of calls into the SCRTD (Southern California Rapid Transit District) telephone information system for Mondays only during a 13-week period in 1981.[3]

The data illustrate the variations among peaking characteristics for different systems. The data suggest that incoming calls tend to have two peaks during the day. A first peak occurs in the morning and a second peak occurs during or just after the noon lunch period.

4.2.2 Calls Per Day

Calls per day to SCRTD are illustrated in Figure 4.2-4. (This data is averaged over a 13-week period in 1981.) The average daily calls for Washington, D.C., as shown in Figure 4.2-5, shows a similar trend in demand by day. The data indicate that the call demand is highest in the beginning of the week, tapering off rather uniformly through the week. It should be pointed out that the combined data regarding calls per hour and calls per day are generally used as a basis for information agent scheduling.

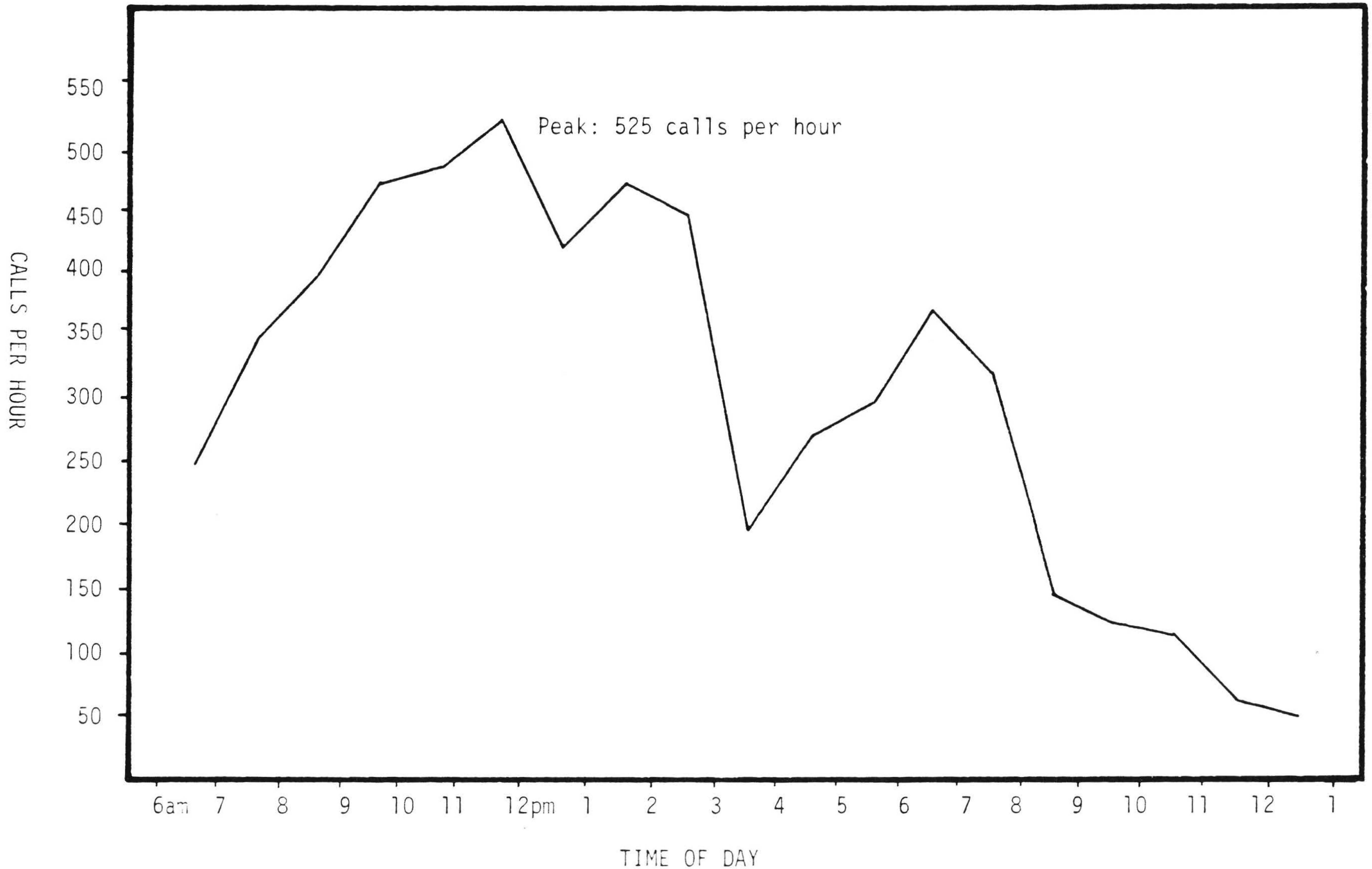

FIGURE 4.2-1: INCOMING CALLS THROUGHOUT THE DAY, - METROPOLITAN TRANSIT COMMISSION (MINNEAPOLIS-ST. PAUL), DECEMBER 1978
SOURCE: REF. 11

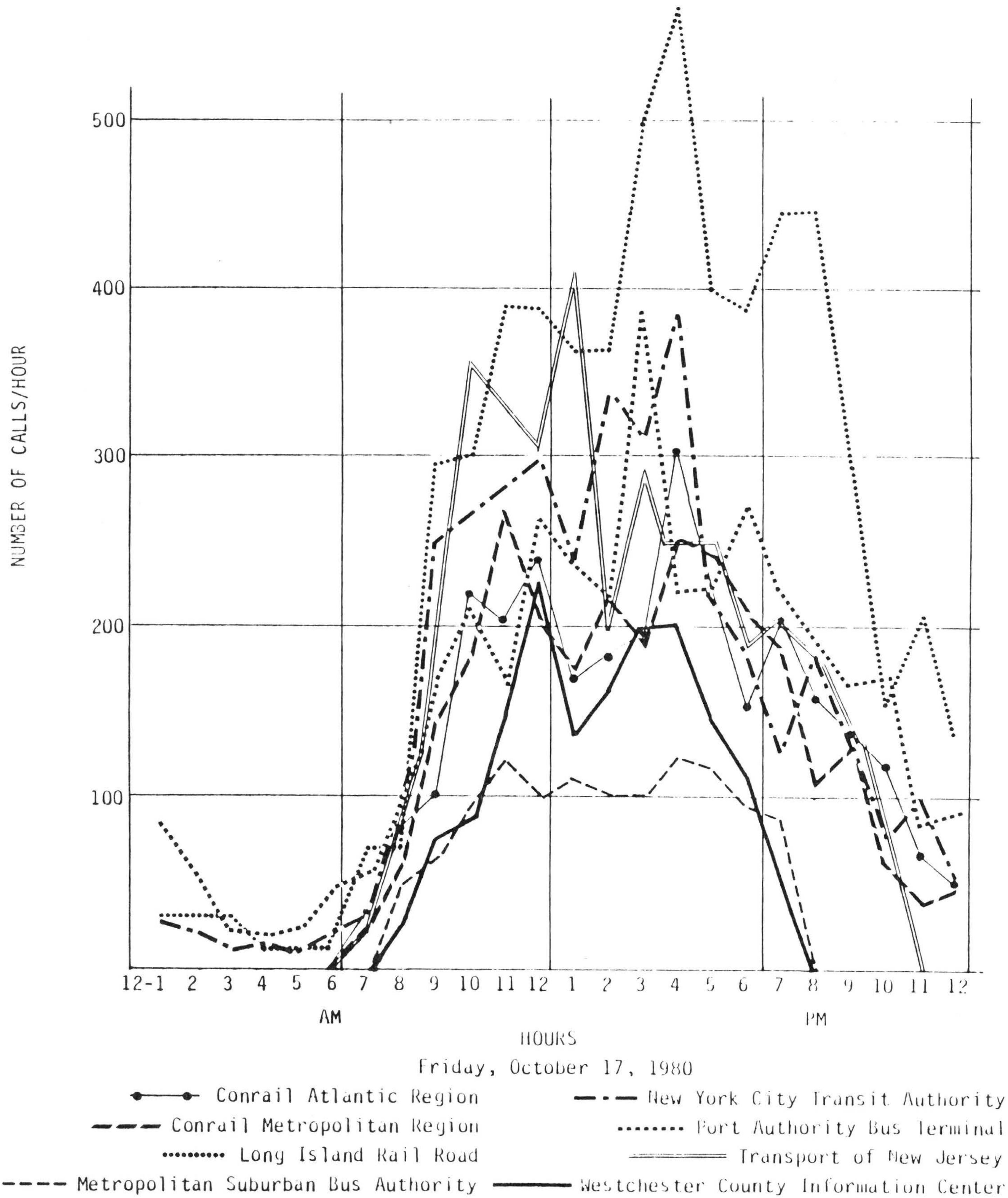

FIGURE 4.2-2: NUMBER OF CALLS/HOUR FOR EIGHT NEW YORK CITY REGIONAL INFORMATION CENTERS
SOURCE: REF. (10)

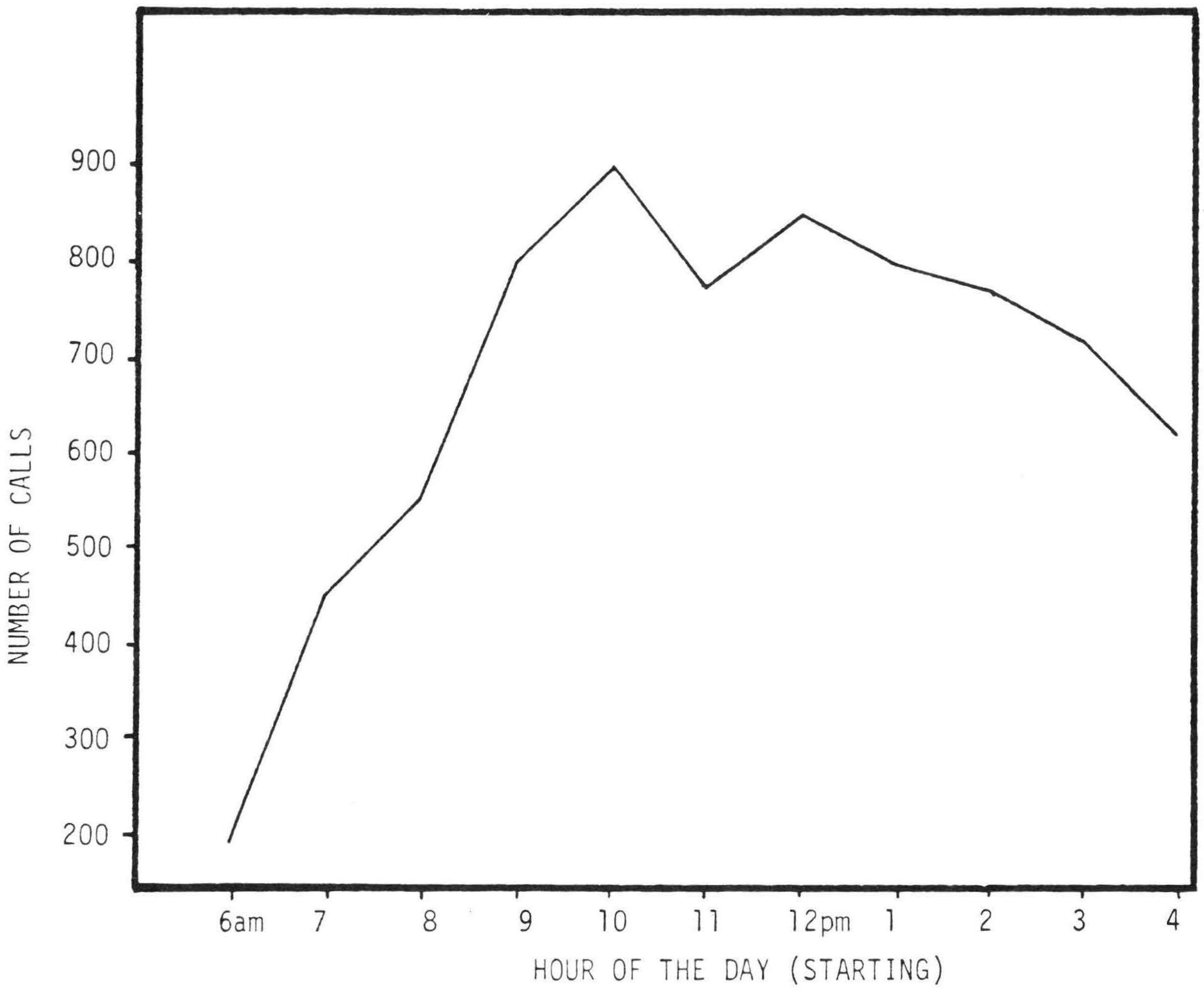

FIGURE 4.2-3: TOTAL CALLS RECEIVED INTO SCRTD (LOS ANGELES), ALL TRUNKS BY HOUR OF THE DAY, MONDAYS ONLY
SOURCE: REF. (3)

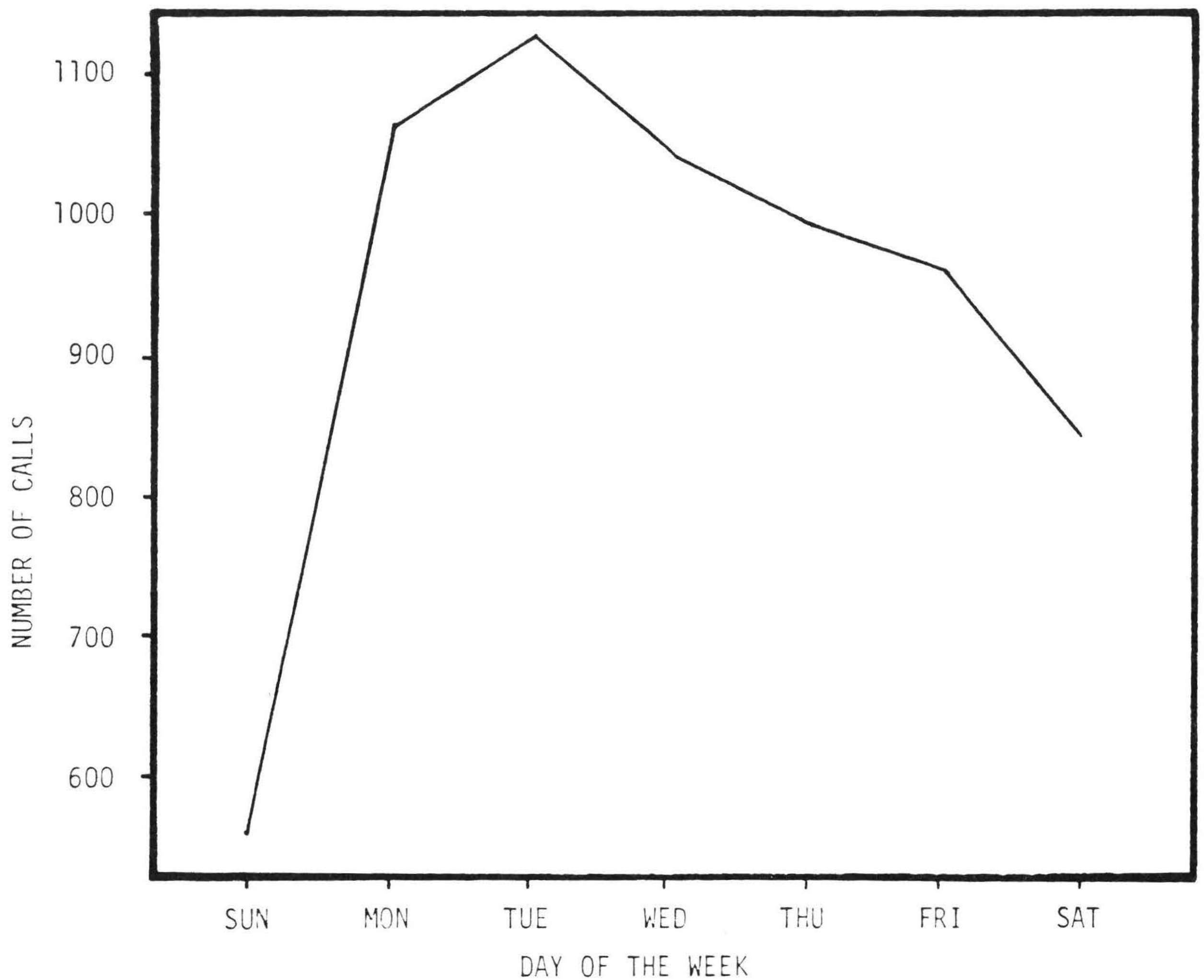

FIGURE 4.2-4: TOTAL CALLS RECEIVED INTO SCRTD (LOS ANGELES), ALL TRUNKS, BY DAY OF WEEK (6 AM-5 PM)
SOURCE: REF. (3)

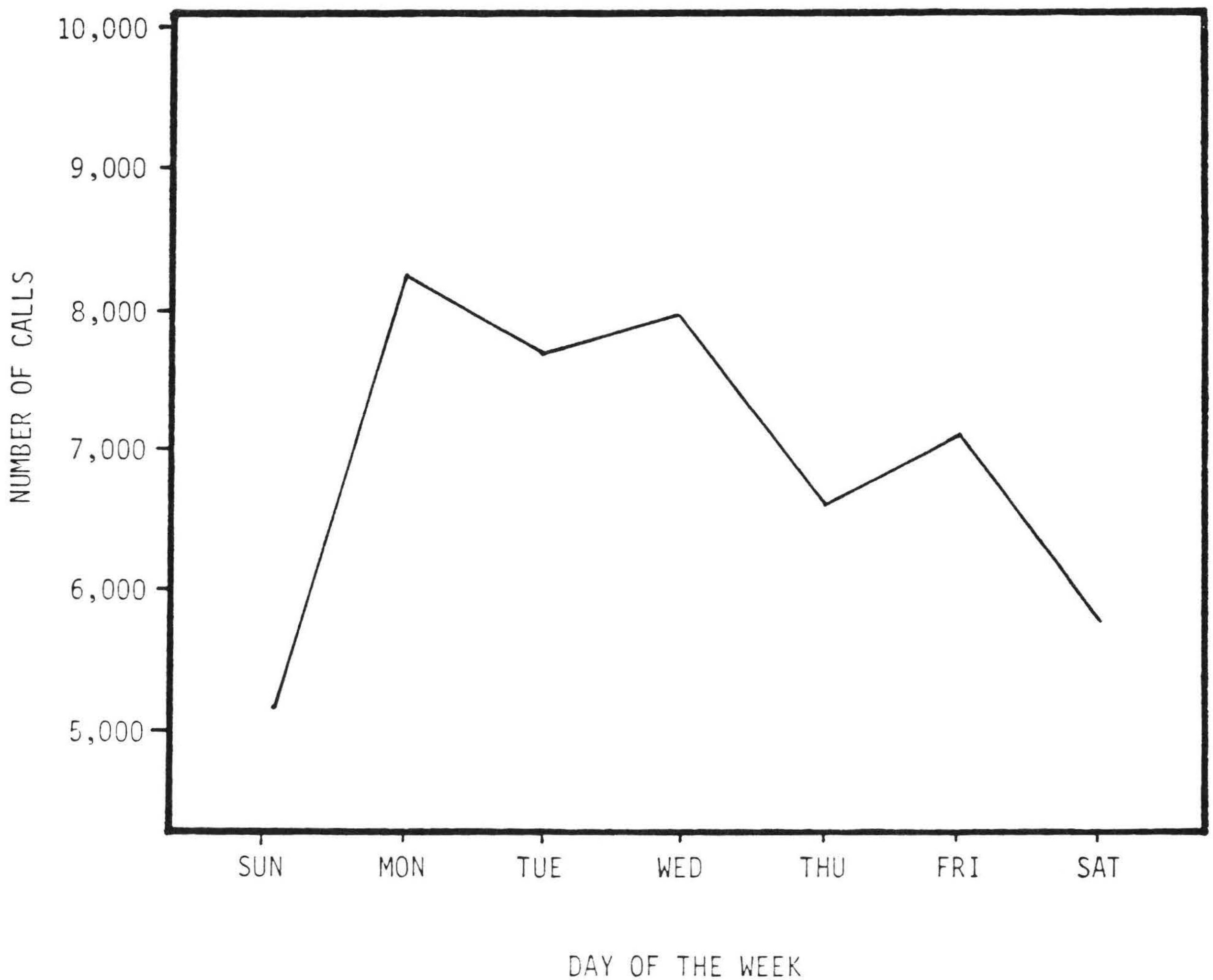

FIGURE 4.2-5: CALLS RECEIVED BY DAY TO WMATA (WASHINGTON, D.C.), SEPTEMBER 1982
SOURCE: REF. (4)

4.2.3 Time Required Per Call

The total time required per call averages about two minutes and appears to be consistent among a number of properties. For example, over a 13-week period at SCRTD the average call time ranged between 1:53 minutes and 2:09 minutes. The NY-NJ Study indicated that two minutes per call was a general average. Similar information was unavailable from WMATA.

With regard to the distribution of call times, SCRTD data for a 13-week test period indicate that 81.5 percent of all calls had a duration of less than three minutes; WMATA has indicated that approximately 80 percent of its calls have a duration of less than three minutes.

4.2.4 Time Required for Information Retrieval

A call consists of essentially two major components, communication and information search and retrieval. The communication component consists of the caller query to the information agent, any additional questions by the agent to clarify the request, and the response to the caller. The information search and retrieval component consists of the activities which the operator must carry out to obtain a suitable response for the caller; it may involve examining schedules, maps, or other hard-copy materials or utilizing a microfiche or computerized data base. It is the search and retrieval component which, for a given set of questions, can be reduced through improved techniques, equipment, or some other method; the communication time will be fairly constant for any search and retrieval method. The data from SCRTD indicate that, over a 13-week period and for calls averaging about two minutes, the communications portion of the call averaged 1:38 minutes. The search and retrieval component, in some cases utilizing a computerized data base, required 24 seconds.

An analysis of the WMATA manual system in 1974 indicated that for a sample of calls the average total time required was approximately 2:47 minutes with search and retrieval time of 1:02 minutes. Data on these items are not available for the WMATA AIDS system as yet.

4.2.5 Calls Per Agent

The number of calls per agent (per unit time) varies as a function of the complexity of the telephone information system, the nature of inquiries, and other factors. Early work by MITRE suggested that operators should be able to handle 32 calls per hour.[6] SCRTD assumed that operators utilizing a computerized data base should be able to handle 30 calls per hour.[3] Operations data from SCRTD indicate that the operators are capable of completing calls within an average of 2 minutes per call, suggesting a rate of 30 calls per hour. However, since the introduction of a computerized search and retrieval system, SCRTD operators have not improved upon the average of 20 calls per hour which they achieved before the system was installed. The NY-NJ Study indicated a range between 25 and 45 calls per hour per agent. The evidence suggests that although an average rate of 30 calls per hour (and maybe higher) is achievable, the pace of 30 calls per hour cannot be maintained throughout the working day and should not be expected.

4.2.6 Percent Lost Calls

A lost call represents a caller who is put on hold by the telephone answering equipment because all agents are busy and who hangs up before ever reaching an agent or receiving any information. In fact, such a caller may call back and receive the information which he seeks, so that the number of lost calls, if known, is actually an indication of the "worst case" situation. In general, lost calls are a function of the number of trunks and the number of information agents. ACD manufacturers claim their equipment keeps the callers occupied while on hold with recorded messages or background music, so they do not hang up so fast.

The NY-NJ Study indicated a range of 10 percent to 43 percent lost calls for the eight systems under consideration. WMATA, prior to the AIDS system implementation, had a lost call rate which ranged from 13 percent to 21 percent. Following the implementation of AIDS, WMATA's lost call rate was 22 percent during September 1-15, 1982. It has been reported that at SCRTD between 30 and 40 percent of all incoming calls are lost during peak-demand periods. Off-peak periods are likely to have a different rate.

4.2.7 Queue Related Measures

Average time in the queue or average wait time is the time that a caller must wait after the call is answered until an information operator can take the caller's query. Average queue length is the average number of callers waiting on hold for an information operator. Although these measures are closely related to the queuing model analysis approach to the representation of the transit information process,[6] no transit data has been identified on these measures.

This data, although it might be useful, is not available through existing data collection methods or equipment. No evidence was found that this data has ever been gathered with regard to transit telephone information systems.

4.2.8 Percent Time Lines Are Busy

Percent time lines are busy is the percent of time that a caller gets a busy signal when he calls the TIS. As with the previous measure, no evidence was found that data has ever been gathered on this item.

4.3 TECHNOLOGY (EQUIPMENT)

In evaluating performance there is a need to examine the various equipment components, their individual reliability/maintainability characteristics and the impact which these characteristics have upon performance of a TIS. The equipment described in Section 3.0 has specific performance characteristics inherent within its own operation and, when used separately or in combination, results in specific service attributes. Moreover, it should be noted that a TIS represents a combination of equipment, personnel, and service which must be examined as a unit in view of specific TIS objectives because each unit, or combination, is capable of yielding different results for different sets of objectives.

The trade-offs which exist in equipment, personnel, and service have been discussed in Section 3.0. There is little evidence that the trade-offs have been examined in detail or that the results of such trade-off studies are available from transit authorities.

Another aspect of the technology component of a TIS that has not yet been examined is the extent that the equipment is used and an evaluation of its use in view of the system cost and the benefits being achieved. For example, a computer system which is used to generate transit routing information may be used for only a portion of the total inquiries and therefore, may not be utilized to its capacity. In this case the equipment is underutilized and not achieving a high level of productivity.

4.4 LABOR PRODUCTIVITY

Labor productivity is an important issue in evaluating the performance of a TIS because labor represents a major cost element for any TIS. In Section 4.2 various indicators of TIS operations were examined which are related to labor productivity. The most relevant include the following:

Calls per agent per day
Operator response rate per time period
Time per call
Time for information retrieval

Response quality is another important agent-related indicator; it does not directly relate to labor productivity but it is important in terms of customer relations. Moreover, it should be pointed out that labor productivity must be considered in relation to the equipment being utilized to handle calls and to retrieve information.

It should be pointed out that information agents are generally entry-level persons, many starting at, or just above, the minimum wage. Consequently there are limits as to how well they can perform a task which is complicated in nature and often performed under stressful conditions. In addition, transit authorities (such as NYCTA) are sometimes required to use union employees as information agents and, in some cases, utilize light-duty employees as agents. (Light-duty employees are employees, such as drivers, who, for reasons of health or other problems, are assigned to the telephone center for "light duty" in lieu of their regular assignment.)

There is ample evidence that information agents take their job very seriously. For example, it has been reported that the more experienced SCRTD information agents take pride in providing personalized information to the caller, in particular, walking instructions to bus-stop locations. (This may actually lengthen the call response time.) Many systems report that agents take pride in answering inquiries without having to resort to hard copy in computer files. The pride factor appears to be quite high for information agents, indicating that system changes or procedural changes should be carefully instituted to ensure maintaining the overall positive attitude of the agents.

4.5 SYSTEM COSTS

There is very little data available regarding the costs of systems in operation. One reference[5] includes cost per call estimates (1979) for 19 systems, with the estimates ranging from $0.12 per call to $1.00 per call. (The mean was $0.40 per call.) Although the data are limited and must be used cautiously, they are indicative of the variations that can be expected.

The major elements of total cost for a TIS are illustrated in Table 4.5-1. The elements for all types of systems have been included within the table; the cost elements for a particular system would not necessarily include all of those listed. Table 4.5-1 also provides an indication of whether the cost elements represent capital costs or annual costs or both. Brief descriptions of the cost elements are presented in Table 4.5-2. An earlier study noted that the cost associated with a particular category may vary in magnitude between two different systems.[2] For example, telephone and furniture costs may be higher in a computer-assisted system because of the need for nonstandard or more specialized office equipment. In addition, computer-assisted systems may require additional training for agents who do not know how to type so that they can efficiently utilize the terminal.

Estimated total costs for planned systems of different types can be determined over any appropriate time horizon. These total cost figures can be used for a number of purposes: (1) to provide an estimate of total costs in current dollars over the assumed planning horizon; (2) to examine cost differentials in terms of the benefits of different systems to provide further comparison; and (3) to

TABLE 4.5-1: COST ITEMS FOR A TELEPHONE INFORMATION SYSTEM*

		CAPITAL COST ITEM	ANNUAL COST ITEM	DEPENDENT ON NUMBER OF INFORMATION AGENTS
1.0	Cost Elements Required of all Telephone Information Systems			
1.1	Information Agents		X	X
1.2	Furniture	X	X	X
1.3	Space Preparation			
1.4	Telephone Equipment	X	X	X
1.5	Physical Plant Overhead	X	X	
1.6	Information Agent Training	X	X	X
1.7	Data Base Management	X	X	
2.0	Cost Elements Required for an Automated Information Retrieval System			
2.1	Computer Space Preparation	X		
2.2	Computer Software Development	X	X	
2.3	Computer Hardware (leased)		X	X
2.4	Computer Operations		X	
2.5	Computer Terminals	X	X	X

* Based on Ref. (2).

TABLE 4.5-2: DESCRIPTIONS OF TIS COST ELEMENTS *

1.0 COST ELEMENT (ALL TIS SYSTEMS)	DESCRIPTION
1.1 Information Agents	Personnel required to adequately staff the agent positions during peak and non-peak periods; salary and fringe benefit costs for agents and supervisory personnel should be included.
1.2 Furniture	Costs of desks, chairs, file cabinets and other needed furnishings.
1.3 Space Preparation	Preparation and sectioning of the available space, sound deadening materials, etc.
1.4 Telephone Equipment	Telephones, automatic call distributing system equipment (ACD), and other related equipment; telephone service is a recurring cost item.
1.5 Physical Plant Overhead	Rental of space, utilities, insurance and janitorial service.
1.6 Information Agent Training	Training of information agents with regard to transit system, information system, and communications skills.
1.7 Data Base Management	Establishment and maintenance of system route and schedule information.

2.0 COST ELEMENT (AUTOMATED TIS SYSTEMS)	DESCRIPTION
2.1 Computer Space Preparation	Preparation of a proper environment for a dedicated computer which includes electrical, air conditioning, and sound conditioning preparations, placement of communication cabling ducts and appropriate flooring modifications.
2.2 Computer Software Development	Development of operating system software, the applications software for algorithms, programs for editing and updating the data base, and management information systems programs.
2.3 Computer Hardware	Lease costs are assumed although they can be replaced by amortized value of purchase cost if equipment is purchased; maintenance and repair costs must also be accounted for.
2.4 Computer Operations	Consists primarily of salaries for computer system operators; may also reflect power costs for computer and peripheral equipment.
2.5 Terminals	Costs for computer terminals dependent upon the number of information agent positions involved.

* Based upon Ref. (2).

examine the cost figures over different time horizons to determine when (or if) the costs of the two systems would become comparable.

4.6 VALUE OF A CALL

One of the more difficult aspects of assessing a TIS is estimating the value of a call into the system. It is generally assumed that a telephone call into the TIS is initiated by a prospective transit user and that by providing the appropriate information the TIS will enable the caller to become a revenue passenger. Since it is quite likely that some calls actually result in a revenue passenger trip being made, it is useful to examine what the value may be. The value of a call might be separated into two components, near term and long term. The near term or immediate value results from the caller making a trip as a new transit user, making a new trip as a regular transit user, or becoming a regular transit user. The long term value may result from a greater frequency of trip use by all callers and callers making additional trips within the system that were not considered previously. Estimating the value of a call is, nevertheless, a question of estimating the number of calls which actually result in a fare being paid and also estimating how many fares a given call will generate.

Information agents generally have experience with callers who request the same information each day and others who make the same request of a number of agents for the same trip in the same day. Callers often request information which is not related to transit travel, i.e., time and temperature, weather-related school and office closing information, and public event time schedules. There are no data available on the numbers of callers who fall into this overall category, but it would be useful to know how many there are because each of these utilizes the TIS resources as much as a transit call but they do not generate a transit fare.

In addition, callers seeking information on peak-hour transit schedules, although they may represent a potential transit fare, may actually cause the O&M costs of the transit system to increase if they add to the peak-period load.

The value of a telephone call to a TIS was discussed at an UMTA-sponsored workshop in November 1979.[5] In an informal survey attendees suggested that one call can generate from one-third to one-half an average fare. No studies have been conducted which substantiate this estimated range although WMATA has initiated just such a study. Moreover, discussions with transit marketing specialists during the course of this project indicate that these estimates may be high for small- to medium-sized transit agencies.

In Hamburg, Germany, surveys of users of the AFI telephone information system indicate that one-third of the test population made transit trips for which private autos would have otherwise been used. Moreover, most of the trips resulting from the use of the information system were nonwork or occasional trips; such trips are not normally transit trips. This indicates that callers were attracted to transit and revenues increased.

4.7 SUMMARY

Systematic procedures for the evaluation of telephone information systems have not been fully developed. Differences in system objectives and system equipment make it difficult to compare performance although in the previous sections data from a number of disparate systems is presented side by side.

System objectives are a very important consideration; increased concern about the cost of providing a TIS has generated interest in making such systems more efficient, especially in cases of decreasing transit ridership and revenues. The three primary objectives of a TIS, personalized information service, customer convenience and provision of special short-term information, are oriented toward a highly customized, labor-intensive service. Efforts toward reducing costs of a TIS must carefully reassess the objectives, and service provided, of the TIS.

The collection of much of the performance-related data is a difficult task which in most cases has not been attempted by operators of systems. Data on a number of incoming calls and calls handled by information agents is available. Information on the number and kinds of inquiries is scanty; the WMATA AIDS specification cites an inquiry distribution which was gathered in 1973 and is based upon 166 inquiries; more recent data is not available. Further, there is no indication that data has been gathered on the number and kinds of calls by route or by area. Information such as this would be very useful in the design of the system and the service and in evaluating eventual system performance.

5.0 ASSESSMENTS OF THREE REPRESENTATIVE SYSTEMS

This chapter summarizes the assessments of three representative telephone information systems which range in technical complexity from labor intensive, manual systems to fully automated computerized systems. The manual system examined was that at the Nashville-Davidson County Metropolitan Transit Authority (MTA). The MTA, with approximately 115 buses in peak service, is a medium-sized system but larger than 75 percent of all U.S. bus systems*; if systems of this size have a TIS, it is likely to be a manual one. The second system examined was the AIDS-Automated Information Directory Service system in operation at WMATA in Washington, D.C. Conceived as a demonstration program, AIDS has evolved into an operating system which forms the basis of all WMATA TIS operations. AIDS is a computerized data storage and retrieval system which automatically provides route, schedule, itinerary, and fare data to the information agents. The third system examined was the AFI system in Hamburg; AFI is a fully automated, computerized system with which a caller can carry out an inquiry dialogue.

5.1 NASHVILLE-DAVIDSON COUNTY MTA ASSESSMENT (MANUAL SYSTEM)

5.1.1 Local Demographic and Transit System Characteristics

Nashville and Davidson County, Tennessee, have a population of 477,811 (1980) within a land area of nearly 1,387 km^2 located in the Middle Tennessee Region (see Figure 5.1-1). Under its present Metropolitan Charter, which became effective April 1, 1963, Nashville and Davidson County have a single government with a mayor, a vice mayor, and a legislative council of 40 members, including five councilmen-at-large. The local bus system is operated by the Metropolitan Transit Authority (MTA), a public agency which was formed in 1973.

Table 5.1-1 presents some basic data on the local demographic and transit system characteristics for Nashville and Davidson County. The automobile ownership level is approximately 710 vehicles per 1,000 population (U.S. average is about 675 vehicles per 1,000 population) and the population density is 344 persons per km^2; both these parameters contribute to a reliance on personal vehicular

* As determined from data in Ref. (6).

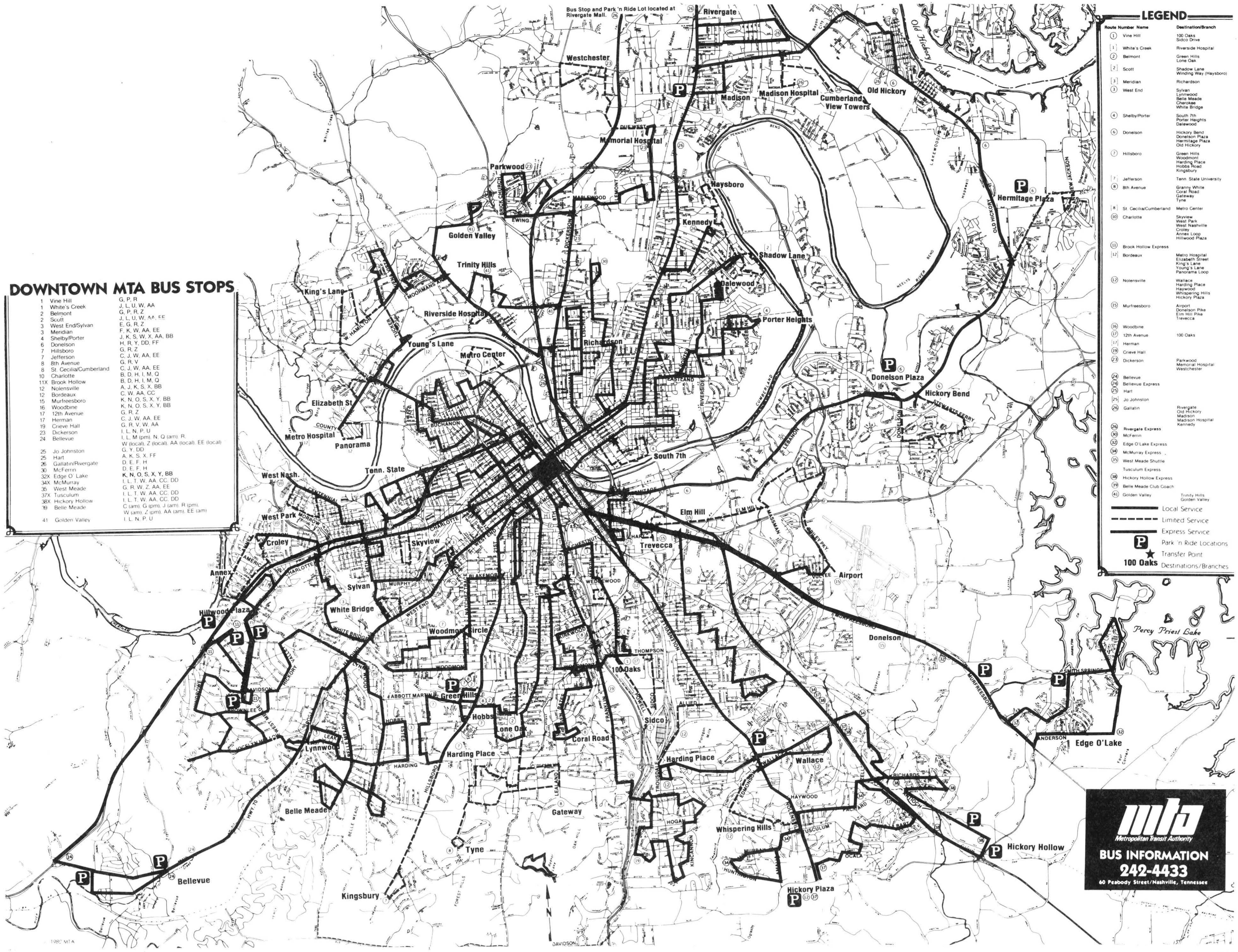

FIGURE 5.1-1: NASHVILLE-DAVIDSON COUNTY AREA MAP

TABLE 5.1-1: NASHVILLE - DAVIDSON COUNTY DEMOGRAPHIC AND TRANSIT SYSTEM CHARACTERISTICS (1980)

Total Urbanized Area	1,377 km^2
Total Area Population (1980)	477,811
Total Number Employed in Area (1980)	259,930
Vehicle Registrations in Area	339,877
Motor Vehicles per 1,000 Population	710
Type of Service Network	Bus:Radial
Operational Characteristics of Transit System	
Buses Operated in AM Peak	117
Buses Operated in PM Peak	110
Average Weekday Bus-km	25,044
Average Weekday Bus Hours	1,128
Average Weekday Unlinked Passenger Trips	14,682
Revenue Passengers per Bus-km	0.95
Total Annual Passengers (1981)	9,763,500
Total Annual Revenue Passengers (1981)	7,355,200
Bus Service Miles (directional) on Mixed ROW	275.8

travel which is characteristic of U.S. cities. The population of Nashville-Davidson County increased 6.7 percent from 1970 to 1980 as compared to an average increase of 50 percent for the six contiguous counties surrounding Nashville-Davidson County for the same period.

Table 5.1-2 presents the transit ridership and transit vehicle miles of service in Nashville from 1964 to 1981. The decline in revenue passengers has been steady except for some increase during the period in which petroleum prices rose rapidly (1977-1980). On the other hand, transit vehicle miles of service, though fluctuating over the years, have decreased only 5 percent from 1964 to 1981.

5.1.2 Marketing and Passenger Information Activities

Within the MTA the Director of Marketing and Planning reports to the General Manager (see Figure 5.1-2, MTA Organization Chart). The marketing function of the position involves all efforts aimed at identifying potential market components coupled with promotional activities and information dissemination. It also includes management of the telephone information system and the local ridesharing program. A survey was conducted for MTA in 1979 which yielded the following information with regard to ridership characteristics in MTA service area:

Rider Age:	18-34 years: 35%
	35-49 years: 20%
	50-65 years: 25%
	65+ years: 20%
	Average age - 46
Education Level:	Less than high school graduate: 29%
	High school graduate and more: 38%
	College graduate and more: 25%
	Average - 13 years of schooling

TABLE 5.1-2: SUMMARY OF RIDERSHIP AND VEHICLE KILOMETERS OF SERVICE

1964 - 1980

YEAR	REVENUE PASSENGERS	PERCENT CHANGE	VEHICLE KM	PERCENT CHANGE	REV. PASSENGERS PER VEHICLE KM
1964	11,628,048		8,162,700		1.42
1965	11,429,743	-1.71	7,993,650	-0-	1.43
1966	11,428,345	-0-	7,180,600	-10.0	1.61
1967	11,095,982	-2.91	7,612,080	+6.0	1.46
1968	10,533,766	-5.16	8,046,780	+5.7	1.31
1969	10,375,751	-1.50	7,377,020	-8.3	1.40
1970	10,154,573	-2.13	6,773,270	-8.1	1.50
1971	8,794,465	-13.40	6,287,050	-7.1	1.40
1972	7,478,500	-15.0	5,549,670	-12.0	1.32
1973*	3,319,862	-	2,685,480	-	1.24
1974**	6,805,000	-	5,557,076	-	1.22
1975	6,692,000	-2.0	5,707,450	+3	1.17
1976	7,439,000	+11.2	6,767,260	+18.6	1.10
1977	8,137,000	+9.4	7,349,465	+8.7	1.11
1978	8,408,000	+3.3	7,409,220	+8.7	1.14
1979	8,673,000	+3.2	7,773,080	+5.0	1.11
1980	8,687,000	+.16	8,109,570	+4.3	1.07
1981	7,355,174	-15.3	7,721,077	-4.7	0.95

Source: Metropolitan Transit Authority Operating Statistics

* Begin fiscal year accounting. Represents data from January 1, 1973 to June 30, 1973.
** Represents data from July 1, 1973 to June 30, 1974.

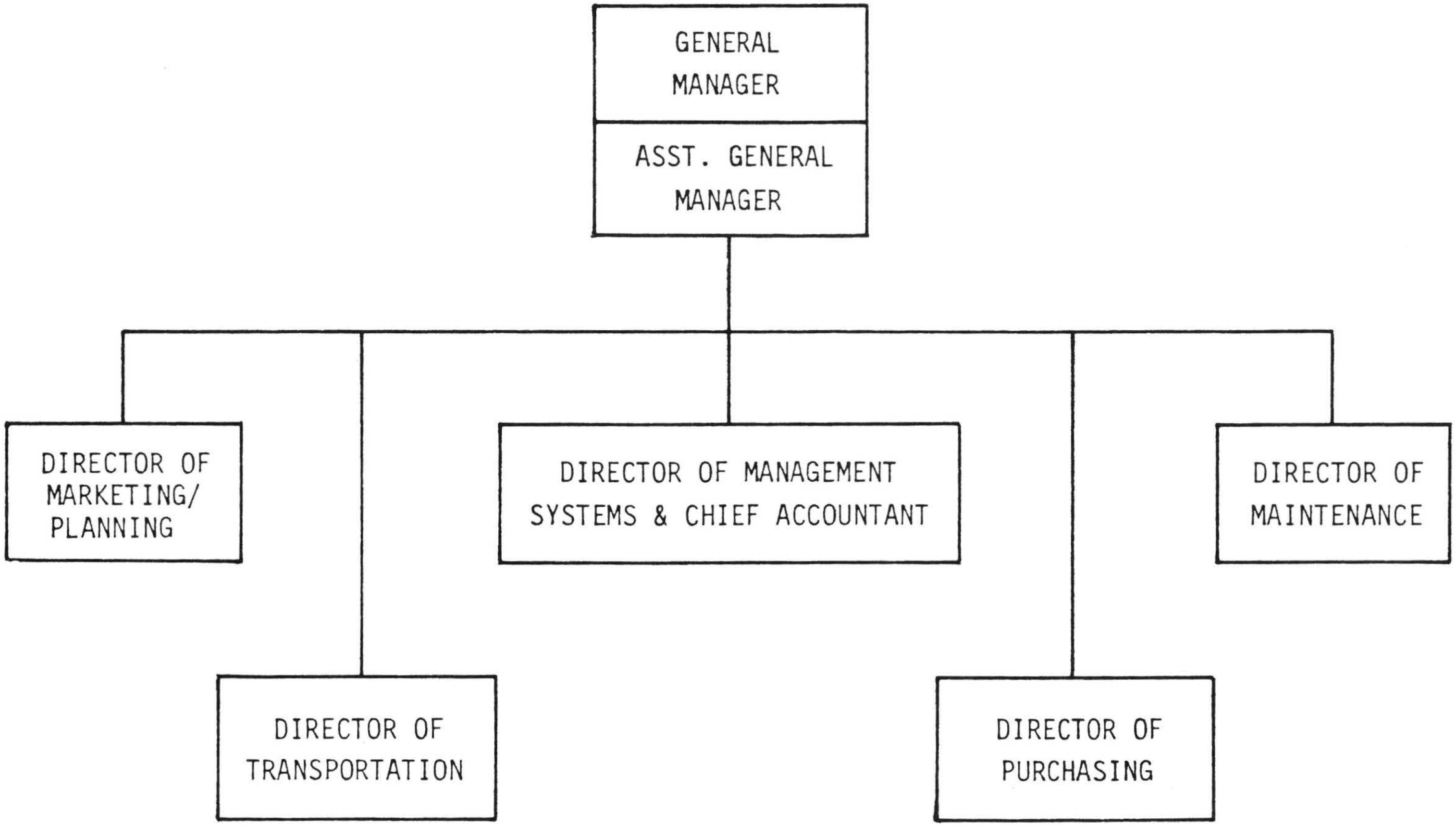

FIGURE 5.1-2: MTA ORGANIZATION CHART

Annual Income Level:	Less than $10,000: 32% $10,000 - $19,999: 36% $20,000 - $29,999: 20% $30,000 and more: 11% Average annual income - $18,000
Sex:	60% Female - 40% Male
Race:	60% White - 40% Black

The typical MTA frequent rider uses MTA three days per week for at least one of five almost equally important reasons; i.e., to go downtown, to save money, because no car is available, to get to work, and for convenience.

MTA promotional activities were severely curtailed during FY 1981. Advertising was limited to charters, ridesharing, and special transportation services; news releases, special news coverage, TV/radio talk show appearances, and community presentations comprised the balance of the promotional campaign. General rider communication was limited to a special brochure entitled "State of the MTA" and existing bus interior advertisements.

MTA's information dissemination program focuses on the telephone information center and the distribution and display of printed materials. Printed materials include timetables with maps for each route, a system map with "how-to-ride" advice, ridesharing promotion brochures and "flyers". Newly installed bus-stop signs (in the downtown area) provide the number and name of each route serving that stop; they also provide the telephone information center access number as do all printed materials distributed by the MTA.

MTA's bus routes are numbered from 1 through 41. The single crosstown route is referred to as 7-Jefferson or 7-Hillsboro depending upon the direction of travel. Express routes have an "X" in addition to the number designation. Bus schedules with route maps are available at the MTA offices, major employment and shopping centers, and banks within Nashville. At the present time route schedule information generated from RUCUS is used directly for consumer schedules; use of RUCUS for this purpose has helped in speeding up transmittal of schedule information to transit users and has helped avoid errors as well.

5.1.3 Telephone Information System Description

The MTA telephone information center operates from 6 a.m. to 7 p.m., Monday through Friday, and from 8 a.m. to 5 p.m. on Saturday. The general schedule of information agent loading is shown in Table 5.1-3; the average number of calls per day is 1,400, the maximum about 4,500. An information agent handles an average of 250 calls per day, a maximum of about 500 calls per day. Figure 5.1-3 presents the number of calls per half-hour during the month of November 1981. The data illustrates the pattern of a call demand peak on Monday with a gradual daily decrease until demand increases again on Thursday and Friday, typical of many telephone information centers.

TABLE 5.1-3: SCHEDULE OF MTA INFORMATION AGENT LOADING

	TIME (a.m.)							
DAY	6:00	7:00	8:00	8:30	9:00	10:00	11:00	11:30
M-F	1	2	3	4	6	5	5	6
Sat.			1	1	1	2	2	2

	TIME (p.m.)								
DAY	12:00	1:00	1:30	2:00	3:00	4:00	5:00	6:00	7:00
M-F	4	6	7	7	6	5	3	1	1
Sat.	2	2	2	2	1	1			

TIME PERIOD	MONDAY	TUESDAY	WED'DAY	THURSDAY	FRIDAY	SAT'DAY
6:00-6:30	36.80	34.75	23.00	23.33	29.75	
6:30-7:00	41.60	35.75	29.75	39.33	28.75	
7:00-7:30	43.00	43.00	41.00	39.67	28.25	
7:30-8:00	58.40	55.75	48.00	53.00	42.25	
8:00-8:30	68.00	77.75	51.25	68.33	68.75	38.25
8:30-9:00	65.60	73.50	49.00	59.67	67.00	46.25
9:00-9:30	78.40	70.50	55.50	63.00	72.00	51.25
9:30-10:00	74.80	65.00	54.00	67.33	80.25	52.75
10:00-10:30	63.60	56.25	43.50	55.00	56.75	55.75
10:30-11:00	61.60	49.25	54.25	60.33	62.00	54.50
11:00-11:30	72.60	61.75	58.00	66.33	68.00	43.75
11:30-12:00	67.00	59.75	69.25	59.00	63.75	41.00
12:00-12:30	89.60	62.00	80.50	69.00	74.50	47.75
12:30-1:00	72.40	69.75	64.75	57.33	69.75	39.00
1:00-1:30	71.80	79.75	68.75	70.33	75.50	42.50
1:30-2:00	74.40	64.50	60.25	65.33	69.50	45.75
2:00-2:30	71.60	65.75	61.00	62.00	78.25	44.50
2:30-3:00	72.80	68.75	63.25	73.00	75.25	44.00
3:00-3:30	71.40	61.50	60.25	59.67	75.00	48.00
3:30-4:00	65.00	69.50	55.50	66.33	69.75	47.25
4:00-4:30	57.00	58.25	64.50	57.67	59.25	41.25
4:30-5:00	39.60	46.75	49.00	46.33	53.00	15.50
5:00-5:30	38.20	35.75	35.00	34.67	35.00	
5:30-6:00	24.80	32.75	22.25	38.67	26.00	
6:00-6:30	21.60	26.00	22.25	24.67	21.75	
6:30-7:00	15.00	23.50	19.50	16.33	15.00	
TOTALS	1516.60	1447.50	1303.25	1395.65	1465.00	799.00

FIGURE 5.1-3: NUMBER OF INCOMING CALLS PER HALF-HOUR DURING NOVEMBER, 1981

The telephone information center has evolved from a single person performing a combination of duties (the transit company receptionist handling all incoming calls and providing service information when requested) to a separate center with a director and five full-time information agents.

The telephone information center is perceived as a public service operation provided for customers seeking any information about MTA service. Telephone information agents respond to all calls, including those which are not related to MTA business; information on schedule/route changes during weather (or other) emergencies is considered extremely important (call volume increases noticeably during such periods). The information center personnel believe that transit users are dependent upon them for system operations information, particularly for work trips.

No surveys have been conducted by the MTA with regard to the nature of telephone inquiries. It was indicated that the center gets all kinds of calls; the telephone information center number is highly publicized as a general information number and callers seek all types of information, including, on occasion, time and temperature. The information agents are located in a single office with six desks for the information agents and a partitioned space and desk for the Director of Information; no additional dividers or sound-deadening materials are used.

5.1.3.1 System Hardware

At the time of this study the system hardware consisted of six call directors with a rotary system. Seven incoming lines are used by the information center; an eighth line, dedicated to ride-sharing information, is also manned by the information agents. An automatic answering device is used when the phones are not being manned. There is a TTY* system for the hearing-impaired at a specially designated number.

The system has been in operation since 1974 and the MTA reports that it has had no problems with the equipment. While this report was in preparation, the MTA

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* A TTY is an electromechanical device which enables a telephone to be used to communicate between two typewriting devices.

purchased an ACD system which can serve up to 8 lines and 8 agent-positions and is expandable to 32 lines and 32 positions.

5.1.3.2 Description of Operations

The telephone information system is a manual system which utilizes hard-copy data storage. The MTA information agents respond to inquiries from memory and/or through the use of printed schedules, route maps, and route descriptions which they keep at their desks. The caller is generally asked to provide information regarding his location, his destination, and his arrival and/or departure times. Once these inputs are established the agent can determine the appropriate response and convey it to the caller.

As mentioned above, no attempt has been made to differentiate the types of calls coming into the information center and the telephone equipment does not have the capability to record data regarding the calls. Moreover, discussions with the Director of Information revealed no basis for determining estimates of percentages for different kinds of calls. The Director of Information indicated a preference for having the agents answer all incoming calls and put the callers on hold if necessary; this action, it is believed, makes the agent more aware of the waiting caller and encourages the agent to get back to the waiting caller as soon as possible. Some other type of automatic system which puts the caller on hold and provides an informative message or provides background music is considered to be too impersonal.

In addition to providing immediate verbal responses to caller questions, the information agents take requests for route/schedule information and mail it out; they also fill out inquiry forms for the ridesharing program.

The information agents are scheduled on the basis of the call demand as evidenced by the weekly call reports which indicate the number of calls answered per half hour. Temporary relief from unexpected demand can be provided by the Director of Information and the MTA receptionist. In addition, the MTA scheduler, whose office is located adjacent to the information center, acts as a standby information agent in emergencies.

5.1.3.3 Staff Requirements and Training

The MTA information agents are high school graduates who must have a good knowledge of the city. There are no training manuals; rather, the MTA relies upon individualized instruction and on-the-job training. Agent training lasts from four to six weeks. As necessary, the agents are sent out to ride the bus routes with which they are unfamiliar.

Agents are evaluated through observation; the Director of Information, a former information agent, works in the same room as the agents and continually spot-checks their performance.

5.1.4 Performance Characteristics and Measures

The MTA collects data on the number of calls per half hour period (as illustrated in Figure 5.1-3). Individual agent call data is not routinely collected but it was indicated that the information can be collected as needed through direct observation. It was estimated that the average time per call is less than two minutes and that 60 percent of the calls are one minute or less. An internal study of agent activities revealed that there are very few lost calls and that a call is usually answered within three rings. No lost call information is available although it would be possible to request that it be collected by the local phone company. The data collection period would be from 8:00 a.m. to 4:30 p.m., the hours of operation of the phone company.

5.1.5 Telephone Information System Costs

Although the MTA does not isolate all costs directly related to the information center, it was possible to estimate the cost of the system from the data available. An internal report indicates that the annual operation (service charge) cost of equipment is approximately $6,200. Annual cost of agent salaries, fringes, and overhead is approximately $132,000 for a total of $138,200. Based upon the weekly call records the annual number of calls answered is between 300,000 and 400,000. The per call cost therefore ranges between $0.30 and $0.37.

5.1.6 Telephone Information System Evaluation

The Nashville-Davidson County MTA telephone information system (TIS) appears to be typical for a transit system and an urban area of this size based upon an examination of the data contained in the summary of a national TIS workshop and inquiries at a number of similar-sized transit authorities. The MTA system is organized to provide responses to all inquiries and is strongly oriented to the public relations objectives of a TIS. The MTA is characteristic of a large number of transit systems in this country in terms of size, service area, etc. The very recent (just prior to completion of this report) acquisition of an ACD provides the MTA with equipment to maintain its highly personalized service and also to provide it with additional management information.

The data that were available to this study regarding the system and the calls it handles was essentially related to the volume of incoming calls and number of calls answered by each of the information agents. The average number of calls per day is 1,400, the maximum about 4,500. An information agent handles an average of 250 calls per day, a maximum of about 500 calls per day. No information is available regarding time required per call, time required for information retrieval, or percent lost calls.

The director of the telephone information center indicated that the MTA strongly supports the public relations aspects of the center and, as a result, the center will continue to respond to all types of calls. The MTA sees no immediate need to change this basic orientation and is satisfied with the performance of the center within this context. Because data were not available on the items mentioned above and the types and percentages of incoming calls, a more quantitative evaluation of the system was not possible. The new equipment which the MTA has purchased should provide a data base for more quantitative evaluation in the future.

5.2 WASHINGTON AIDS ASSESSMENT (COMPUTER-ENHANCED SYSTEM)

The AIDS (Automated Information Directory System) used by the Washington Metropolitan Area Transit Authority (WMATA) in Washington is one of the most sophisticated transit telephone information systems in North America and has been the subject of an extensive development program. AIDS is a computerized data storage and retrieval system which allows information agents to provide detailed routing and schedule information for trips on the fifth largest multi-mode transit system in the country.

5.2.1 Local Demographic and Transit System Characteristics

The demographic and system characteristics of the Washington, D.C. region and the local transit system are presented in Table 5.2-1. Until World War II, Washington, D.C. was a fairly small city; Washington and the surrounding region experienced extensive growth in the decades following, and the structure of the region has been shaped by the automobile and highways (see Figure 5.2-1). In this respect, the city and region have more in common with Sunbelt cities such as Phoenix or Houston than its neighbors in the Northeast corridor. The current Washington D.C. regional population is 3,060,922 (1980). It has increased at a 2.5 percent annual rate since 1950. The population in the Washington area is highly unstable. Estimates are that one-third of the population turns over annually.

WMATA was created in January 1973 from four private transit companies. Although routes and schedules were consolidated, the different fare structures of the four companies were kept relatively intact; as a result, fare information can be difficult to calculate.

WMATA operates some 1,767 buses over 775 bus routes (143 bus lines). There are four rail lines at present, covering 67.8 km (42.4 mi.). When it is completed, the rail system will have five lines, covering 162 km (101 mi.).

Transit ridership is shown in Table 5.2-2. The 1981 ridership of 182,532,237 passengers was a decrease from the previous year, the first decrease since WMATA was formed in 1973. The decrease has been attributed in part to passenger concern

TABLE 5.2-1: WASHINGTON DEMOGRAPHIC AND TRANSIT SYSTEM CHARACTERISTICS

Total Urbanized Area	3,111 km^2
Total Service Area*	3,961 km^2
Total Metropolitan Population**	3,060,922
Total Service Area Population	2,743,695
Total No. Employed in Metropolitan Area	1,536,620
Total No. Employed in Service Area	1,402,138
Number of Automobiles in Metropolitan Area	1,802,173
Number of Automobiles in Service Area	1,623,313
Type of Service Network	75% radial routes, some cross-town routes, grid routing in inner city
Type of Fare Collection	Zone, concentric. Special fare structure in Alexandria and Fairfax County
Operational Characteristics	
Total Number of Vehicles	Bus: 1,767 Rail: 296
Vehicles Operated in Morning Peak	Bus: 1,520 Rail: 256
Vehicles Operated in Evening Peak	Bus: 1,476 Rail: 256
Total Line Length	Bus, mixed ROW: 2,098 km Rail: 67.8 km single-direction
Total Number of Stations and Stops	Bus: approx. 11,000 Rail: 42 current, 87 projected
Total Number of Park-and-Ride Lots	Bus: 22 Rail: 9
Total Number of Unlinked Passenger Trips	177.6×10^6

* District of Columbia, Montgomery, Prince George's and Fairfax Counties, Cities of Arlington, Falls Church and Alexandria.

** SMSA: Service area plus Charles, Loudoun, and Prince William Counties.

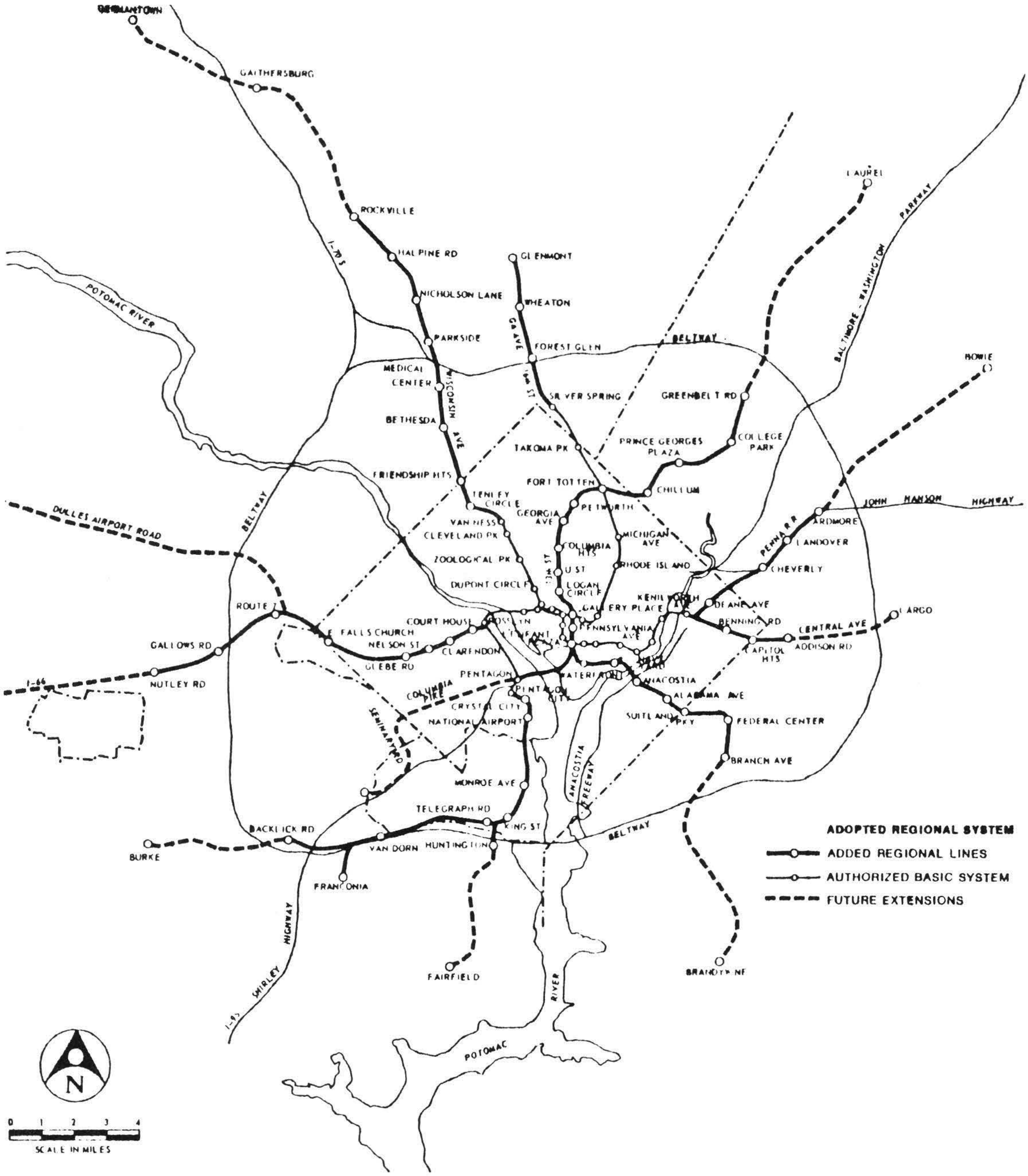

FIGURE 5.2-1: WASHINGTON, D.C. AREA MAP

TABLE 5.2-2: COMPARISON OF WMATA SYSTEM RIDERSHIP, REVENUE AND AVERAGE FARES FOR FISCAL YEARS 1973 THROUGH 1981 - Source: WMATA

FISCAL YEAR	RIDERSHIP 1/						SYSTEM PASSENGER REVENUE 2/	SYSTEM AVERAGE FARE
	BUS ONLY	RAIL ONLY	BUS/RAIL	BUS RELATED	RAIL RELATED	TOTAL TRANSIT		
1973 3/	53,914,369			53,914,369		53,914,369	$ 24,687,884	45.79¢
1974	116,808,677			116,808,677		116,808,677	53,650,739	45.93¢
1975	122,841,746			122,841,746		122,841,746	56,639,577	46.11¢
1976	126,366,388	1,084,535	438,689	126,805,077	1,523,224	127,889,612	59,830,670	46.78¢
1977	124,855,121	4,714,326	1,906,919	126,762,040	6,621,245	131,476,366	63,716,607	48.46¢
1978	96,596,101	21,284,034	16,003,082	112,599,183	37,287,116	133,883,217	73,886,193	55.19¢
1979	95,113,062	34,438,910	24,734,475	119,847,537	59,173,385	154,286,447	86,753,158	56.23¢
1980	111,784,888	38,195,902	37,439,548	149,224,436	75,635,450	187,420,338	106,500,000	56.82¢
1981	106,942,422	41,120,859	34,468,956	141,411,378	75,589,815	182,532,237	$125,368,000	68.68¢
1982 4/	102,407,000	45,445,000	35,275,000	137,682,000	80,720,000	183,127,000	$136,988,000	74.80¢

1. Includes weekday, Saturday, Sunday, School and Midibus riders.
2. Includes passenger revenues, Midibus and School subsidy.
3. Reflect one-half year only.
4. Estimate adjusted to reflect actual FY 1981 levels, and actual FY 1982 fare and service changes.

about system reliability, both bus and rail. Ridership for 1982 is estimated at 183 million, about the same as that in 1981.

There have been more than 20 passenger surveys and six major transit studies carried out since 1974. These were necessary for allocating subsidy costs among the jurisdictions that provide financial support for WMATA. Maryland, Virginia, the District of Columbia, four counties, and three cities subsidize the system on the basis of ridership in their jurisdictions. In addition to the ridership data generated from these studies, there is considerable additional information available on rider demographics compiled in many of these reports.

Demographic data from a ridership survey taken in June 1979 are presented below.

		METROBUS PASSENGERS	METRORAIL PASSENGERS
Sex	Male	38%	52%
	Female	62%	48%
Age	Under 20	5%	2%
	20-34	42%	54%
	34-49	25%	26%
	50-64	21%	16%
	Over 65	7%	2%
Annual Household Income	Under $8,000	15%	5%
	$8,000-$15,999	31%	24%
	$16,000-$23,999	21%	21%
	Over $24,000	33%	50%
Years of Education Completed	0-12	26%	11%
	13-15	27%	23%
	16	19%	24%
	Over 16	28%	42%

5.2.2 Marketing and Passenger Information Acitivites

Since its inception, WMATA has placed marketing among the most important functions of its organization. A policy for marketing transit services was agreed upon in November 1972, just prior to public takeover of the four local transit companies, which calls for the following:

(1) an agressive marketing effort patterned after the approach of successful private retail enterprise.

(2) initiation of a series of customer-oriented actions supported by a positive sales promotion program, and

(3) full commitment of the Authority to better public transportation.

The objective of marketing is to maximize provision of transit service while minimizing the amount of subsidy required. The marketing department formed to meet those goals is believed to be among the first for a transit authority in the U.S.

The Customer Information Section is one of several sections in the Office of Marketing (Figure 5.2-2). It is part of the Consumer Affairs Branch, which supplies information to the Authority's customers and assists the customer in using WMATA's transit services. The Consumer Assistance Section represents the customer's viewpoint to the Authority's organization. The Customer Information Section supplies the customer with the information that he will need in order to ride Metro or Metrobus.

5.2.3 Telephone Information System Description

5.2.3.1 System History and Evolution

As stated previously the current WMATA transit system represents a fairly recent consolidation of four private bus companies into a single public transit authority in 1973. In addition, an extensive rail system which initiated operation in 1976 is still under construction. The public information system has been the focus of much attention and effort because of the need to provide consumers with information about the new system and about changes in the bus system. In the first year and one-half of consolidated service, the number of information agents on duty was doubled. In 1982 there are 57 information agents with up to 30 on duty at one time. In 1974 a microfiche system was implemented to improve upon the information retrieval characteristics of the operation. Initial reaction to this system was positive but by October 1974 it was noted that the complexity of the bus

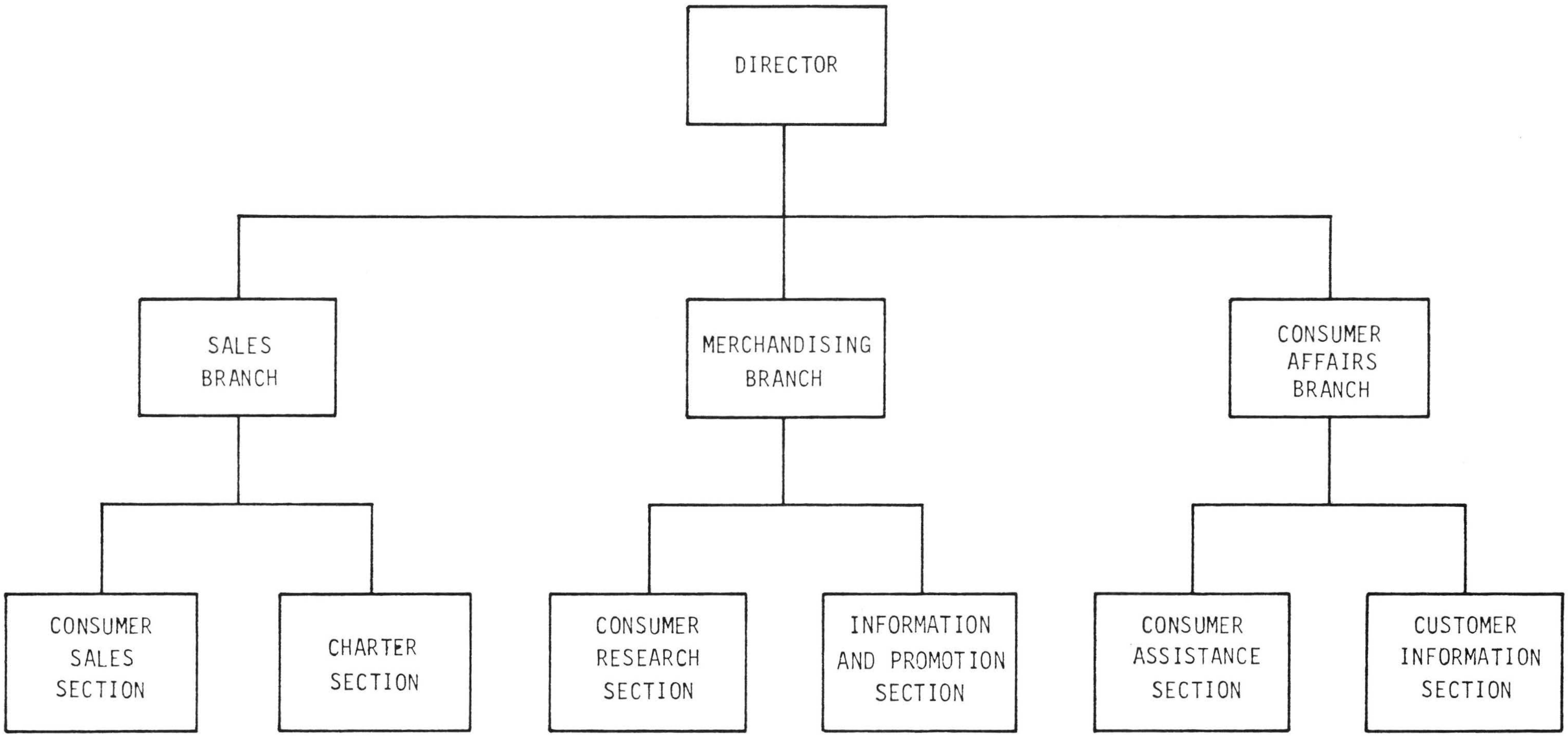

FIGURE 5.2-2: WMATA OFFICE OF MARKETING ORGANIZATION CHART

and rail systems would necessitate an improved information storage and retrieval system. WMATA decided that because of repeated schedule and route changes (partly due to the staged opening of Metrorail) the need for microfiche production was too extensive; in addition the microfiche did not help with itinerary questions. A 1974 report set forth the basic performance requirements for the Automated Information Directory Service (AIDS) System and compared it with other generic system types. Since that time work on the AIDS system has progressed through the development of system specifications (July 1977) to the implementation of AIDS.

5.2.3.2 System Objectives

The objective of the WMATA telephone information system is to provide a transit customer with personalized information about transit system service. For customers who do not possess printed transit schedules or maps, calling the transit telephone information service is a quick and convenient method of learning how to make a particular trip via transit. Even customers who possess printed transit schedules or maps often find it useful to call a telephone inquiry service in order to interpret or verify information. Telephone information systems are also used by transit companies to disseminate information about temporary service disruptions and special transit services to sporting events or other public gatherings. The AIDS project was sponsored by UMTA as a demonstration effort "to develop and evaluate a usable and effective computer-aided transit information system that can be used throughout the U.S., particularly where properties operate a complex transit network."(12)

5.2.3.3 System Operating Characteristics

The WMATA telephone information system is in operation from 6:00 a.m. to 11:30 p.m., seven days per week. It receives 200,000 calls in a typical month, between 5,000 and 9,000 calls per day.

Peak calling days during the week are Mondays and Tuesdays. Following these two days there is a gradual decline in calls until the weekend; the number of callers picks up again on Sunday night. During the day, the busiest period is between 8:30 a.m. and 5:00 p.m. Specific daily peaks are 9:00 a.m. to 11:00 a.m. and 2:30 p.m. to 5:00 p.m.

It is possible to collect data on the distribution of calls by route via AIDS, but this is not done for several reasons. First, agents do not use AIDS for all calls. Calls that were answered from memory or by reference to hard-copy materials would not be tallied by AIDS. Second, WMATA has determined that callers are not representative of system riders. Callers are skewed toward suburbanites, who have more need for telephone information because bus service is less frequent and they are usually not as familiar with the system. The information on callers which has been collected by AIDS has not proven to be useful because it does not provide information about the entire population of callers or riders. Even origin-destination information was found to be too skewed to be of value.

Marketing promotions tend to increase calls into the telephone information system. When a promotion is held in a subregion of the Washington area, there is an increase in calls received from that particular area.

The information agent staff consists of 57 agents and 7 supervisors with one trainer and an AIDS coordinator. There are at most 30 agents on duty at any particular time (see Table 5.2-3 for schedule).

The average call load per agent is 180 calls per day; the maximum is approximately 300 calls per day, although one agent logged a record 700 calls during a blizzard (this was prior to AIDS). On that day there were a great many short calls inquiring about a change in the transit schedules for workers going home early, or inquiring if federal employees would be released early. Such calls are common during bad weather. It is assumed that since there are so many workers with one employer (the Federal Government) that the transit system will be forewarned when the commuting pattern is changed; this, in fact, does not occur at the present time.

Information regarding the nature of inquiries to the information system is available from a survey conducted in 1973. The following four categories of calls were observed:

Type I - Trip Itinerary: how to get from A to B (76.9%)

Type II - Boarding Time: time of arrival for a particular bus at specified location (16%)

TABLE 5.2-3: INFORMATION CENTER STAFFING PATTERNS

MONDAY - FRIDAY SCHEDULE		SATURDAY SCHEDULE		SUNDAY SCHEDULE	
TIME	STAFF ON DUTY	TIME	STAFF ON DUTY	TIME	STAFF ON DUTY
6:00 a.m.	13	6:00 a.m.	8	6:00 a.m.	7
6:30	18	6:30	11	6:30	9
7:00	18	7:00	11	7:00	9
7:15	19	7:15	14	7:15	10
7:45	20	7:45	15	7:45	12
8:00	20	8:00	15	8:00	12
8:15	22	8:15	17	8:15	14
8:45	24	8:45	18	8:45	16
9:00	24	9:00	18	9:00	16
9:15	27	9:15	21	9:15	17
10:00	27	10:00	21	10:00	17
11:00	27	11:00	21	11:00	17
12:00 p.m.	27	12:00 p.m.	21	11:15	22
1:00	27	1:00	21	12.00 p.m.	22
2:00	27	2:00	21	1:00	22
2:45	30*	2:45	25*	2:00	22
3:00	30	3:00	25	2:45	29
3:15	25	3:15	22	3:00	29*
4:00	24	4:00	19	3:15	27
4:30	23	4:30	18	4:00	26
5:00	21	5:00	16	4:30	24
5:30	19	5:30	15	5:00	22
6:00	16	6:00	12	5:30	20
7:00	16	7:00	12	6:00	19
8:00	16	8:00	12	7:00	19
9:00	16	9:00	12	8:00	14
10:00	16	10:00	12	9:00	14
11:00	16	11.00	12	10:00	14
11:30	16	11:30	12	11:00	14
				11:30	14

* Shift change

TABLE 5.2-4: LOCATION PARAMETER BREAKDOWN

LOCATION PARAMETER	FREQUENCY OF OCCURRENCE	PERCENTAGE OF TOTAL
Street Intersection	104	39.0
Street Address	52	19.5
Suburban Community	52	19.5
Shopping Center	20	7.5
Government Building	11	4.1
"Downtown" or "D.C."	7	2.6
Transportation Terminal	6	2.2
Store	4	1.5
Hospital	4	1.5
Hotel	2	0.7
Theater	2	0.7
Museum	1	0.4
Housing Development	1	0.4
Monument	0	0
Restaurant	0	0
Other	1	0.4

Source: Ref. (12)

TABLE 5.2-5: REQUEST PARAMETER BREAKDOWN

REQUEST PARAMETER	FREQUENCY OF OCCURRENCE	PERCENTAGE OF TOTAL
Bus Route	125	79.1
Boarding Time	68	43.0
Return Itinerary	21	13.3
Fare	20	12.7
Bus Stop Location	12	7.6
Send Schedule	10	6.3
Other Metro Telephone Number	4	2.5
Alternate Itinerary	3	1.9

Source: Ref. (12)

the phone. The agent's console does not permit adjustment of receiver volume, call transfer, or dialing out.

The supervisor console consists of a "turret" with a display of red and green lights to indicate the status of the agents manning the lines in the following manner:

Red: Line is busy
Green: Line is available
Flashing Red: Caller on that line is on hold

Status of the system is displayed on the supervisor console as well. An analog meter indicates up to 12 calls waiting. Lights for each trunk show the calls in queue, although it is difficult to count them because they change rather quickly. A trouble light indicates problems in the system. There are no billboards or flashing lights indicating the status of incoming calls for all agents to see.

The supervisor is able to silently monitor each agent, but cannot break in on agent conversations. Recording conversations is possible; new employees are required to sign a release, allowing their calls to be recorded for training purposes.

The Stromberg-Carlson ACD is equipped with a peg counter which counts the number of calls received and the number of calls answered. The difference between these two indicates the number of calls lost. The counter is read hourly, and although it can be reset, this is not done. The counter will reset itself to 000 after 999 calls are counted. It will also count the number of calls handled at each agent position. The counting of calls is by work station rather than by an agent identification.

No reports are available on average caller waiting time, average call length, or trunk condition.

For the AIDS system WMATA purchased Hazeltine 1510 video display terminals which have the following specifications:

Display Area	12 in (30.48 cm) diagonal screen
Character Generation	9 x 11 dot matrix
Character Size	0.14 x 0.10 in (0.36 cm x 0.25 cm)
Characters Per Line	80
Lines	24
Storage	2 pages (screens)
Progammability	Key functions are software programmable

The system also uses two identical Hewlett-Packard HP 3000 Series II computers, installed in 1978, and is in the process of being expanded with an HP-3000 Series III computer. The two Series II computers are being upgraded to Series III models as well. The computers are dedicated to the information system during the hours it is in operation; in the off-hours they are used for related activities, including generation of bus-stop files, landmark files, and lists of routes for cost allocation. These data are readily available through the AIDS data base and can be used for planning and scheduling.

The HP 3000 Series II operates with a word length of 16 bits, has an internal memory of 256K bytes, and a simultaneous input/output capability of 48 terminals, printers, and consoles.

There is one hard-disk storage unit with each CPU, with a capacity of 512 megabytes. No speech synthesizers or decoders are used in the AIDS system.

System Software

The applications program for the AIDS system was custom written for the system. It includes data base search, retrieval, and handling. The computer does not store the entire data base in internal memory during operation. Data called up most recently stay in internal RAM memory, and periodically it is all dumped back to the disk. Data used most often tends to stay in internal memory, which provides shorter response times.

The programs will calculate itineraries based on shortest travel time, shortest wait time, or shortest walking distance as requested by the caller.

Data Base

AIDS uses a geographic data base constructed by overlaying a grid of squares 25 ft (7.6 m) on a side on the Washington region. Thirteen thousand bus stops, 700 routes, 26,000 streets, 40,000 intersections, and other landmarks are located by coordinates on the grid.

Description of Operations

The AIDS system provides agents with a prompting method of data entry. The system displays on the VDT a series of statements and blanks to be filled in by the agent. When all entries are completed, the system evaluates the entries to determine the type of query and selection ranking. It then performs the calculations and displays a reply.

The system includes automatic correction of misspellings entered by information agents. If the system is unable to find a misspelled entry in the data base, it defaults to a spelling corrector routine, which generates alternate entries for the misspelled name. The routine displays:

(1) An indication that the name entered is misspelled
(2) Display of the misspelled entry
(3) A list of logical alternate names from the data base

The system permits the agent to select one of the displayed alternates or a name not on the list as the correct entry.

At any point during the entry and processing of a query, the agent may correct or alter any entry already made. The AIDS system recognizes erroneous entries and displays a prompting message so the agent can re-enter the data. Once the entry has been made properly, the system continues handling the transaction normally.

The AIDS system has a specific set of calculations and a display for each type of query as discussed below:

(1) Type I Query - Trip Itinerary.

In processing this type of query, the system identifies all reasonable trip itineraries between the caller's origin and destination, ranking them according to the following criteria:

(a) Proximity of the origin and destination stops to the caller's specified origin and destination
(b) Required walking distance
(c) Number of transfers
(d) Proximity of actual departure or arrival time to those specified by the caller
(e) Trip duration

The weighting of the factors used in determining these rankings is variable in the program. The weighted factors were determined by trial and error when the system was implemented. During implementation the programmers and information agents worked together to adjust the weight assignments so the program would give the highest ranking to the "best" routing alternative. The information agent can choose the selection criteria based upon caller preference. All undisplayed trips are held in the system in rank order, pending an alternate trip request from an information agent.

In response to the Type I Query, the system displays the following information concerning the trip itinerary: route number, boarding time, fare (with conditions), stop locations, walking time estimates, and direction of travel.

(2) Type II Query - Boarding Time.

The system identifies and displays a series of scheduled stop times covering the time specified by the information agent, showing route number, stop location, boarding time, and direction of travel.

(3) Type III Query - Bus/Rail Stop Location.

The system will search the data base to locate stops and stations within reasonable proximity of the caller's entry. Caller origin locations need not be bus stops. Valid inputs to the system include the following location descriptors: street intersections, major street addresses, suburban communities, and prominent local landmarks, such as large buildings (commercial, government, apartments), transportation terminals, monuments, and shopping centers.

The system will automatically estimate walking distances from the location designated to the nearest transit stops, displaying information for the agent on route number, stop location, walking time estimate, and direction of travel.

(4) Type IV Query - Service Information.

Determination of which routes service a specific location or bus stop.

- Origin location
- Destination location
- Route
- Day and time of travel
- Special fare category

When this information is entered, the system refers to the fare structure and displays:

- Fare
- Conditions

(5) Follow-on Queries.

In answer to any of the other four types of queries, the system retains all information so that a follow-on query can be handled efficiently. Information from the original query is retained for use in producing the information for the subsequent query.

The caller can use the telephone information system with very little initial information. He enters the system with basic geographic information about his own location. Prominent landmarks, buildings, shopping centers, or monuments are adequate, as are street addresses or intersections. He needs to indicate where he wants to go and the time he wishes to travel.

The AIDS system accepts all these geographic data for route calculation. It will calculate on the basis of bus only or rail only travel, for a particular day of the week, for arrival or departure times, and for current information or for information that will be correct after an upcoming schedule change.

Information Agent Training

Information agents at WMATA are given a five-week training course in the transit and telephone information system before they are put to work full time. The training manual used by WMATA, entitled "Reaching Out for Riders", emphasizes the sales aspects of the job. Information agents are trained to think of themselves as WMATA's first sales contact with the customer. As a result, the attitude and courtesy of the agents is considered very important.

The training program covers the necessary skills for the job and the WMATA system. Three main areas are covered: (1) attitude and courtesy, (2) routes, schedules and fares, and (3) actual riding of the buses and trains to become familiar with the routes. Time spent on each of these areas is currently broken down approximately as follows:

Attitude and courtesy:	20%
Riding:	10%
Printed information study:	48%

The remainder of the time is spent in orientation, training, exercises, and on-the-job training.

Attitude and courtesy training concentrates on developing a friendly telephone technique, and keeping it regardless of how rude or disorganized the customer might be. Agents are trained to treat callers as important customers at all times. The attitude or mood of the customer is not something that the agent should react to, and likewise, the agent's mood should not be transmitted to the caller.

Along with proper telephone style, an information agent at WMATA is given training about the transit system. When AIDS was first developed, it was assumed that the computer programs and data base would take the place of the individual agent's knowledge of the system. After implementation of AIDS, it was found that the agents worked fastest when they knew how to use every information source at hand, i.e., AIDS, printed schedules and route maps, and their own knowledge of the system. As a result, training sessions on system familiarization which had been dropped were reintroduced into AIDS operator training.

System familiarization is made up of two parts, learning the routes and schedules from maps and headway sheets, and learning the routes and route surroundings from riding trains and buses. Trainees are encouraged to take their area maps with them while riding the system and to trace in the route as they travel, writing in landmarks and other aids for future calls. Altogether, system familiarization takes up more than half of the time spent on training.

5.2.4 Performance Characteristics and Measures

WMATA collects data from the ACD on calls per hour and calls per day. These are collected by work station, and for the information section as a whole. This information as well as the calls per agent data are used primarily for counseling agents to improve their performance.

In 1982 the average agent at WMATA handled 22 calls per hour and 179 calls per day. Choice of information materials is left up to the agent, so these figures include use of AIDS, manual information retrieval, and answers from memory.

Lost calls are tallied by the ACD and used as a measure of overall system performance. The 1982 average annual number of calls answered was 83%. The average annual number of calls answered during 1981 was 81%.

Data is not available on the length of time per call, or the information search time per call, although the management of the information section would make use of it if it was available.

5.2.5 Telephone Information System Costs

System capital and annual operating costs are listed in Table 5.2-6. Operating costs are estimated at approximately $1,743,950 annually, while the total capital cost of the AIDS system was approximately $1,258,000.

Daily call counts are approximately 6,000 calls, averaged over a week, resulting in an annual total of 2,190,000 calls. The operating cost per call, therefore, is on the order of $0.72. If the AIDS development costs are amortized over a ten-year period it would add $0.06 to each call for a total of $0.78 per call.

5.2.6 Telephone Information System Evaluation

The stated objective of the AIDS system was "to develop and evaluate a usable and effective computer-aided transit information system that can be used by many transit properties throughout the United States, particularly where properties operate complex transit networks in terms of size and number of modes".[4] Thus, the implementation of AIDS was originally a demonstration of new technology rather than the application of existing technology. UMTA's goal was to determine if a computer system could be developed which would provide for automation of the telephone information function and to determine the cost of such a system. AIDS must be evaluated in view of the fact that it is a first-of-a-kind application.

The expected benefits of a computer-assisted telephone information system like AIDS were stated as the following:

(1) Improved productivity in terms of agent calls per hour answered due to faster data retrieval. Productivity should improve through automation of the data retrieval function, because information search time is reduced. The computer should be able to locate the necessary data and make route and schedule calculations faster than the information agent can.

TABLE 5.2-6: WMATA TELEPHONE INFORMATION SYSTEM COSTS

	CAPITAL $	ANNUAL $
Information Agents	-	747,000
Supervisors	-	157,000
Furniture	24,000	250 (maps)
Space Preparation	224,000	-
Telephone Equipment	200,000**	12,000*
Physical Plant	-	720,000***
Information Agent Training	-	26,500
Data Base Management	300,000*	(2)
Data Processing Space Preparation	(1)	-
Data Processing Hardware	350,000	27,000 contract maintenance
Computer	(3)	(3)
Terminals	(3)	(3)
Data Processing Operations	-	28,000
Software		
System	(3)	3,000
Applications	160,000*	20,000
Office Supplies and Special Materials	-	3,200

* Estimates by Mr. Michael Noonchester of WMATA
** WMATA has budgeted almost $200,000 for a replacement telephone system.
*** Based on a space estimate of 3,000 sq. ft., and rental of $20 per sq. ft. per mo.

(1) Included in general space preparation.
(2) Included in data processing operations below.
(3) Included in turnkey hardware contract.

(2) Increased reliability and consistency of agent responses. A computerized system is expected to improve reliability of responses by ensuring that agents at all experience levels have access to the same data and the same calculations of optimum routes and transfers. Without the computer, experienced agents might give different responses than novices, and the novices might answer the same complex itinerary questions differently at different times. The common data base helps to eliminate this problem and results in higher caller confidence in the information system since repeating a question to the system will likely result in the same response.

(3) A reduction in training time for new agents. By putting system and geographic data in computer memory, it was expected that there would be less need to teach it to the agents and, therefore, agent training time would be reduced.

(4) Enhancement of the agent's overall job satisfaction by automating the tedious and repetitive elements of the job.

(5) Expanded capability to gather statistics concerning individual agent and Information Section performance. Performance is not easily measured with a manual information system because of the lack of data. However, with an automated system, all information retrieval queries and calculations can be stored for later study. Data is available to determine where the callers are traveling to and from and to assess the need for information on a geographical or route basis. Performance of the agents themselves can be measured with the telephone equipment or with a program associated with the data retrieval system.

(6) Use of the transit system data base by other WMATA departments as a planning resource. The data base developed for the AIDS system consists of extremely detailed geographic data, and includes information on streets, intersections, major traffic generators, and bus stops. This information can be put to use by other departments and agencies for various types of planning and budgeting efforts.

In comparing the results of the AIDS system with the system goals and the expected benefits it seems clear that UMTA's goal of demonstrating computer technology for a telephone information system has been met satisfactorily. The system is workable, useful, and, after the initial debugging period, has not required an inordinate amount of maintenance and repair. As a result of the AID demonstration, information has been obtained which will prove useful in reducing errors and avoiding unnecessary costs in other deployments.

The purpose of a demonstration is to show that an experimental technology which may have benefits in a particular setting can be made to work in that setting. The AIDS demonstration has resulted in a working system which operates successfully everyday in a real-world environment. The AIDS system has become an essential tool for the WMATA information agents; it has not replaced agent memory or the hard-copy data base used in the past, but it now complements them as a data and information source.

The fact that the agents use AIDS and rely on it for certain types of queries is important evidence of its technological success. The agents are free to use any information source available; if the AIDS demonstration was a failure, they would have abandoned the system for manual methods.

The demonstration has shown, however, that automated information retrieval and calculation is a substitute for a portion of inquiries, but not all. Information agents have shown that they can answer certain inquiries faster and as effectively as the computer. A study of AIDS operations has shown, for example, that 84.7% of schedule queries were answered by manual data retrieval. (This has been decreasing, however.) On the other hand 36.7% of the itinerary calls were handled by manual data retrieval or memory; whereas 29.8% were handled by the AIDS system. AIDS-only calls were most likely to be itinerary requests (84%) which is not surprising in view of the complexity of such calls (Table 5.2-7).

It is apparent that AIDS is used for highly complex queries, such as those regarding itineraries, and can provide an answer more quickly for such calls. On the other hand, agent familiarity with certain data or responses will result in AIDS being bypassed in order to provide the caller with a quicker response. The judgmental

TABLE 5.2-7: CROSS-TABULATION OF QUERY TYPE VS. RETRIEVAL MODE AFTER-IMPLEMENTATION CALL MONITORING

	MODE OF DATA RETRIEVAL				
QUERY TYPE	MANUAL ONLY	AIDS ONLY	AGENT MEMORY	MIXTURE	TOTAL
Itinerary	325	264	164	133	886
Schedule	316	31	14	12	373
Route	0	1	0	0	1
Fare	38	20	10	13	81
Total	679	316	188	158	1,341

Source: Ref. (4)

factor of the information agent enables the agent to choose the retrieval mechanism best suited for the individual query.

5.2.6.1 Productivity

With regard to agent productivity there is very little data on the number of calls handled by agents before and after implementation of the AIDS system. The distribution of calls by call length were measured in the AIDS evaluation study.[(4)] When compared with pre-AIDS data and expressed as percentages, the results show little change (Table 5.2-8). Before AIDS, 72% of the calls lasted two minutes or less; after installation 72.5% of calls were of this same duration. The percentage of calls three minutes or less were 86.5% and 87%, respectively. There is some indication of a shift from the longest calls to the shortest after AIDS was implemented. It was expected that the longest calls would be most affected because they involve more complex calculations. The computer should speed up these calls, so there would be fewer calls on the long end of the spectrum.

TABLE 5.2-8: DISTRIBUTION OF CALL LENGTH AT WMATA BEFORE AND AFTER AIDS IMPLEMENTATION

	LENGTH OF CALL (MINUTES)				
	0-1	1-2	2-3	3-4	4+
Before*	38.2%	33.8%	14.5%	5.3%	8.2%
After**	45.5%	27.0%	14.5%	6.4%	6.6%

Source: Ref. (4)

* Sample size: 6,162 calls
** Sample size: 5,126 calls

These results were not translated into operator call counts, however. The number of calls handled by each operator in a fixed period of time (one hour, for example), and the number of calls handled by the Information Section are typical measures of performance. The same AIDS evaluation did analyze data from the ACD and it was found that the Information Section handled fewer calls after implementation.[4] However, the sampling periods were small and conclusions are not possible.

External events often dictate TIS demand and the length of individual calls. Moreover, given the percentage of time of a call which is spent on information input and dissemination, and the relatively small percentage spent on functions which can be handled by the computer, there is not a lot of leverage on total call time which can be affected by speeding up data retrieval and calculation.

WMATA does not have the ACD equipment and software necessary to monitor and compare a single agent's performance while using AIDS and while relying on manual techniques. Should they acquire such equipment in the future, it would be useful to monitor the system in a controlled experiment to get a better feel for productivity changes.

5.2.6.2. Reliability and Consistency of Responses

WMATA relies on agent assessment of the AIDS information to evaluate the quality and reliability of the information. Agents indicate that AIDS provides reliable information while making a greater quantity of information available for servicing callers. It is also reasonable to assume that when the agents use AIDS they will be drawing from a consistent data base and, particularly for complex inquiries, the agent response will be consistent throughout the section for the same inquiry. The penalty attached to a longer call which provides improved quality and quantity of information is considered acceptable.

5.2.6.3 Agent Training

The expected benefit of reducing the amount of time needed for agent training has not come about. Early in the program, a group of newly hired agents were trained on the AIDS system, without the extensive geographic training which had been given until then. These agents quickly developed respectable call counts, but did not progress any further. WMATA management observed that by using AIDS for every query, these agents could not handle the simpler calls any faster than the computer, which is not the case with more-experienced and broadly trained personnel. In order to maximize call counts, they discovered that it is necessary to have a mix of memory, manual data retrieval, and computer-assisted answers. As a result, all information agents now receive a five-week training course in the regional geography and the route system of WMATA's buses and trains. The agent training course now is as long as it was prior to AIDS implementation. However, with AIDS, once training is completed, the agent achieves an acceptable level of productivity more quickly.

5.2.6.4 Job Satisfaction

The evaluation project indicated that AIDS had no negative effects and some positive effect on job satisfaction. The percentage of agents choosing "excellent" or "good" to describe job satisfaction rose by 12, and no agents reported AIDS as having a "negative influence".

5.2.6.5 Performance Statistics

The computer system is able to gather statistics on the queries put to it and its replies. However, the data collected are not complete by any means. Gaps come about because of the following:

(1) Callers do not represent riders. Frequent riders and riders who live in the city and are familiar with the transit system have less need for telephone information. Callers and the data collected on their queries are skewed towards suburban locations.

(2) AIDS is not used on every call. Queries that are not keyed in to AIDS do not exist as far as the system is concerned, and data on these queries can not be collected. Since a large percentage of calls is answered without the use of AIDS, its data collection is skewed toward more complex questions and longer trips.

The computer system does not collect information on agent performance. It can keep track of the length of time required to key in a query, the data retrieval time, and the length of time before another query is input, but these numbers may have very little to do with how long it takes an agent to answer a caller. The AIDS system is not connected with the ACD in any way and does not collect data on how long the telephone is in use for each call. Agent performance data can be collected with a state-of-the-art ACD or PABX, but at the present time WMATA does not have this kind of equipment.

5.2.6.6 Other Use of the Data Base

Funding has been obtained to begin work on a program for bus-stop information signs. The AIDS data base will be used to generate a schedule for each bus stop that shows which buses serve the stop and their time of arrival. Since the information already exists in the data base, and is updated whenever schedules change, the main effort is to program the system to print out the data in the format required.

5.2.6.7 Further Development

Plans for expanding the capabilities of the AIDS system fall into three categories: addition of agents, addition of more sophisticated equipment, and addition of more information.

When the present facility was installed, provision was made for more agents. There is enough furniture and floor space to accommodate 35 agents (including 2 positions in the training room).

In order to add more agents, it will be necessary to replace the telephone system. WMATA is in the process of purchasing a computer-based ACD which would generate the kind of management information currently lacking. In three to five years the computers may be replaced with others which have more powerful CPUs capable of faster response.

WMATA has also considered installing remote terminals connected to the AIDS computer so that passenger information can be accessed without a telephone. Likely places for such an installation are the two metropolitan airports, large shopping centers, hotels, etc. Hardware procurement was being planned in late 1982. WMATA is actively pursuing other spin-off applications of the AIDS system and its data base, including market and planning research, graphics and bus-stop information. Consideration is also being given to the integration of AIDS with interactive cable television and information systems.

Use of the AIDS system has shown areas where improvements can be made in the kinds of information delivered. The system currently is not capable of identifying when the last bus or train leaves a particular stop, nor is it capable of identifying the last itinerary from origin to destination. These are under consideration for addition to the programming.

There is a desire to add the locations of all bus-stop shelters to the AIDS data base. Addition of identifiers for buses accessible to the handicapped is also contemplated.

Another calculation that may be added is one which would force an itinerary to a particular bus route. The system does this in a limited way now, by forcing calculations of all-bus or all-rail itineraries at the caller's request. Frequently callers are familiar with only one route and wish to be routed along it, even though there may be a faster or more efficient routing available. At the present time, forced routings must be calculated manually by the operators. In the future, it is hoped that the AIDS system can be programmed for these calculations.

5.3 HAMBURG AFI ASSESSMENT (AUTOMATED SYSTEM)

The review of the automated telephone information system (AFI-Automatische Fahrplan Information) in Hamburg was performed to present a description and assessment of a system which operates in a large, multi-modal transit system, and provides 24-hour access to full, vocal schedule information. The Hamburg AFI system is a highly complex passenger information system which is fully automated and capable of user-machine dialogue utilizing synthetic voice generation. There are no human information agents.

5.3.1 Local Demographic and Transit System Characteristics

Information and data on the overall transit system were collected and are presented in Table 5.3-1. As in many urban areas in Germany, the overall Hamburg transit system is organized as a Transport Association (Verkehrsverbund), which is a cooperative organization. The Hamburg Transport Association (Hamburger Verkehrsverbund or HVV) consists of nine member organizations. The AFI system covers the whole service area and all modes. However, calls could only be made from within the local Hamburg call area. This call area excludes some small parts of the service area.

The population stability in the service area may be judged as high when compared with most U.S. cities. Some movement of people from the urban area into the suburban area can be observed. It is estimated that approximately 20,000 people, about 1.2% of the total urban population, move out of the city in a year. However, this is about balanced by newcomers moving into the city. In 1980, people moving into the city exceeded people moving out by 2,200.

5.3.2 Marketing and Passenger Information Activities

The Hamburg Transit Association has a broad and active public relations program to market its service. Passenger information provisions are an integral part of this program and are seen as an important service. The total annual budget for these activities is approximately DM one million.* There are 200,000 work place locations concentrated in the CBD. This is reflected in the fact that

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* DM1 (Deutsche Mark) = approximately U.S. $0.50

TABLE 5.3-1: HAMBURG DEMOGRAPHIC AND TRANSIT SYSTEM CHARACTERISTICS (1980)

Total Urbanized Area	747 km^2
Total Service Area	3,000 km^2
Total Urban Population	1,645,000
Total Service Area Population	2,440,000
Total No. Employed in Urban Area	935,000
Total No. Employed in Service Area	1,050,000
Number of Automobiles in Urban Area	562,000
Number of Automobiles in Service Area	850,000
Type of Service Network	Rail: radial
	Bus: feeder to rail
Operational Characteristics:	
Total Number of Vehicles	Rapid rail: 835
	S-Bahn: 526
	Bus: 1,008
	Ships: 14
Total Annual Vehicle Kilometers	Rapid rail: 50.8 x 10^6
	S-Bahn: 47.3 x 10^6
	Bus: 56.2 x 10^6
	Ships: 0.1 x 10^6
Total Line Length	Rapid rail incl. S-Bahn: 311.3 km
	Bus: 2,565.7 km
	Ships: 59.3 km
Total Annual Number of Passengers	Rapid rail: 183.2 x 10^6
	S-Bahn: 137.0 x 10^6
	Bus: 231.6 x 10^6
	Ships: 1.3 x 10^6
Total Number of Stations and Stops	Rapid rail and S-Bahn: 179
	Bus: 2,458
	Ships: 45
Total Number of Park & Ride Facilities	48 with a total of 7,250 places

80 percent of the transit trips are to and from work. Overall, 40 percent of all trips in Hamburg are transit trips.

The service and marketing program includes provision of ticket sales offices in different parts of the service area. In 1980, 11 of these offices, which also disseminate schedules and other information, were in operation.

To a large degree, Hamburg's marketing effort has two thrusts, the local press and advertising. To obtain coverage in local papers, publications, radio, and television, 50 statements to the press were released during 1980 and 14 contributions to radio and television programs were made to inform the public about the transportation system. In addition, 13 press conferences and other promotional presentations were made. Advertisements in local papers and journals emphasize the service and special fares which show transit to be attractive compared to private automobile trips.

A new schedule is printed twice per year. The entire schedule book consists of about 660 pages and approximately 120,000 to 150,000 are sold for the price of DM 3.50 each. They cost about DM 5.00 each to produce. The transit system schedule changes which occur in Spring and Fall result from the schedule changes of the Deutsche Bundesbahn (German Railways) which operates the S-Bahn. Presently, methods are being developed which will allow schedules to be set for a full year, a practice which will save considerable costs.

The conventional central telephone information service has been in operation since 1980. It is completely manual and concentrates previously decentralized functions under one published telephone number at the Hamburg Transit Association (HVV). Total staff for the manual telephone information service is five. The service operates on weekdays from 7:00 a.m. to 10:00 p.m. In the absence of the automated telephone information service, approximately 500 to 600 calls per weekday were serviced by the manual system. Of these calls, about 60 percent are related to schedule information, about 28 percent to fares, and about 12 percent are classified as other.

5.3.3 Automatic Telephone Information System Description

5.3.3.1 System History and Evolution

Extensive surveys conducted in Hamburg showed that there is an estimated demand for 10,000 to 20,000 schedule information requests per day. Such a demand cannot be satisfied economically with a manual telephone information system. The labor cost for information agents limits the possible size of any manual system. The availability of the service from the manual central information system was never widely publicized to keep demand and costs low. However, the need for a telephone information service was recognized by HVV and it was also concluded that full and simple access to schedule and other important information would induce potential passengers to use the transit system more.

The decision was made to develop an automated telephone information system to provide a needed service to transit users and, by doing so, to make transit more competitive with automobile usage resulting, HVV hoped, in higher transit ridership. The system was to be automated to keep personnel costs to a minimum.

Major design and development work was performed during an 18-month period in 1978 and 1979. Funding was provided by the Federal Ministry for Research and Development (Bundesministerium fur Forschung und Technologie). DM 2.5 million was budgeted for development of hardware and the basic software. Another DM 2.5 million was available for final, specific software development and refinement, system demonstration, and accompanying studies.

From June 1979 until May 1981 an automated telephone information service was operated as a demonstration and test system in Hamburg. During the demonstration, periodic changes were made to hardware and software and accompanying studies were performed. In these studies user surveys were conducted to measure acceptance, cost-effectiveness, and influence on user behavior.

At the completion of the demonstration, work was continued on development of final modifications to the hardware, software and operation of the system. This work is nearing completion now. The implementation of such a system with full access for the total service population is being planned. However, no final decision has been made at this time. Hamburg is interested in having the first fully implemented AFI system; other cities and regions are also interested in acquiring such a system.

5.3.3.2 System Objectives

It is not possible to quantify the value of easily accessible and complete passenger information in choosing between private automobile trips and transit trips or in making or not making some transit trips. However, one important motivation for development of the automated telephone information service was the assumption that in many cases the private automobile user can be lured to transit if the details about transit alternatives are made easily accessible. It was also expected that some patrons would make other occasional trips which would not be made in the absence of this service.

The following were specified as basic goals for an information system, in general, and, consequently, to be fulfilled by an automated system:

- For the caller:
  - unlimited access
  - simple to use
  - fast, up-to-date and complete information
  - responsiveness to individual trip requirements

- For the transit operator:
  - high performance
  - high reliability
  - economical
  - flexibility for different capacity requirements

These same goals are presently used for further system development.

5.3.3.3 System Hardware

The automated telephone information system as demonstrated in Hamburg consisted of three main parts as shown in Figure 5.3-1.

- a central processor unit which stores all schedule data and which computes the "best" connection based upon trip request inputs;

- five Automated Auxiliary Machines which provide hard-copy printouts for the trip information after user input of destination code numbers;

- the telephone interface system which includes the speech generation component.

The caller communicates with the system via either (1) the keyboard on the Automated Auxiliary Machines, or (2) a telephone at home or any public telephone in the local call area.

A DEC PDP 11560-CD (Figure 5.3-2) from Digital Equipment Corporation (DEC) was used as the central processing computer. This unit has a 16-bit processor and a 128K memory capacity.

For the speech output, nine CAMAC-Telephone Interface Modules (Figure 5.3.2) were used, one for each line. Each module had one telephone connection which was dedicated to one output.

The output from the CAMAC-Telephone Interface Module is routed through the appropriate channel of the Multiple Call Director (Figure 5.3-2) to the correct outgoing telephone line.

Nine Speech-Vocoders interface with the nine CAMAC controllers. For this application a digital Formant-Vocoder System (VORTAX) was selected. It generates speech with analog filters. Voice pitch, volume and speed were manually adjustable. To generate all names and sentences, 63 basic sounds were permanently stored. These sounds included consonants, vowels, sibilants, and pauses. Phonetic transcription is used to call up the appropriate basic sounds to compose words and sentences. This system allows fast and efficient changes in programmed name and text outputs.

The eight-channel multiplexer transmits signals between the central processor and the five automated auxiliary machines over hard-wired communication lines

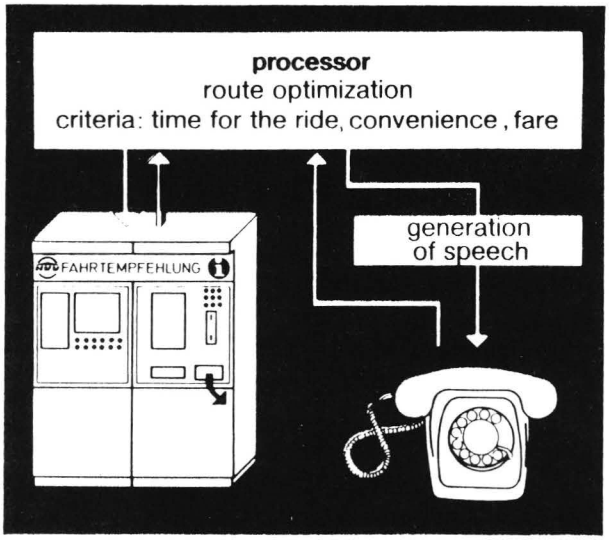


FIGURE 5.3-1: MAIN COMPONENTS OF THE HAMBURG AUTOMATED TELEPHONE INFORMATION SYSTEM

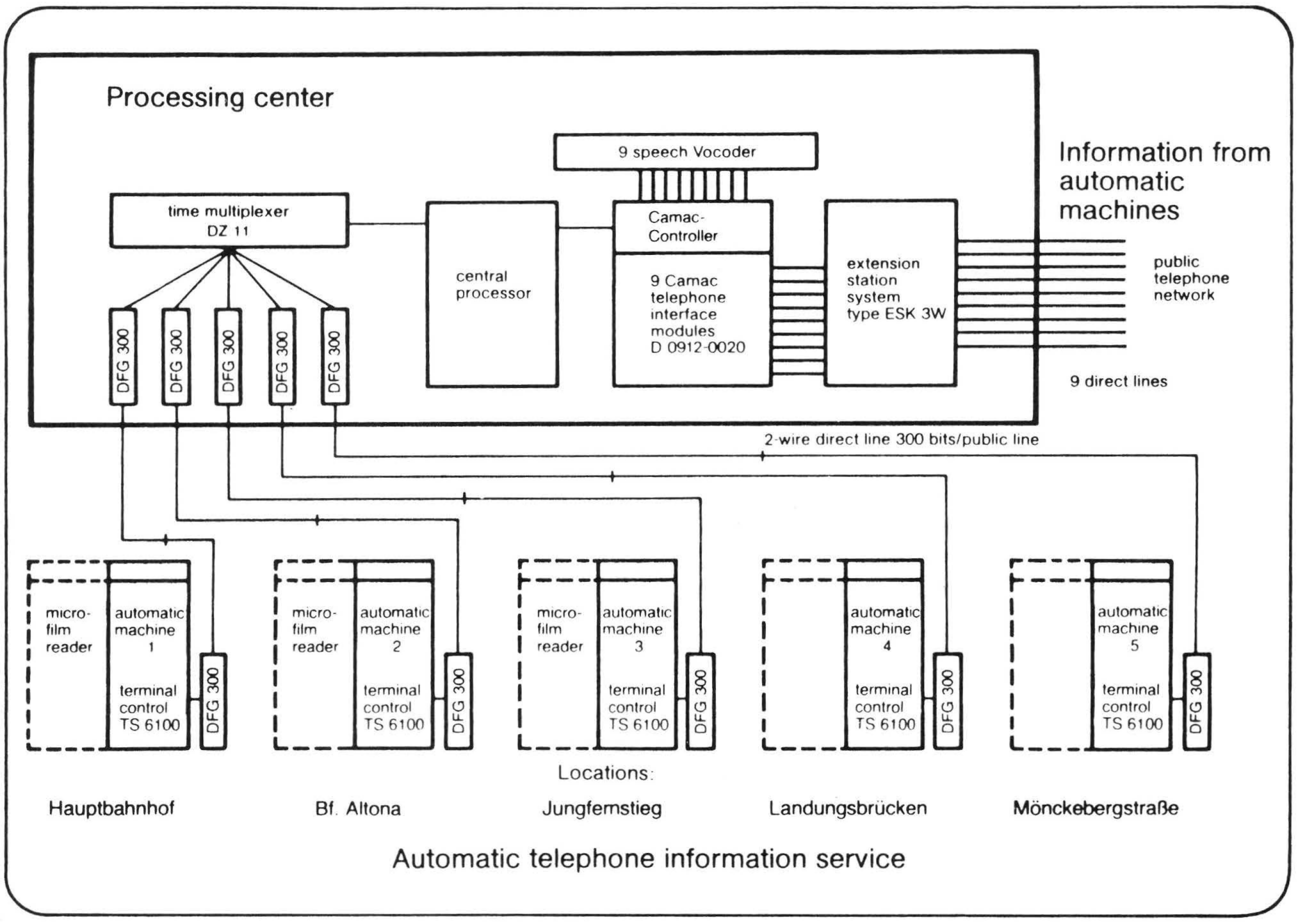


FIGURE 5.3-2: HAMBURG COMPUTER INTERFACE MODULES

(2-wire 300-bits-per-second public lines). The main components of these machines are the terminal controller, printer and a microfilm reader.

5.3.3.4 System Software

The system is programmed in FORTRAN IV. The main part of the program is the "Route Search Routine". It is designed to select the optimum route for the caller from a large number of possible connections between the origin and destination points. The trip recommendation is determined in four steps:

(1) search for feasible connections
(2) preliminary evaluations of connections
(3) determination of trip data
(4) evaluation and selection

Feasible Connections

Feasible connections between origin and destination are searched and calculated using a stepwise approach. In the first step, connections with a minimum number of transfers are calculated. The second step establishes connections with one additional transfer required. If a second step connection is not feasible, the third step is initiated and connections with more transfers are searched.

Preliminary Evaluation of Connections

Once a set of feasible connections has been established a preliminary evaluation is performed. This is done to reduce computer time because both accessing schedule data and evaluating connections are time consuming. In the preliminary evaluation, the connections are evaluated using factors which are available without disk access. These factors include average ride time between stations or stops and average transfer times. The preselection routine results in a rank-ordering of connections.

Determination of Trip Data

The following schedule data are calculated for each of the connections:

(1) departure time from origin station/stop,
(2) arrival and departure times at transfer stations, and
(3) arrival time at the destination station/stop.

The data are determined for at least the first five rank-ordered connections. In the event that each of the five connections has a waiting time greater than 30 minutes before departure or if the trip falls into the transition period of schedule changes between day and night operation, up to 20 additional connections are considered.

Evaluation and Selection

The evaluation is based on a set of attractiveness factors which reflect estimates of passenger preference with regard to transit service. Passenger preference studies indicated that the primary factors considered were swiftness of travel, availability, convenience, and cost. Because the automated information system provides trip recommendations which relate to stations and stops, the following trip time components are taken into account for the evaluation:

(1) waiting times,
(2) ride times, and
(3) transfer times.

Different subjective passenger assessments of the travel time components and convenience are taken into account in the "ride time equivalent traveling time" as shown below. This is the main criteria for the trip recommendation.

Wait Time

When the caller uses the Automatic Auxiliary Machine, the waiting time before the departure is calculated from the difference between the scheduled departure time and the assumed arrival of the passenger at the departure station. This calculation does not include the time required for reading the trip recommendation printout, the walk from the machine to the departure station or stop, and the purchase of a ticket.

When the caller uses the telephone, the waiting time is calculated from the difference between the scheduled vehicle/train departure time and the departure time requested by the caller. Because the automated telephone information service provides trip recommendations for freely selectable departure times, the waiting time in the departure station is not specially weighted as other travel time components are.

Transfer Time

The transfer time includes the time required to reach a different platform if this is needed (active transfer time) and the waiting time for the connecting vehicle/train (passive transfer time). The evaluation performed for the automatic passenger information telephone service is based upon consideration of which choice a passenger would take among the possible alternatives. The evaluation of transfer times concentrates on the possible reduction of total trip time to increase acceptability by occasional riders.

On the basis of data from previous studies, it was assumed that a transfer is acceptable to passengers if it results in a travel time gain of five minutes for short trips and 15 minutes for longer trips. The weighted transfer time is then calculated according to equation (1).

$$t^*_b = 3.5 + 0.1t_f + 1.5t_u \qquad \text{Eq. (1)}$$

where

t^*_b = weighted bus transfer time (min)

t_f = ride time (min)

t_u = bus transfer time (min)

Thus the time penalty $(3.5 + 0.1t_f)$ depends on the ride time.

To take into account the generally more favorable transfer conditions in the rail network, as compared to the bus network, the time penalty for transfers within the rail network is reduced by two minutes as in Eq. (2):

$$t^*_b = 1.5 + 0.1t_f + 1.5t_u \qquad \text{Eq. (2)}$$

Trip Quality

As documented in other studies, passengers perceive the trip quality of rapid rail systems as higher than other transit trips. Therefore, an extra time penalty is applied to ride times on buses. This gives priority to rapid rail within a certain tolerance limit (t in minutes) which depends on ride times:

$$t = 0.6923 + 0.0615t_f \qquad \text{Eq. (3)}$$

Ride Time Equivalent Traveling Time

The ride time equivalent traveling time (t^*_R) is calculated according to equation (4) from the sum of the weighted travel time components:

$$t^*_R = t_w + t_{fs} + t^*_{fB} + \sum(U_i + 1.5\, t_{ui}) \qquad \text{Eq. (4)}$$

where

t_w = waiting time (min)

t_{fs} = sum of ride times on railcars (min)

t^*_{fB} = sum of ride times on buses including time penalty for reduced trip quality (min)

n = number of transfers

U_i = time penalty for transfers depending on mode. For rapid rail it is $u_i = 1.5 + 0.1t_f$ (min) and for buses it is $U_i = 3.5 + 0.1t_f$ (min).

t_f = total ride time equal to $t_{fs} + t_{fB}$ (min).

t_{ui} = transfer time for transfer i (min).

Cost

The fare is considered an additional criterion when express bus connections are included in the evaluation. At present, there is a surcharge of DM 0.70 for express buses. Based on experience, the time advantage of short express bus trips must be proportionally much greater than for longer trips to make the higher fare acceptable to the passenger. This is accounted for in comparisons of "ride time equivalent travel time"; for alternatives within five minutes of each other, the alternative with the lower fare is selected.

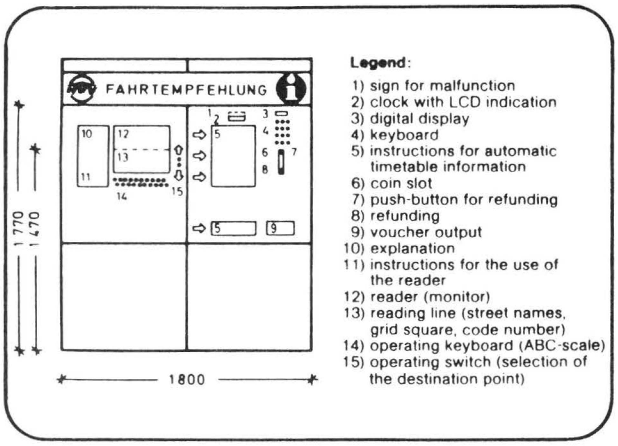
5.3.3.5 System Operation

The Automatic Auxiliary Machines as shown in Figure 5.3-3 were installed at five selected locations in the city.

As a first step, the user has to look up his destination point on the microfilm reader located on the left side of the machine. This unit stores approximately 17,000 street names, stops and stations, and important points of interest in the service area.

After typing in the first letter of the destination (street, place, building, etc.), this address can be brought onto the monitor using a push button. The four-digit code number of the assigned station is shown beside the destination address. This code number is entered on the keyboard on the right side of the machine. After insertion of a 10-pfennig coin, the data is transmitted and the central processer starts selecting recommended connections. After approximately 15 seconds the data is transmitted back to the machine. Here the trip recommendations with all required data are printed on hard copy and passed through the dispenser slot to be used by the passenger. A typical printout with three transfers is shown in Figure 5.3-4.

The alternative, and most often used, access to the system was the telephone. The single access telephone number could be reached from any telephone in the local area.



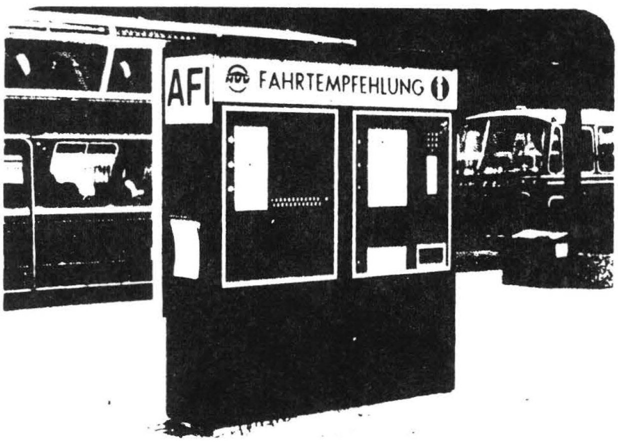


FIGURE 5.3-3: AUTOMATIC INFORMATION MACHINES

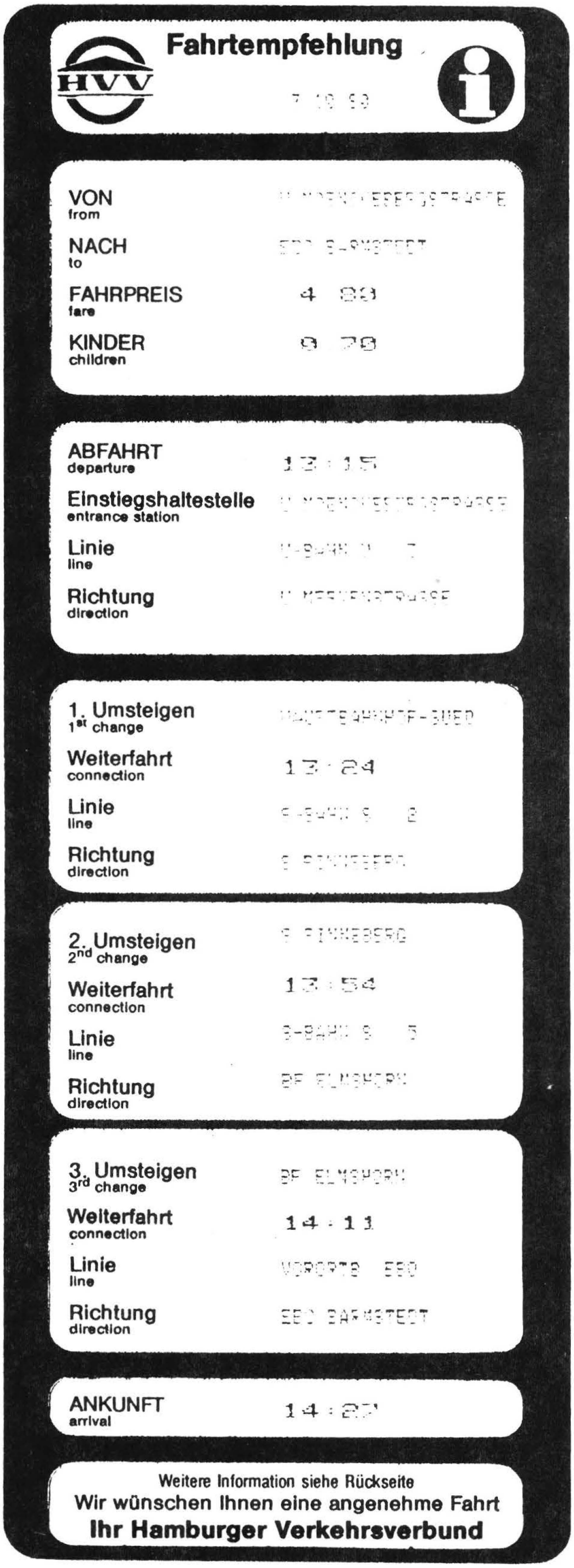


FIGURE 5.3-4: TYPICAL AUTOMATIC INFORMATION MACHINE PRINTOUT

The user must first look up the code numbers for his origin and destination station/stop in an address directory which includes simple instructions for system use. After making telephone connection with the system, the user starts his dialogue with the system. During this dialogue, the system takes the "speaking" part and the user responds by dialing code numbers on his telephone. A typical dialogue sequence with the text "spoken" by the system is illustrated in Figure 5.3-5.

The dialogue sequence starts with the machine requesting the required inputs from the user. The caller then dials the code numbers for departure station, destination station, the weekday, the desired departure or arrival time, and a number for designating the desired time as departure or arrival time. Special note pads as shown in Figure 5.3-6 are provided to help the caller. If the caller makes an input error, dialing 99 allows him to start the sequence again from the beginning without losing the connection. The number of digits to be dialed is 14 plus the telephone number to access the system.

Figure 5.3-7 is a progress chart which illustrates possible dialogue sequences, machine logic, and checks performed.

5.3.4 AFI System Performance

The Hamburg automated telephone information service application was a test and demonstration program. Therefore, a system with only limited capacity was installed. To avoid overloading the system, the distribution of directories and the number of automatic auxiliary machines which were installed was limited. Several surveys and accompanying studies were performed during the more than two years of system operation to measure system performance and acceptance by the user.

At system start-up, directories which enable callers to use the system were distributed to 1,500 households which statistically represented the service area. After the system software and hardware were performing well, an additional 8,000 directories were distributed to interested persons.

Both after the issuance of the first set of directories and, again, after the issuance of the second set of directories, user frequency was very high. However, after some initial fluctuations in demand, the user frequency stabilized. The

Dialogue sequence		text of speech/activity
I		Good day, this is the automated information service of the HVV. Please dial the code numbers of your departure point your destination point the weekday and your requested departure or arrival time as well as the code number for your time request
II		(The caller dials the code numbers)
III		You would like to have a connection from 8162 to 3113 on a Friday; departure: approximately 1.10 pm.
IV	IVa	Please note: departure at 1.15 pm from Mönckebergstraße with subway, line 3 in direction Merkenstraße
	IVb	first change at central station south. The ride continues at 1.24 pm with suburban train line 2 in direction Pinneberg
	IVc	second change in Pinneberg The ride continues at 1.54 pm with suburban train line 5 in direction Elmshorn
	IVd	third change in Elmshorn The ride continues at 2.11 pm with EBO railway system in direction Barmstedt
	IVe	Arrival in Barmstedt: 2.27 pm
	IVf	Fare for adults: DM 4.80 Fare for children: DM 0.70
V		I repeat (if necessary repetition of IV)
VI		We hope you enjoy your trip. Goodbye.

FIGURE 5.3-5: TYPICAL DIALOGUE SEQUENCE

HVV

Fahrtempfehlung

AFI
Automatische Fahrplan-Information

Eingabe

Kennziffer für				
Startpunkt	**Zielpunkt**	**Wochentag** Mo = 1 Fr = 5 Di = 2 Sa = 6 Mi = 3 So = 7 Do = 4	**Abfahrtzeit oder Ankunftzeit**	**Abfahrtzeit = 1** **Ankunftzeit = 2**
☐☐☐☐	☐☐☐☐	☐	☐☐☐☐	☐

Telefonnummer AFI 33 30 53

Fahrtempfehlung

Abfahrt

Uhrzeit: ____________ Uhr ab Haltestelle: ____________

mit Linie: ____________ in Richtung: ____________

Erstes Umsteigen

Haltestelle: ____________ Weiterfahrt: ____________ Uhr

mit Linie: ____________ in Richtung: ____________

Zweites Umsteigen

Haltestelle: ____________ Weiterfahrt: ____________ Uhr

mit Linie: ____________ in Richtung: ____________

Drittes Umsteigen

Haltestelle: ____________ Weiterfahrt: ____________ Uhr

mit Linie: ____________ in Richtung: ____________

Ankunft

Haltestelle: ____________ Uhrzeit: ____________ Uhr

Fahrpreis für Erwachsene: ____________ DM, für Kinder: ____________ DM

Wir wünschen Ihnen eine angenehme Fahrt
Ihr Hamburger Verkehrsverbund

Weitere Informationen siehe Rückseite

FIGURE 5.3-6: SPECIAL NOTE PADS

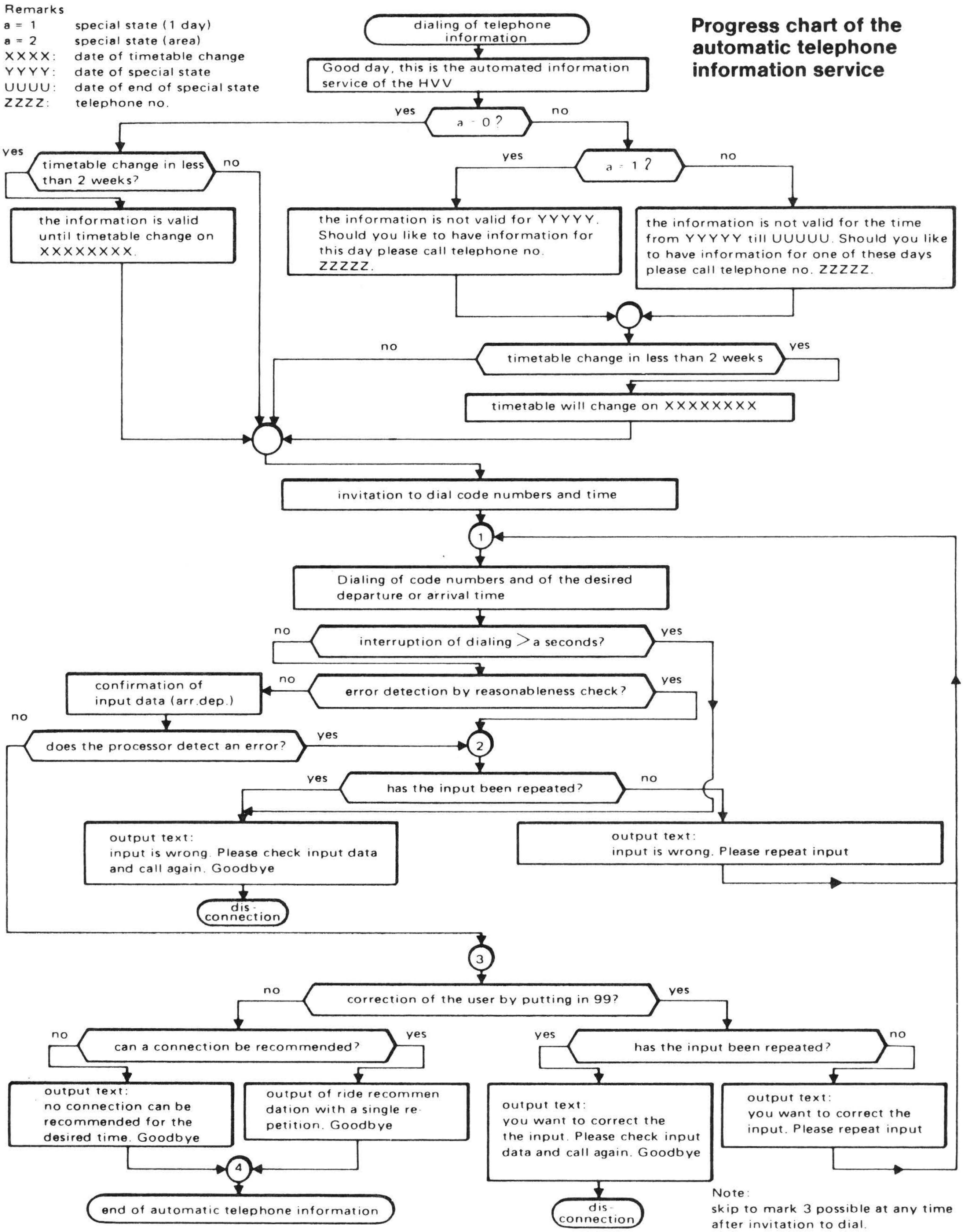


FIGURE 5.3-7: PROGRESS CHART/DIALOGUE SEQUENCE, ETC.

average demand upon the system was about 1,000 calls per day and 100 calls per peak hour. An extrapolation of the experienced user frequency from the test households to the 750,000 households in Hamburg was performed. It was projected that, if the system is made accessible to all households in Hamburg, approximately 10,000 to 12,000 calls per day would be made. The peak hour frequency would be approximately 1,000 calls per hour.

It takes approximately three minutes to obtain a trip recommendation over the telephone. Many users became very adept with the system and needed only two minutes or less.

Lost calls were not a problem. According to German communication regulations, all telephone systems must be sized such that no more than three percent of incoming calls encounter a busy line.

Data on the system availability over the demonstration period was not made available. The system was maintained by the supplier (Dornier). Based on the demonstration experience, the operator expects an availability of 99 percent when the final, expanded system is installed. This expanded system will have 80 incoming lines to fill the demand as outlined above.

5.3.5 AFI System Costs

Price estimates for the planned, expanded system with 80 incoming telephone lines and sufficient capacity for 10,000 to 12,000 calls per day have been made by the operator in cooperation with the suppliers. It is estimated that the capital costs will be DM 2.5 million. The annual costs including O&M are estimated to be DM 0.9 to 1.0 million, and approximately DM 0.5 million for annualized capital costs.

5.3.6 AFI System Evaluation and Future Development

Most of the problems encountered with the system during the demonstration were with the software and the automatic auxiliary information machines. The reliability of the auxiliary machines was low and there are no plans to use them again.

The software had to be improved considerably in the beginning; currently, the software is performing well including the route search routine which is the principal part of the system.

The quality of the computer-generated voice was not fully satisfactory. The users did not have any special problems with the voice, but the speech sounded too mechanical or computerized. Different systems are presently under consideration as alternatives; the recent advances which have been made in this technology should permit considerable improvement.

The central processor has performed well. For the expanded installation a newer model of the same processor with 32-bit capability will be used.

A potential limitation in some application areas is the lack of accessibility with some telephone systems when outside the local call area. In Hamburg, the system could only be accessed by local calls. Long distance call usage was not possible. Touch-tone telephone systems provide unlimited access. Special technical provisions need be provided by telephone company authorities for non-touch-tone telephone users to allow code number input to such an information system.

Further improvements and addition of new features are being developed. The new PDP 11/44 central processor will have a higher storage capacity and will use two redundant external disk drive sets. The new configuration is designed to allow schedule changes during operation in an expeditious manner. For Hamburg it is planned that the automated passenger information telephone system will be placed in the same room with the scheduling computer.

An additional development under way is the integration of the system into the forthcoming public videotext system. The German Federal Post and Telegraph Service (Bundespost) is starting a national demonstration program in eleven major cities, including Hamburg, of video display systems for citizen information. The information can be accessed by subscribers on their video display through an attachment to their television receiver. The initial phase is not interactive and includes only about a thousand pages of preprogrammed information text. In

Hamburg, officials plan to rent a number of pages to provide general transit information. Moreover, an additional system is under development allowing alphanumeric dialogue with the automated passenger information system to obtain specific trip recommendations as from the telephone.

The statistical evaluations of survey data taken during the demonstration provide some interesting results. Note should be taken that these results are only fully applicable to a German city; U.S. experience may be different.

Three surveys were performed during the operation of the system. In the first four weeks after system operation started, 26 percent of the subjects used the system an average of eight times each. This user frequency stablized at ten percent of the test population using the system an average of 1.4 times per week per subject.

Surveys indicated that more than three-quarters of the people calling the system also made a trip. One-third of the test population made transit trips for which private automobiles would have otherwise been used. Normalizing the statistical results shows that 0.053 transit trips per household per month are made for which an additional fare needs to be paid. It should be noted that in Germany use of passes or multi-trip tickets is much more common than in the U.S. Most of the trips resulting from use of the information system were nonwork or occasional trips; for example, 26 percent for visits, 21 percent for shopping, and 17 percent to special entertainments. This shows that such a system not only can attract riders, but also increases revenue. The high proportion of occasional riders also increases transit utilization in the off-peak hours.

6.0 ADDITIONAL TRANSIT TELEPHONE INFORMATION SYSTEM TECHNOLOGIES

6.1 TELERIDER SYSTEMS

Telerider* is an automated schedule information system which enables a caller, by dialing a special telephone number, to obtain information regarding the scheduled arrival of buses (usually the next two to arrive) at a particular stop, as well as preprogrammed status information and public service messages for the route and/or the transit system in general. Each bus stop can be assigned its own telephone number and the computerized Telerider data base and voice digitizer equipment provide the specific information desired within a short period of time and without the cost or delays of human information agents.

A call to Telerider represents the information request function; the system is only capable of only one response: "the time(s) of the next (one or two) bus arrival(s) at this stop". The caller selects a particular bus stop by the number which he dials; he cannot provide any other information or make other inquiries. The response information is stored in the Telerider computer and the call into the system initiates the automatic response.

An advantage of the Telerider system is that, once implemented, it can provide responses quickly, efficiently, and reliably without using information agents and without busy signals. Schedule changes can be accommodated almost immediately from RUCUS output or direct input into the data base.

The system includes an automatic message-shortening capability which is activated when most of the telephone trunk lines are busy. This provides an automatic capacity increase in the event of high demand without the cost of adding more capacity; it also provides more flexibility for system sizing. In the rare event that all trunk lines are busy and additional calls come in, excess calls receive a busy signal.

The Telerider computer (both DEC and IBM Series I hardware have been used) has two basic data bases, a stop file and a schedule file. An incoming call actuates

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* Telerider is a registered trademark of the Telerider Corporation.

the stop file first (since each telephone number identifies a unique bus stop location) and then a request is made to the schedule file for information. Additional messages can be accommodated and any voice can be used to present the message; the voice used may be chosen on the basis of its information clarity or its promotional value.

Telerider uses digitized speech because it is considered to be simpler and of higher quality than formant synthesized speech. Telerider modifies existing off-the-shelf equipment to suit its purposes.

6.1.1 Telerider in Ottawa, Ontario, Canada

In September 1980, OC Transpo (the regional transit authority in Ottawa-Carleton, Ontario, Canada) initiated operation of a Telerider system; it is known locally as "560", the first three digits of the telephone numbers for access to system information. OC Transpo had estimated that 40 percent of all calls into its conventional telephone information system request only schedule information; it was thought that Telerider or "560", could more easily and more accurately provide the information requested for this subset of calls.

A major impetus of OC Transpo's decision to implement an automated telephone information system was the dynamic nature of OC Transpo's services and schedules and the amount of information associated with a system which operates 750 buses on an average of 3,523 weekday route kilometers. The utilization of RUCUS at OC Transpo for automated scheduling and run-cutting has reduced the requirements for buses and platform hours, but it has also put pressure on the passenger information system because every change in routing or scheduling requires substantial effort to publicize the change. Automation of schedule information eliminates the three to five week delays associated with the printing and manual distribution of schedule information. Consequently, OC Transpo chose to install a Telerider system to handle the calls which are schedule information calls.

Another objective of OC Transpo's Telerider installation was to increase ridership during the off-peak in an effort to increase bus load factors; peak ridership could not be increased very much without adding equipment and thereby increasing operating costs. OC Transpo has concluded that the off-peak rider is somewhat different than the peak rider in that he is not a habitual rider, he generally has a higher auto availability, and he is less concerned with traffic congestion, parking availability, and parking cost. In addition, transit service levels are generally lower during the off-peak, trips made during the off-peak are more variable, and off-peak riders are less knowledgeable about available transit service. OC Transpo assumed that the Telerider system would provide the off-peak rider with the information necessary to enable him to use the system without undue waiting and delays. OC Transpo had concluded that the fear of a lengthy, uncertain and uncomfortable wait keeps many people away from transit during off-peak periods. The availability of up-to-date schedule and status information for each bus stop via telephone was considered to be an excellent means for reducing the fear of waiting.

The OC Transpo Telerider system requires the caller to dial a 560-XXXX number which is keyed to a specific bus stop; the caller is automatically given information on the scheduled arrival time of the next two buses at the stop. The system is designed to provide information for one, two, or three routes which utilize the stop. Stops serving more than three routes have two or more bus stop telephone numbers. In addition, in order to reduce the cost of telephone number rentals, stop numbers are shared among three or four consecutive stops, provided the stops serve the same combination of routes and are within a driving time of two minutes of each other.

The Telerider system can also provide additional messages of any type; messages regarding route status information, route/weather emergencies and route or fare changes are particularly useful. All OC Transpo messages are bilingual as well, the sequence, English-French or French-English, being chosen to correspond to the predominant user group.

The automated system utilizes 36 telephone trunk lines. The average length (time is occupied) of a call into the system is 22 seconds, yielding a potential capacity of 5,891 calls per hour. The conventional telephone information system handles from 200 to 250 calls per hour. The automated system was first installed in about 40 percent of the OC Transpo system, operating 24 hours a day, seven days a week. It has since been expanded to serve the entire urban area. The conventional system operates 16 hours per day, seven days a week.

OC Transpo planned to examine the Telerider system's impact on ridership in three ways: (1) a comparison of ridership growth within a Telerider test area with that in a non-Telerider control area; (2) a comparison of ridership growth within the area covered by Telerider against that in the service area not covered by Telerider; and (3) a measurement of telephone activity associated with a group of bus stops related to boardings at those stops. Of these three, only the first analysis has been completed; information on the latter two was not available at the time this report was prepared.[1, 2]

For purposes of comparing ridership growth in a Telerider test area and a non-Telerider test area, OC Transpo chose two similar neighborhoods. For two weeks in the spring and two weeks in the summer of 1980, passenger boardings in both areas were counted; information calls originating from the two communities were counted during the same periods. Telerider was implemented in September 1980 and counts were taken again in early winter and in midwinter.

The changes in ridership on a typical weekday in the two communities were examined. Between April 1980 and January 1981, the increase in ridership in the Telerider test area was greater in each time period (peak, midday, and evening) than that in the control area without Telerider. The evening ridership in the control area decreased 25 percent; whereas, in the Telerider test area, it increased by 45 percent. Midday trips in the Telerider area increased by 70 percent as compared to 62 percent in the control area and peak-period trips by 15.9 percent as compared with 10.3 percent. Although the ridership sample was small (1,639 riders originating from the Telerider area and 786 originating from the non-Telerider area on a typical January day) the changes in ridership are substantial. Moreover, during the test period, the daily ridership increased from 0.4570 passengers per household to 0.5679 passengers per household (24%) in the Telerider area and from 0.2318 passengers per household to 0.2683 passengers per household (16%) in the non-Telerider area.

OC Transpo has concluded that automated schedule information has a favorable impact on both public perception of the transit system and transit ridership. This is particularly the case with regard to an increase in confidence in transit information aids because it was concluded that "whatever level of confidence may have been undermined by continuous change in transit service and more and more complicated routing and scheduling attuned to the ever-shifting demands for service, can be regained and surpassed by the application of technologically sophisticated information aids, aids which are matched to the industry's sophisticated methods of planning and implementing its on-the-street service."

6.1.2 Telerider in Columbus, Ohio

In April 1982, the Central Ohio Transit Authority (COTA) in Columbus, Ohio, initiated service for a Telerider installation on three of its urban routes. The installation was designed as a test of the Telerider automated telephone information system. Revenue and ridership as well as Telerider inquiries will be monitored during the test period and, if revenue and ridership increases meet predetermined levels, Telerider will be expanded to include all routes served by COTA in Columbus.

Prior to initiating the test installation COTA compiled a data base on ridership and revenue for the three Telerider routes and for three similar "control" routes which will not be serviced by Telerider. COTA will be in a position to obtain statistics to virtually eliminate all variables other than the influence of Telerider.

In the first eight weeks of operation COTA reported a significant reduction of Telerider calls relative to the first week of operation with a steady-state level well below the expected call counts (Table 6.1-1). However, the number of Telerider inquiries were above corresponding conventional telephone inquiries for bus schedules. It was expected that Telerider would have the most value as a "foul weather" device; transit riders would use Telerider to better schedule their arrival, at a bus stop to more closely coincide with the bus arrival.

The Columbus Telerider system was designed as a turnkey purchase, with a total cost of $550,000 for the entire COTA service area. Predetermined levels of ridership and revenue were not met within the 10-month experimental period; however, 1983 revenues for all routes show a drop from 1982, but the drop on the Telerider routes is only 6.3% as compared with the control routes which dropped by 13.2%. Since the Telerider routes are performing 6.9% better than the control routes, COTA decided to retain Telerider and extend it to all routes.

TABLE 6.1-1: COLUMBUS TELERIDER INQUIRIES

	TOTAL TELERIDER INQUIRIES FOR WEEK BEGINNING							
	4/19/82	4/26/82	5/3/82	5/10/82	5/17/82	5/24/82	5/31/82	6/7/82
MON	1,880	493	313	312	300	111	250[1]	269
TUE	1,775	510	297	244	234	459	96[2]	257
WED	1,016	408	299	270[1]	325	280	240	249
THU	968	361	298	270[1]	248	226	245	245
FRI	551	461	344	234	315	367	250[1]	227
SAT	547	290[1]	340	297	290[1]	105[2]	457	236
SUN	301	622	140	123	130[1]	130[1]	179	90
WEEKLY TOTALS	7,038	3,145[3]	2,031	1,750[3]	1,842[3]	1,678[3]	1,717[3]	1,573

1 Data reported was extrapolated due to reports lost due to printer problems.

2 Data reported represents partial day due to reports lost.

3 Total includes extrapolated and/or partial day data.

NOTE: The only system interruptions experienced were due to severe electrical storms and ensuing electric power or telephone service disruptions.

6.2 COMPUTERIZED DATA STORAGE AND RETRIEVAL IN MINNEAPOLIS-ST. PAUL

The Metropolitan Transit Commission (MTC) of Minneapolis-St. Paul has installed a computerized data storage and retrieval system for use by its Telephone Information Center (TIC) information agents. The purpose of the TIC system is to (1) provide accurate information to callers and (2) respond to telephone inquiries for information as soon as possible when calls are received.

The TIC (computerized) System consists of data stored according to the following classifications:

(1) RUCUS updates: When bus drivers pick their routes every eight weeks, headway files on the RUCUS System are used to update headway data on TIC files; this is done via a magnetic tape transfer between the RUCUS System computer and the TIC System computer.

(2) Supervisor updates: Supervisors are able to add, change, or delete any information on file, in particular headway updates and non-headway updates. Headway updates include schedule changes which occur between the eight-week RUCUS data transfers and bulletins indicating temporary, short-term headway alterations for detours, etc. Daily run-cuts due to lack of drivers, bus breakdowns or other reasons are another type of temporary headway update. Non-headway updates include Activity Center Data, Bus Stop and Shelter Data, Park and Ride Data, and TIC Personnel Data.

(3) Inquiry transactions: Data regarding inquiries into the TIC System will also be recorded and stored in the System on the basis of the following categories: headway inquiries; bus stop, shelter, and park-and-ride inquiries; activity center inquiries; and TIC personnel inquiries.

In addition, a bulletin file contains special bulletins that pertain to headway information, such as detours, parades, etc., which are entered into the data base by route number. As TIC information agents reference headway data for a route that is affected by a bulletin, the bulletin appears on the bottom of the CRT screen and the requested headway appears on the top of the screen.

The TIC System was designed and implemented to provide a rapid response time for TIC information retrieval and to accommodate a high volume of inquiries, especially during peak periods.

7.0 OTHER DEVELOPMENTS IN PASSENGER AND RELATED INFORMATION SYSTEMS

7.1 AUTOMATIC PASSENGER INFORMATION MACHINES IN GERMANY

The German National Railway System has implemented an automated passenger information system of many major station locations. The system consists of an automatic machine which passengers can use to obtain itinerary and schedule information for rail travel. Origin and destination information is input via three-digit location codes. Printed information is generated by a computer terminal and presented on special trilingual forms which the passenger retains for reference (see Figure 7.1-1). The information provided includes train departure times and locations, train types, train arrival times, transfer information, and details on fares. Trip planning is facilitated since origins, destinations, and desired departure time may all be input by the traveller.

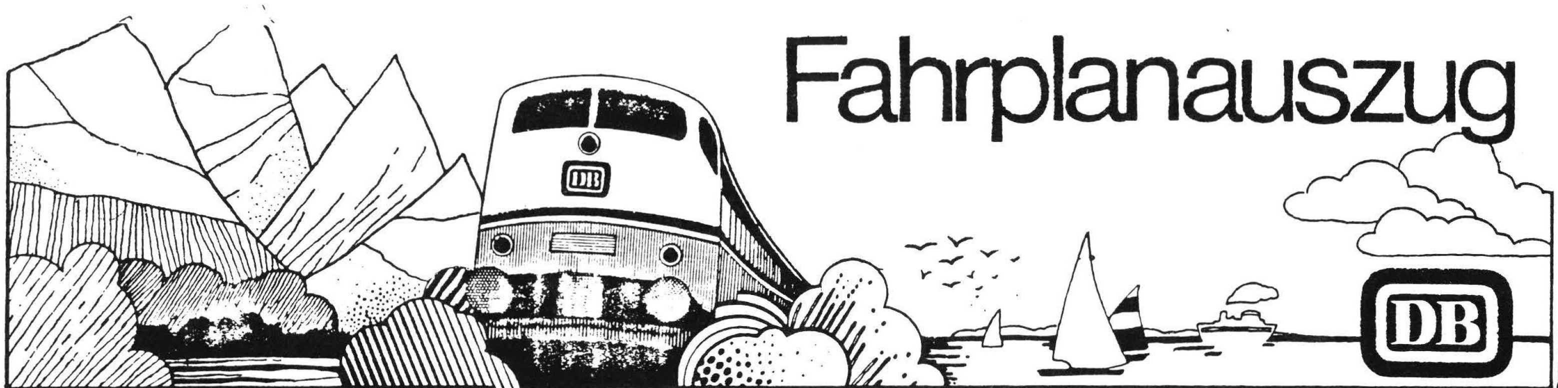
7.2 COMPUTER-GENERATED PUBLIC TRANSPORT INFORMATION IN GREAT BRITAIN

The Transport and Road Research Laboratory (TRRL) in Great Britain has developed a computerized system for determining optimum routings over the public transport network of bus, rail and coach services within the country.[8] The computer algorithms are based on the minimization of overall travel time but do not preclude the output of other optional routings that are not the quickest but are worthy of consideration. The software has access to all modes within the timetable data base, but there is an option that enables the specification of acceptable modes. The computer processes all feasible routes through the network as determined from the timetable data base and accepts or rejects them according to predetermined options and criteria. It was suggested that the computerized data base could be used by local authorities for the production of ordinary mode-oriented timetables or integrated mode timetables on an area basis. It can also be used for the production of information sheets for display at bus stops, rail stations, etc.

7.3 FEDERAL AVIATION ADMINISTRATION VOICE RESPONSE SYSTEM

The U.S. Federal Aviation Administration (FAA) began testing an automated weather information system for pilot preflight planning in 1982. By dialing via any

Fahrplanauszug



Von de from	Nach à to	Gültig bis Valable jusqu'à Valid up to	ohne Gewähr
MUENCHEN HBF	INNSBRUCK	31. 01. 1983 2232951110	

Abfahrt départ departure	⊕	Gleis voie track	Zuggattung catégorie de train type of train	Service	Ankunft arrivée arrival	*	Route	1. Umsteigen in / 1er changement de train à / 1st changing of the train in	Ankunft arrivée arrival	Abfahrt départ departure	Zuggattung catégorie de train type of train	Service	2. Umsteigen / 2ième changement de train à / 2nd changing of the train in	Ankunft arrivée arrival	Abfahrt départ departure	Zuggattung catégorie de train type of train	Service
1356	T	13	E		1620		A	ROSENHEIM	1438	1446			KUFSTEIN	1519	1535	D	B
1400	T	32	E		1653		B										
1421		18	IC	B	1620	1	A	KUFSTEIN	1524	1535	D	B					
1421		18	IC	B	1638	1	A										
1431		21	D	B	1721	2	A	WOERGL	1616	1639	D	B					
1535	T	30	E		1910		B	GARMISCH-P.	1703	1731							
1538	T	12	TEE	B	1726	3	A										
1600		25	IC	B	1910	4	B	GARMISCH-P	1716	1731							

* Besonderheiten: Particularitées: Particularities:

1= NUR SA VOM 02. 10. -30. 1+. TGL. 16. 12. -26. 12. , 31. 12. -08. 01. NUR FR U. SA 14. 01. -19. 03.
2= NUR FR U. SA VOM 04. 02. -26. 03. AUCH 01. 04. , 08. 04. -09. 04.
3= 1. KL.
4= TGL. , VOM 26. 09. -31. 10. , 10. 12. -31. 01.

Route	Fahrpreise ohne Zuschläge in DM ← 2. Klasse	← 1. Klasse	⇄ 2. Klasse	⇄ 1. Klasse	D-Zug Zuschlag	Route
A	33. 30	48. 40	66. 60	96. 80		KUFSTEIN
B	28. 70	43. 20	57. 40	86. 40		MITTENWALD #
C						

Für TEE- und IC-Züge werden Sonderzuschläge erhoben

NEU : PREISWERT REISEN AN ROSAROTEN WOCHENENDEN BIS 12. 12. 82

Aus technischen Gründen kann diese Anlage Auskünfte über Sonder- und Entlastungszüge sowie Verbindungen mit vielfachem Umsteigen nicht geben. – Gleisänderungen vorbehalten, bitte auf Lautsprecher achten.

Service
B = 🍸 ✉ ✂
K = 🛏 🛌
L = 🛌
S = 🛏

⊕ Verkehrstage
T = ①–⑦
U = †
V = ①–⑤ nicht †
W = ①–⑥ nicht †
X = nicht ⑥
Y = nicht ⑦
Z = ⑥ und †

79817 – Fahrplanauszug 51 SZ × 270 mm 4s-70 Kdi 05.82 1.2.3.4.5.6.7.8.9.10./82.83.84.85.86.87.88.89.90.91. B 300

FIGURE 7.1-1: OUTPUT FROM THE GERMAN NATIONAL RAILWAYS PASSENGER INFORMATION MACHINES push button telephone a number of weather information products are made available. The Voice Response System (VRS) features a computer voice which provides the information. The 12-key telephone signalling system is used to request information from the computer based on a set of dialogue rules which utilize the three-letter combinations called location identifiers (LOCIDs) which uniquely identify weather reporting stations and airports.

The rules for using the system are not difficult as shown in the following description of two "data entry" rules. The rules are necessary because the telephone keypad does not have enough keys to allow the entry of an alphabetic character (letter) with a single keystroke, but it is possible to make an unambiguous entry by depressing two keys. Thus, first, a letter is entered by first depressing the key on which that letter appears and then another key (1, 2, or 3) to indicate which of the three letters it is, 1st, 2nd, or 3rd. (Most number keys have three letters displayed on them.) Second, if a number is used as part of an alphanumeric character, it is again necessary to use two key strokes to make the entry, the OPER key followed by the correct number key. Other rules and use of the #, *, and OPER keys control all entry procedures.

The VRS provides valuable pilot planning information via a computer data base which is continually updated. In addition, it incorporates a dialogue mechanism enabling the pilot to interact directly with the computer within fixed boundaries. This test system is primarily designed as part of a program to improve and automate weather briefings for general aviation pilots.

7.4 PROPOSALS REGARDING AIDS AND AIDS-TYPE SYSTEMS

Discussions with WMATA and UMTA staff indicated an interest in further development of the AIDS system to enable access to it by travelers via an automated device at transportation terminals such as the city's airports. The device would direct travelers to use the AIDS system in an interactive manner (somewhat like the Hamburg AFI System) to obtain route, schedule and itinerary information for the public transportation system. Other AIDS-type systems such as that at SCRTD in Los Angeles might be developed to provide the same service.

7.5 INTERACTIVE CABLE TELEVISION

The use of interactive cable television systems, such as the Warner Qube system present a possible access mode for transit passenger information systems. Discussions with UMTA staff have indicated interest in utilizing this method; before a passenger information system can be developed around an access mode such as this, however, the coverage within an urban area must be greater than that currently realized. In addition, consideration must be given to the fact that satellite-based television transmitting systems have evolved to a point that they may soon preclude the need for a cable-based system. The cable system is necessary for an interactive connection.

7.6 OTHER RESEARCH NEEDS

There is considerable opportunity for additional research and development with regard to transit passenger information systems. The computer data storage and retrieval systems developed in Washington, D.C. and Los Angeles have shown that such systems can be developed and operated successfully for large transit networks. Further, automated answer systems such as Telerider have had successful applications in a number of cities. However, the high development cost of an AIDS-type system and the limits of a Telerider system indicate that additional efforts should be directed toward identifying the requirements and cost-effectiveness of transit telephone information systems. In addition, efforts toward development of a generic system which encompasses the advantages of both automated and non-automated systems, particularly for use by the vast majority of transit systems which currently utilize a small number of telephone answering information agents, would be very useful. The cost of an AIDS-type system may be prohibitive for a medium-sized transit system, even scaled down; however, the low cost of minicomputers and the success of AIDS for certain calls suggest that the potential exists for some additional innovative developments. Denver RTD has made the decision to install an AIDS-type system. The decision was partially based on the RTD's estimate of the utility of the spin-off applications of the data base.

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APPENDIX A

DETAILED FEATURES FOR THE WMATA AIDS VDT EQUIPMENT

Ref: An Automated Information Directory System (AIDS) - Review and Specifications, July 1977, UMTA Report No. UMTA-VA-06-0038-77-1

TABLE 1

BASIC TERMINAL CHARACTERISTICS

CRT FEATURE/FUNCTION	EXPLANATION	SPECIFICATION
Display Area	Height and width, in inches of the area of the screen used to display character	6 x 8 minimum
Spot Diameter	Diameter of the focused spot on the screen in thousandths of an inch	30 maximum
Character Generation Technique	Dot matrix (5x7, 9x11), strike, etc.	5x7 dot matrix minimum
Brightness	In foot-lamberts	30 minimum
Characters per Line	Number of characters that can be displayed across a single line	64 minimum
Lines	Number of lines that can be displayed vertically	24 minimum
Character Size	Height and width, in inches of the character front	0.15x0.12 minimum
Control Type	Integral to terminal or external	Integral
Characters in	The number of characters which can be held in storage at one time	Same as the minimum number of display characters based on minimum characters per line and number of lines above
Output Code	USASCII, EBCDIC, etc.	Compatible with main frame

TABLE 2

TERMINAL EDITING FEATURES

CRT FEATURE/FUNCTION	EXPLANATION	SPECIFICATION
Character Typeover	With cursor over a character, pressing a key will replace the character with a new one	Required
Character Insert	With cursor over a character, pressing an "insert" key displays that character and moves others one space to the right	Very desirable
Character Delete	With cursor over a character, pressing a "delete" key causes the character under the cursor to disappear and everything to the right shifts one space to the left	Very desirable
Tabulatory Feature	Ability of a key push to move the cursor to the next predetermined position on the terminal to the right and down	Required
Cursor Type	Character underlined and blinking	Required
	Also,	
Cursor Type	Character surrounded by square character	Desired

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