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TRIP

THE TRANSPORTATION ROUTING AND INTERMODAL PLANNING SYSTEM: AN AID FOR TODAY'S TRAVELER

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16. Abstract

The Transportation Routing and Intermodal Planning (TRIP) System was conceived as an aid to today's traveler. It assumes a traveler wishes to choose from all available modes of transportation generally air, automobile, rail, and bus. It is based on the utilization of current computer display technology. The TRIP System accepts information from the traveler in real time while the traveler sits at an input terminal. The information describes the individual travel needs and desires. The computer produces actual travel plans with comparative cost and time data for each mode. Results of a demonstration on existing TSC computer equipment are reported. (In this report, the concept is described and possibilities for future development and potential application are given.)

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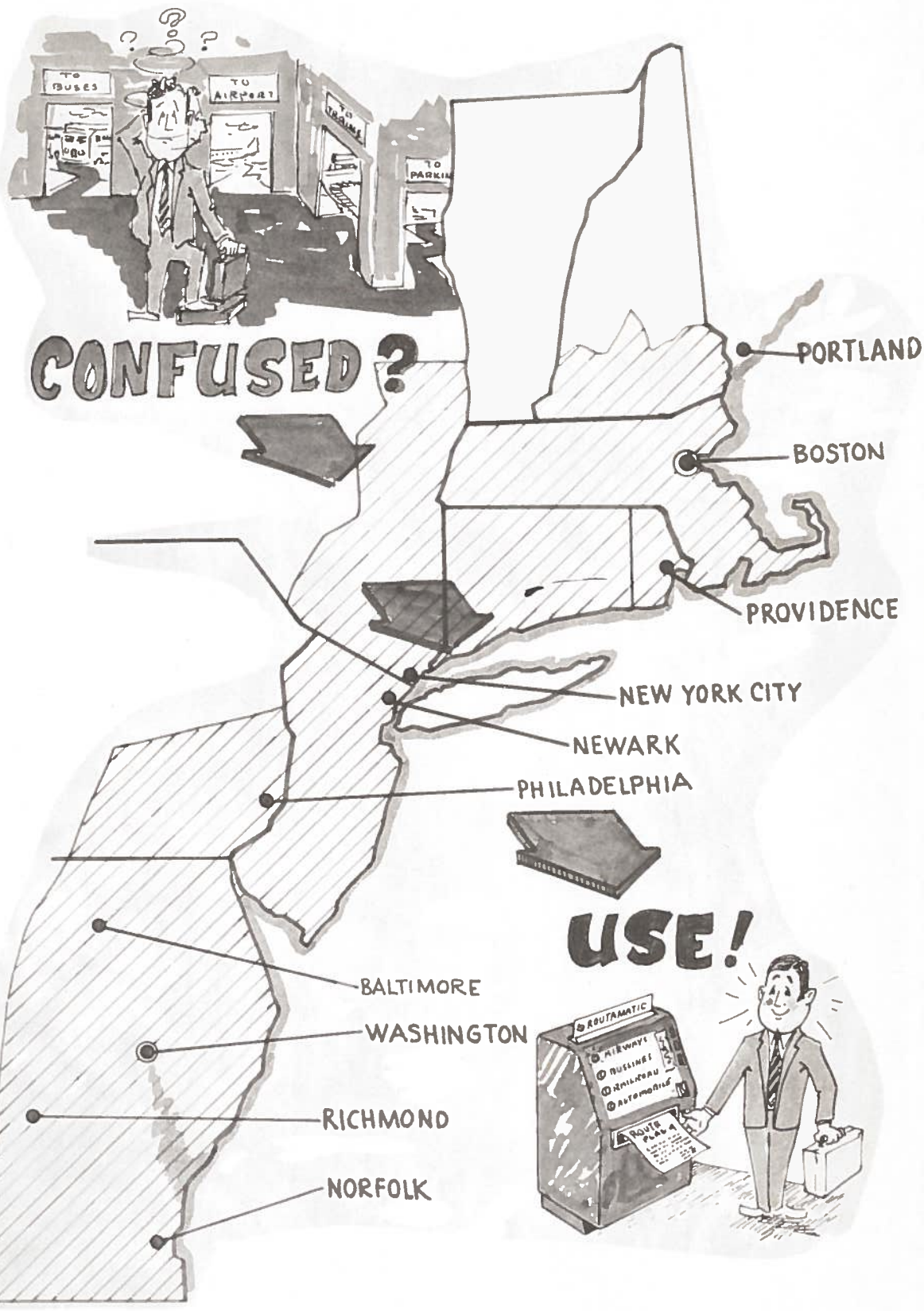
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ROUTE PLAN

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I. INTRODUCTION

Normally, in planning a trip for business or pleasure, the traveler makes a number of decisions based on scattered pieces of information derived from a variety of sources. Changes in weather or other requirements result in a new series of decisions based on new information. The process can be very time consuming and frustrating.

To minimize these frustrations, today's traveler often does not even try to find out what all his alternatives are. He resorts to an irrational approach. He satisfies himself with just getting to his destination! The rational traveler considers all factors in planning each individual trip. These generally include travel time, out of pocket costs, comforts, conveniences, interchanges, and privacy. This information is often obtained only through actual travel. Often comments from other travelers are determining factors.

The TRIP (Transportation Routing and Intermodal Planning) System was conceived as an aid for the individual traveler. It assumes he wants to consider all the alternatives in traveling by air, rail, bus, or automobile. It also assumes that he considers travel time, cost, class of service, and other factors in planning his trip. Finally, that he wants the information in a matter of minutes. TRIP utilizes modern developments in time-shared high-speed digital computation with graphical input/output displays. The user tells the system to make a travel plan satisfying his unique requirements by an input device (light pen or push button selectors). After he fully describes his travel requirements (a process taking a few minutes), the computer generates the plans and the teletype prints hard copy. This process could be done anywhere in the country or internationally with appropriate remote access equipment.

The concept has been demonstrated at the Transportation Systems Center using existing computer display equipment. Being a preliminary investigation only two modes were actually programmed: air and automobile. A variety of users (DOT employees mainly) tried it out and found it generally satisfactory.

Questions of utility, user acceptance, and costs have not been resolved in this preliminary study. They would have to be studied in depth before future applications are made. However, technical feasibility has been established. Other developers may find this experience of value.

II. THE TRIP SYSTEM CONCEPT

The Transportation Routing and Intermodal Planning (TRIP) System was conceived as an aid to rationally organized travel appropriate to today's business and nonbusiness traveler. Its function is to collect information from the potential traveler on a real-time basis and to generate for him a unique travel plan which closely fits his needs and wishes. This is accomplished via a time-shared digital computer with large memory capacity, rapid table search, arithmetic ability, and flexible computer graphic communication facilities.

Typically, the TRIP system user inputs his itinerary, certain critical portions of his schedule, size of travel party, and class of service desired. The user's perception of trip cost, travel times, comfort, and convenience factors will be considered. The TRIP system operates by asking a series of questions, displayed on a Cathode Ray Tube (CRT). The user specifies his requirements by activating a light pen. TRIP helps the user state his itinerary, specify consistent schedule information, and present a formalized time value for trip costs, comfort, and available modes of travel. The TRIP system determines suitable travel plans and constructs a comparison matrix for cost, time,

and comfort. The end product is a travel plan which the user may retain and by which he may realistically decide on his best travel arrangements. The computer laboratory setup is illustrated in Figure 1.

To facilitate utilization of TRIP, communications terminals would be placed strategically throughout the geographical area covered. These terminals would be operated directly by the user or booth attendant (if placed at busy centers such as a World's Fair).

It is important to note that the TRIP user will concentrate only on his travel needs in either case. The mechanics of conversing with TRIP support this concentration. The vast travel data network and large computer complex will be physically and psychologically removed from the user.

The TRIP model is a conversational tutorial system designed for effective use by a broad range of traveler's. There is no requirement that they be trained either in computer utilization or in the TRIP system concept. The user concentrates on his own travel criteria. After giving his requirements to the system he receives a printed travel plan. He never sees any complicated travel time tables nor is he confronted by involved procedures needed to compile travel plans.

Since the geographical area covered by TRIP will be large and trip specification varied the potential data base is extremely large and complicated. The estimated size of the data base for airline travel alone in the Northeast Corridor is 10,000,000 bytes*. File maintenance and access programs require another 250,000 bytes. Means of reducing the data base through file

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*A byte is eight binary bits.

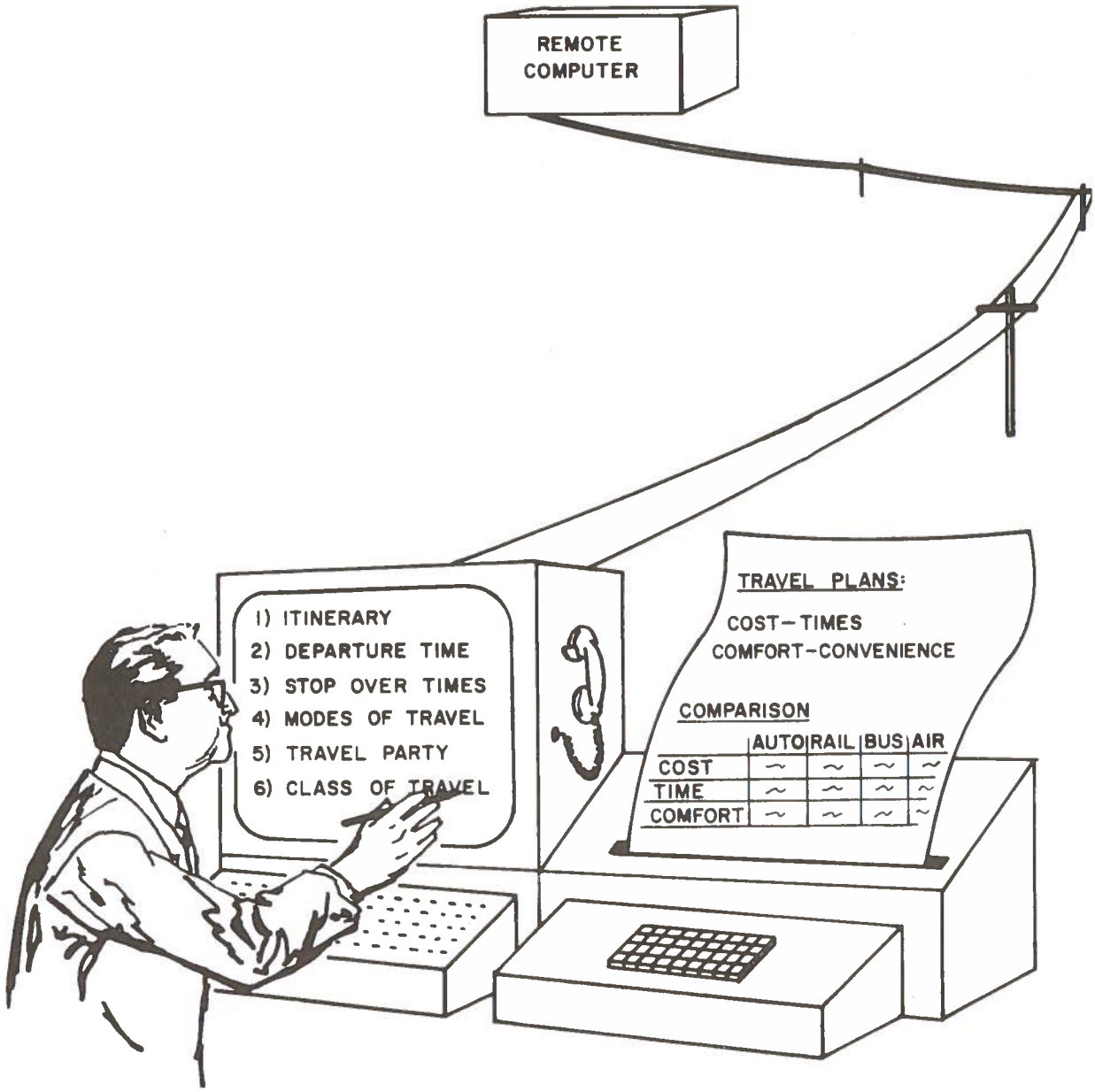

Figure 1.- Computer Laboratory Setup

organization, interlocation communication, functional representation of information, and other data processing techniques are available but would require further development and design.

Many portions of the available data in the current TRIP model are idealized. In a more realistic model, statistical variations caused by traffic density variations with time of day, day of week, and season of year would be modeled. Many schedules contain terminal to terminal times which are different from center city to center city times. The terminal to center city times and costs must be included with their statistical variations. These phenomena have been investigated for certain modes of travel and certain cities in great detail. However, much of the necessary data may be incomplete or nonexistent. Local weather conditions, transportation innovations, and construction changes which effect travel are factors which are changeable but which can be considered in future TRIP models. However, these factors create two problems for TRIP. First, their effect on trip specifications must be ascertained and modeled. Second, a flexible file maintenance system which can update old files or create new ones must be developed.

Many user options are of a subjective nature. Some work has been done quantifying factors such as time value. However, more needs to be done. TRIP can be used to investigate the feasibility of users requesting trip specifications based on mixed criteria such as weighted values of trip time and cost. Effective means of user communication in the conversational tutorial mode can be studied with various display terminals and techniques.

TRIP incorporates:

(1) Air, rail, bus, and automobile modes of travel.

(2) Users options on time of departure, cost, time, intermediate destination, number of people in travel party, and restrictions on the modes of transportation considered.

(3) A conversational tutorial operating system.

(4) A modular construction to facilitate future TRIP modifications.

(5) A provision to add local travel times to center city from suburban points.

III. POTENTIAL APPLICATIONS FOR TRIP

Various applications of TRIP have come to the attention of the authors during this preliminary investigation including the following:

(1) TRIP could be introduced to assist travelers attending large conventions such as the United States Bicentennial celebration in 1975-1976. Various locations around the country participating in the celebration would be continuously linked through such remote terminals. Foreign visitors and U. S. travelers would benefit from simplified information exchange about activities in other cities and through ready information and planning assistance on travel to the other locations. It is envisioned that in each participating city several booths would be clearly marked as Bicentennial Transportation Assistance Booths. Travelers would enter and leave in a matter of minutes fully informed on ways and means of traveling to other celebrations.

(2) TRIP could be used as an aid in travel offices within government or industry. It would provide complete and timely travel information on all modes of travel and would allow economies through comparative travel analysis and planning based on cost and time data for each trip.

(3) If developed fully, the TRIP system could be used as a urban traffic routing system. It could be extended to exercise routing control by suggesting alternative

routes and/or transportation modes to traveler's in order to avoid congested areas during certain peak travel times.

(4) The TRIP system could be tied in to transportation and hotel reservation systems. This would be more convenient for the user and would supply the TRIP system with statistics on its usefulness.

(5) The TRIP system could be used as a geographic aid to foreign traveler's. Terminals could be set up at transportation information centers around the world telling users about travel services in other countries. Communications satellites could be used to transmit information on a remote time-shared basis.

(6) Government transportation agencies could utilize the system to aid in collection of timely travel data. This could be used for more effective planning and prediction of travel demand.

:V. THE TRIP MODEL

The TRIP model described here was designed for preliminary ;tudy and demonstration. It is necessarily a simplified model. :t has been implemented on a small scale computer; a Honeywell)DP-516. To distinguish it from more complete versions it will)e designated in the sequel as TRIP 1.

TRIP 1 has four component subsystems:

(1) Scenario
(2) The Operating System (TOS)
(3) Travel Plan Generator
(4) Data Base

The scenario introduces the user to TRIP 1. The operating ;ystem (TOS) collects the user's itinerary, schedule, and cost :riteria. The travel plan generator searches through the data

base and compiles a travel plan from amoung four modes of transportation (air, rail, bus, and auto) and four cities (Boston, New York, Philadelphia and Washington). The data base is drawn from air, rail, bus, and auto travel guides. It contains time tables, costs, and descriptive information about travel by each mode of transportation for each origin-destination city pair. Figure 2 indicates how these component subsystems fit into the TRIP 1 model structure relative to the user.

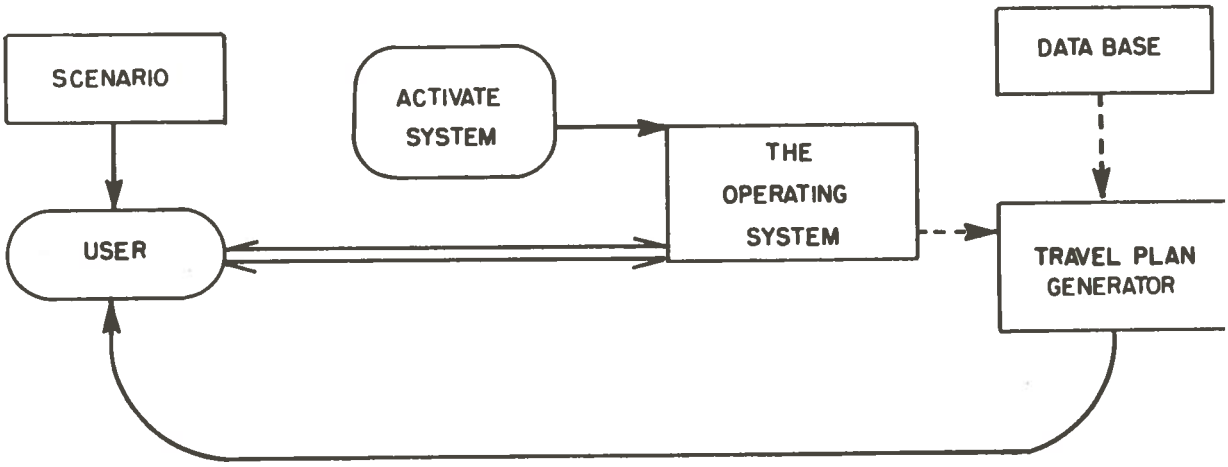

Figure 2.- TRIP 1 Model Structure

This TRIP 1 model was implemented in FORTRAN on a Honeywell DDP-516 computer with 16,000 words of core memory and disc storage. TRIP 1 converses with the user by means of Cathode Ray Tube (CRT) graphic displays and teletype printout. The user converses with TRIP 1 by means of a light pen which activates parts of the CRT display. The actual communications terminal used in TRIP 1 is pictured in Figure 3.

It was intended that TRIP 1 be able to compile travel plans for four modes of transportation; however, the limitations of the available computer system made this impractical. As a result, only air and auto travel plans are available.

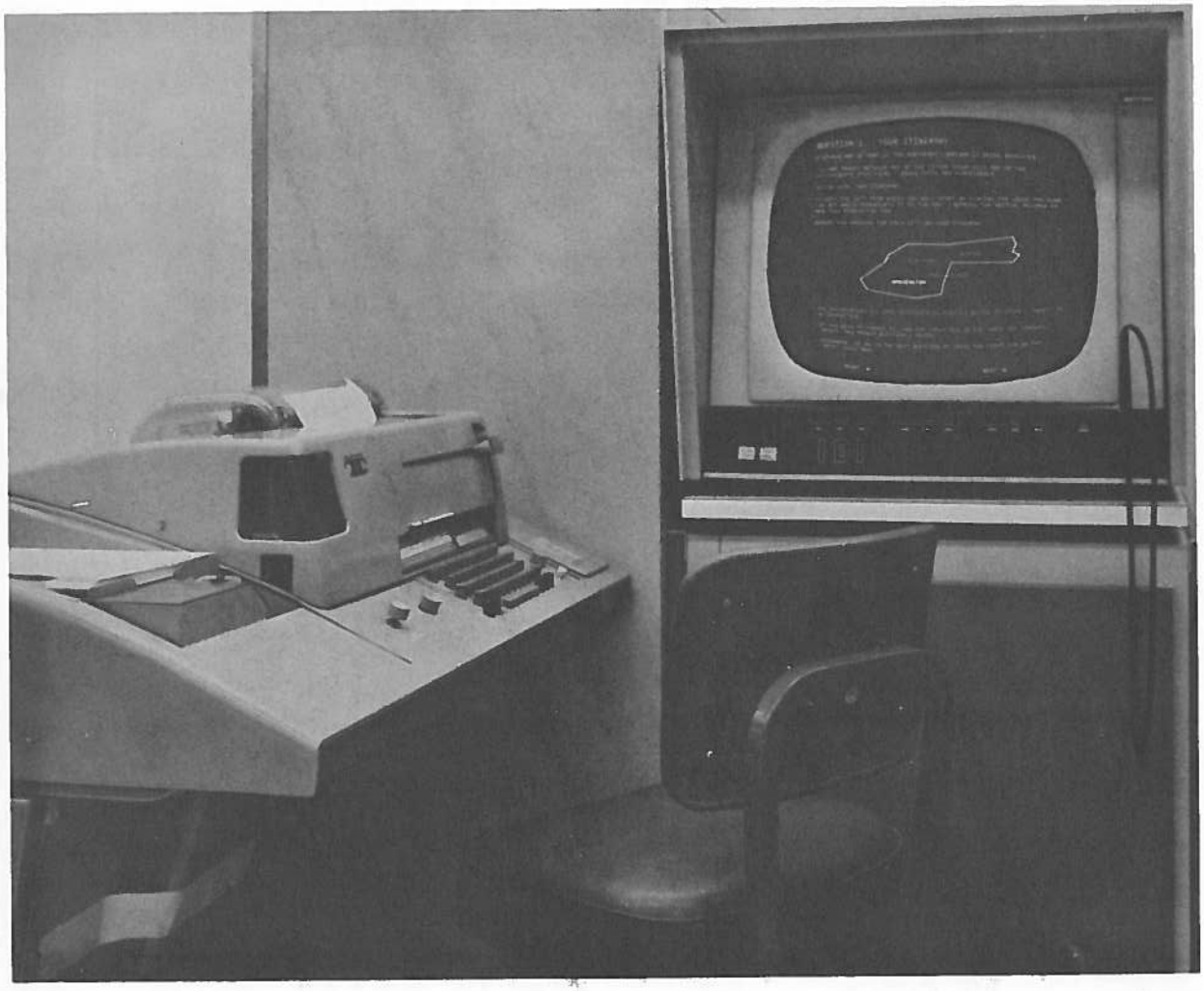

Figure 3.- The Communications Terminal for TRIP 1

The following sections describe in detail the component sub systems of TRIP 1. In the sequel, a CRT picture will be called "frame", and a teletype printout will be called "hard copy".

A. Scenario

The scenario is displayed at the TRIP 1 communications terminal and serves three functions:

(1) Introduces TRIP 1.
(2) States its major limitations.
(3) Specifies activation procedures.

A scenario is necessary only for the inexperienced TRIP user. However, since almost all users will be generally inexperienced, the scenario is considered an integral part of the system. The scenario used for demonstration and experimentation at TSC is shown below:

SCENARIO

YOU ARE ABOUT TO USE A COMPUTER GRAPHICS ORIENTED TRANSPORTATION ROUTING AND INTER-MODAL PLANNING SYSTEM CALLED "TRIP."

TRIP WILL AID YOU IN PLANNING YOUR JOURNEY BETWEEN BOSTON, NEW YORK, PHILADELPHIA AND WASHINGTON. YOU MAY TRAVEL BY AIR, RAIL, BUS, OR AUTO.

THE DATA CURRENTLY AVAILABLE TO YOU IN THIS DEMONSTRATION ARE INCOMPLETE AND QUITE SIMPLIFIED. MANY USER OPTIONS HAVE NOT BEEN INCORPORATED INTO THE OPERATING SYSTEM, AS YET.

This scenario does not include activating instructions, since a general purpose digital computer was used. It required a computer operator to activate the TRIP model.

The Operating System (TOS)

The TRIP 1 operating system is a conversational tutorial erating system. It converses with the user via CRT graphic splays and teletype printout. The user converses with TOS by ans of a light pen which is used to select from data sets pre- nted on the CRT.

TOS has five functional parts:

(1) Introductory Frames.- These frames introduce the user to the light pen and the TRIP 1 model.

(2) Operational Frames.- These frames ask the user questions concerning his travel and collect the appropriate data.

(3) Final Frame.- This frame gives the user the option of resetting the TRIP operating system or requesting his travel plans.

(4) Hard Copy Records.- This teletype printout is a permanent record of the user's travel data. It also warns the user if an inconsistency in his data has been detected.

(5) Frame to Frame Operation.- This is the process by which the user proceeds through the operating system in a systematic manner.

igure 4 indicates the TRIP 1 operating system structure in terms f these five parts.

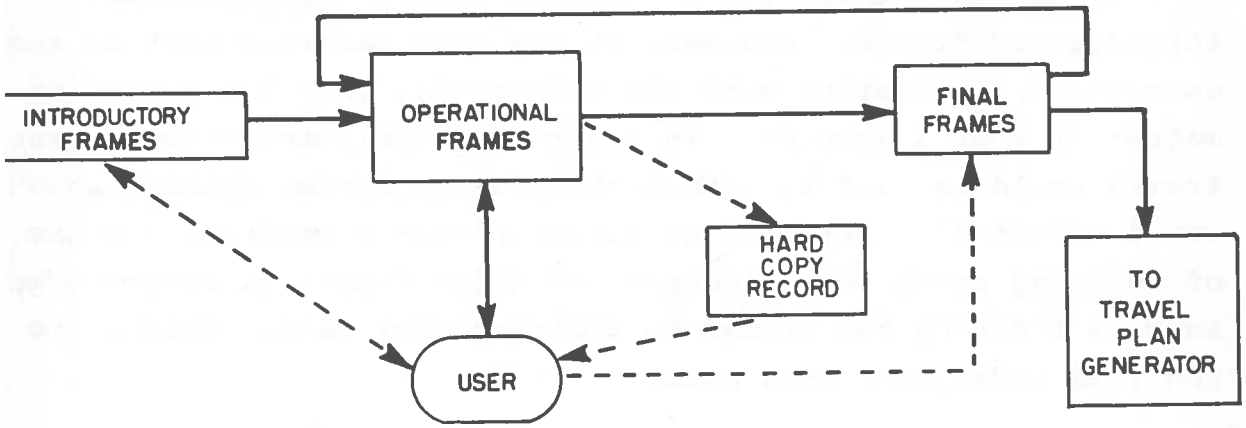

Figure 4.- The Operating System Structure

In the following sections the five functional parts of TOS will be described in detail.

1. Introductory Frames.- There are two introductory frames: (a) the light pen frame which introduces the user to the light pen and instructs him on its use (Figure 5), and (b) the TRIP model instruction frame which introduces the user to the TRIP operating system and gives him preliminary instructions on how to specify travel information (Figure 6).

Each of these frames has three components.

(1) The Conversational Component.- A brief statement of the purpose of the frame. Character size is large and character brightness is normal.

(2) The Tutorial Component.- Instruction to the user. Character size and brightness are normal.

(3) The Frame Close Component.- This component is a box labeled "NEXT". It allows the user to call the next frame via the light pen. It provides an exercise for the tutorial component. Character size is normal. Character brightness is normal unitl it is light pen specified. Then its brightness is intensified.

The structure of these frames and their use are illustrate in Figure 7.

At present, there are no precise timing data on these introductory frames. However, it has been observed that as the user gains familiarity with the TRIP model, they are passed in matter of 2 or 3 seconds. In a more sophisticated model, these frames would be used to inform the user of system changes which would affect his operation or travel plans; therefore, a means of detering preemptory dismissal of these frames is recommended such as flashing the frames to indicate that recent changes to the TRIP model have been made.

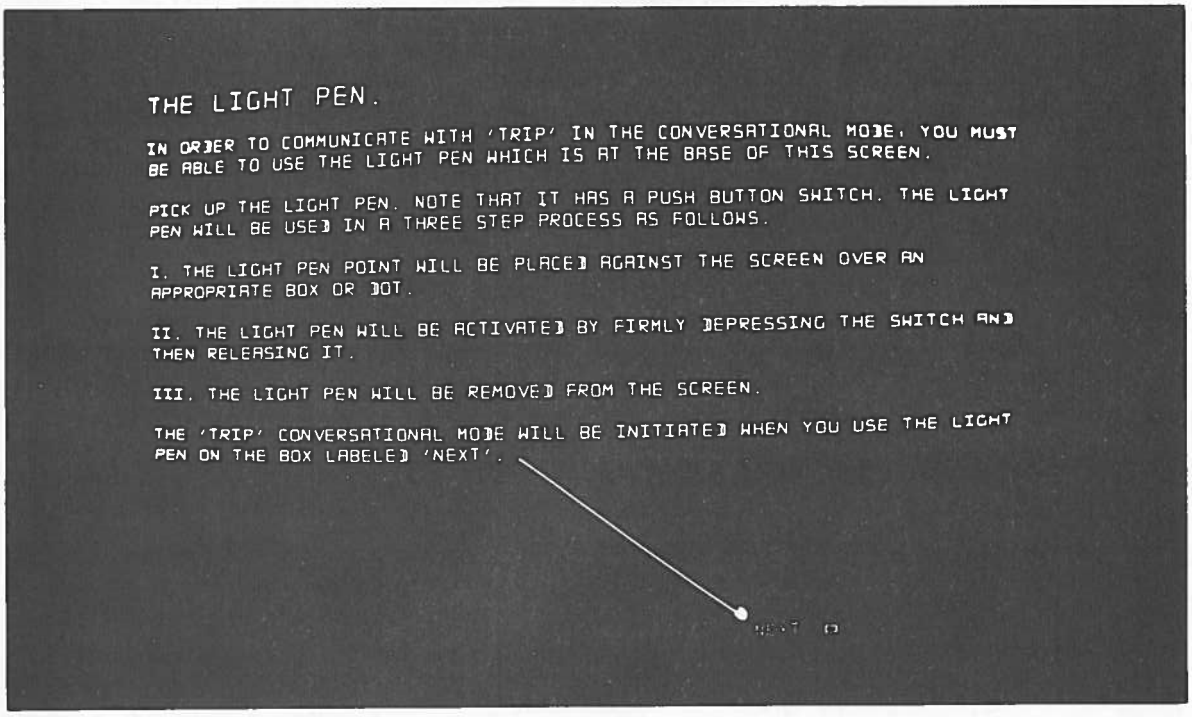

Figure 5.- The Light Pen Introduction Frame

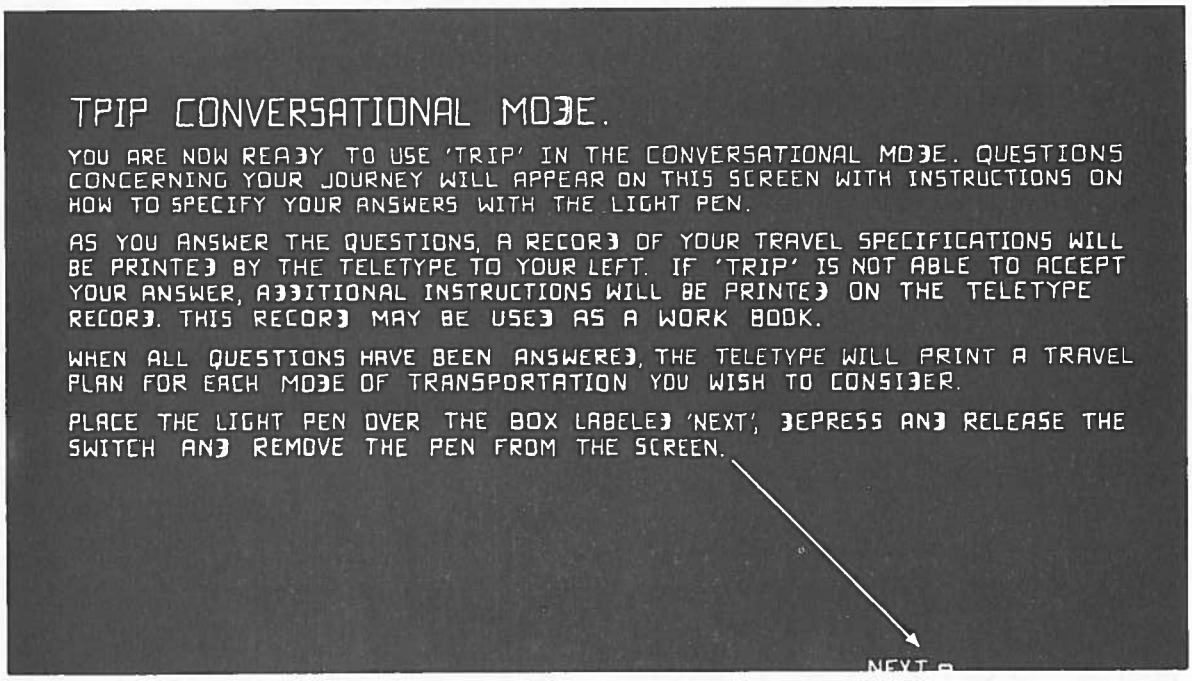

Figure 6.- The TRIP Model Instruction Frame

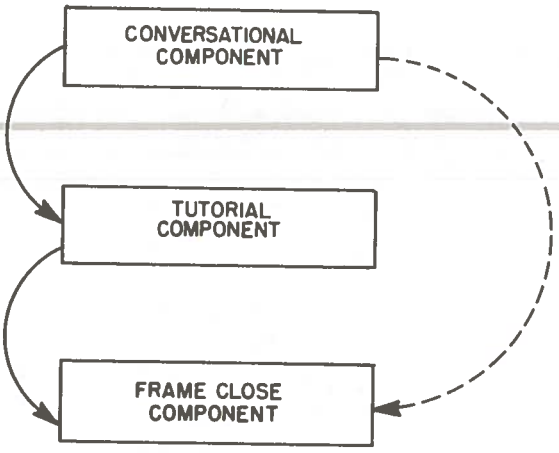

Figure 7.- Introductory Frame Structure and Usage

2. Operational Frames.- There are six operational frames which form the core of the operating system. Their purpose is to collect the user's travel information through a series of specif: questions. These include the following:

(1) Itinerary.
(2) Departure Time.
(3) Stopover Times.
(4) Modes of Travel.
(5) Travel Party Size.
(6) Class of Service.

Photographs of each of these frames were obtained from TSC's computer display. These are illustrated in Figure's 8 through 13 Each of these operational frames has five components. Three are conversational and two are tutorial. An associated hard copy record is produced simultaneously as a checking mechanism.

(a) Conversationsl Components.

(1) Introduction.- A brief statement of the purpose of the frame is given. Character size is large and character brightness is normal.

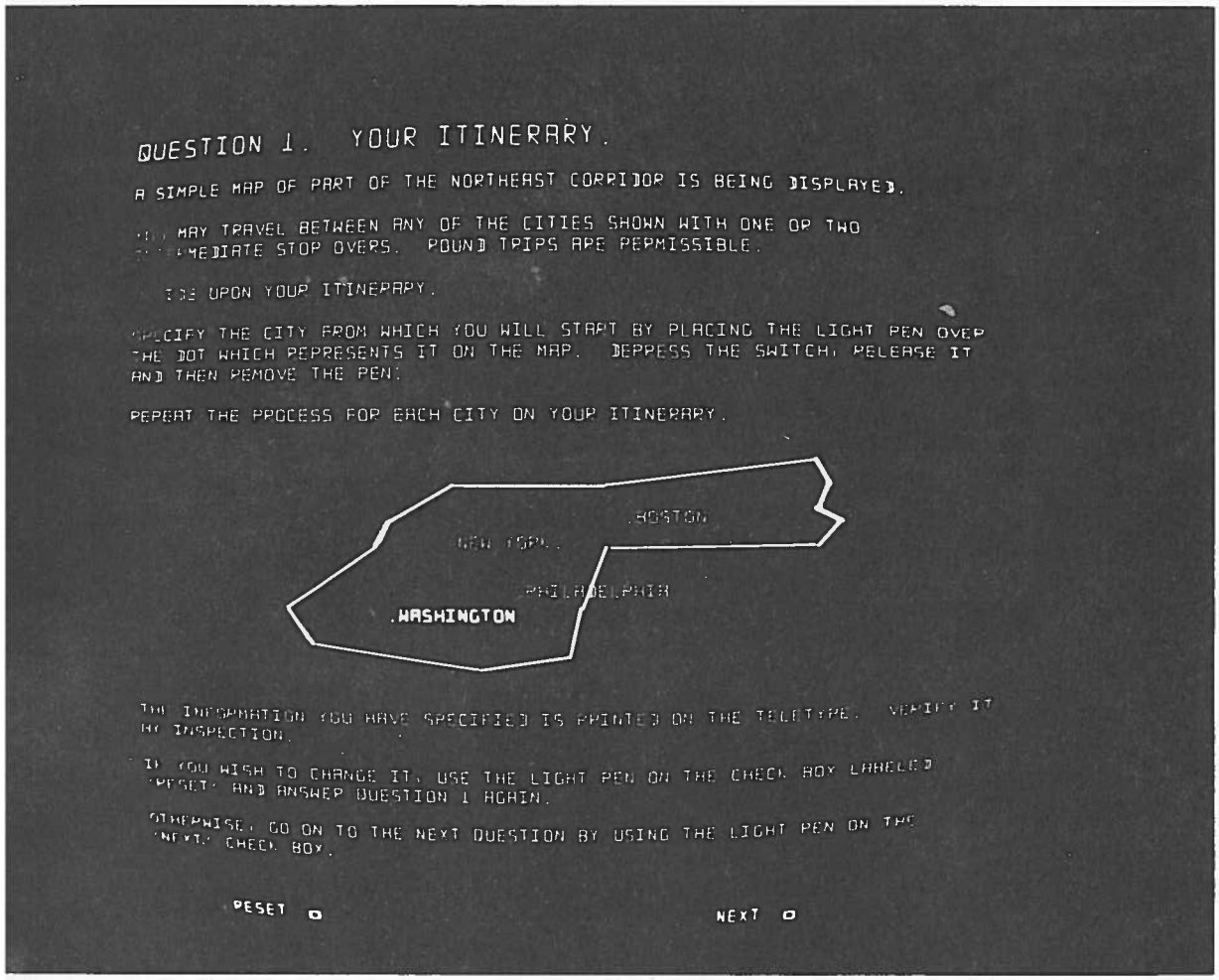

Figure 8.- Itinerary Frame

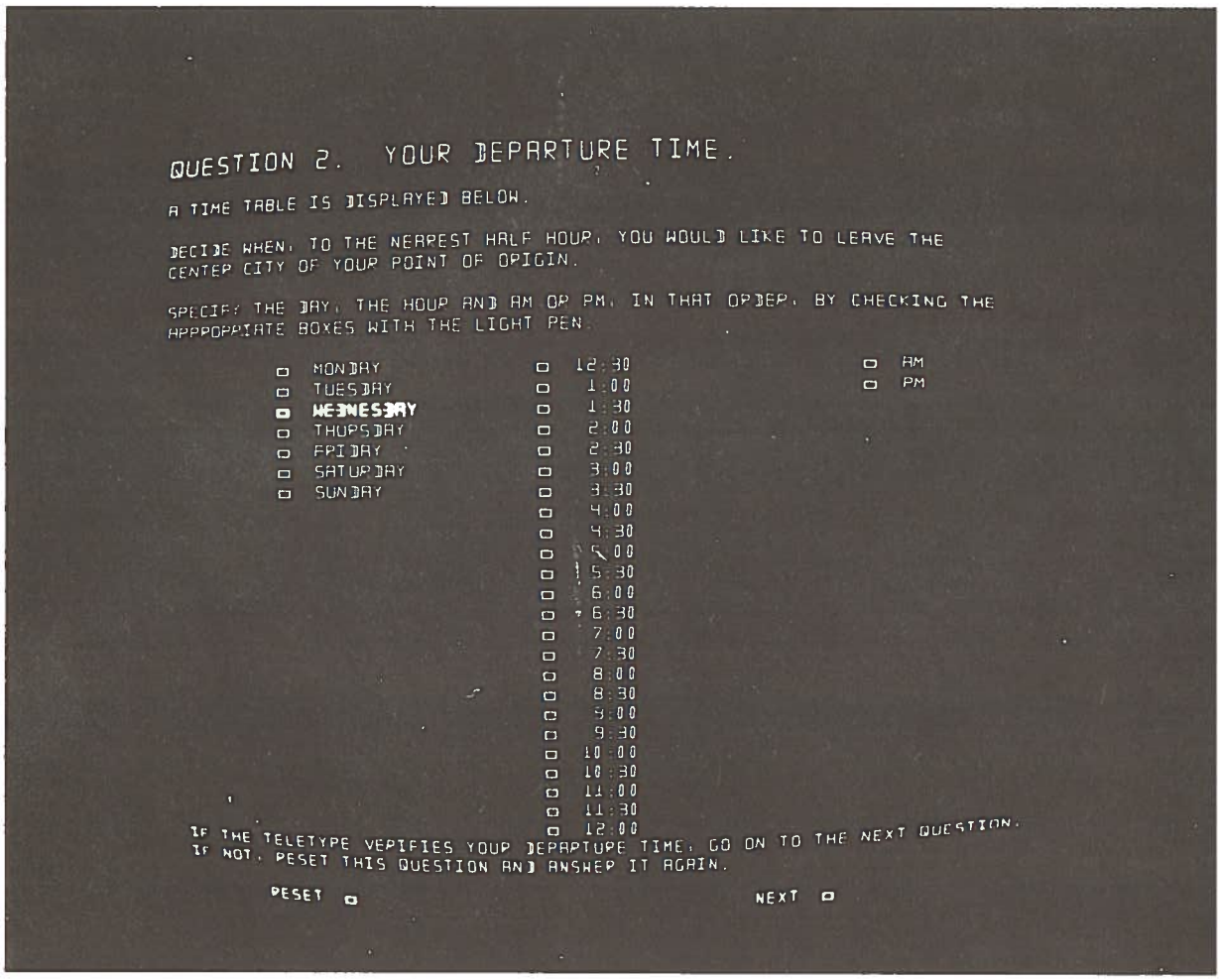

Figure 9.- Departure Time Frame

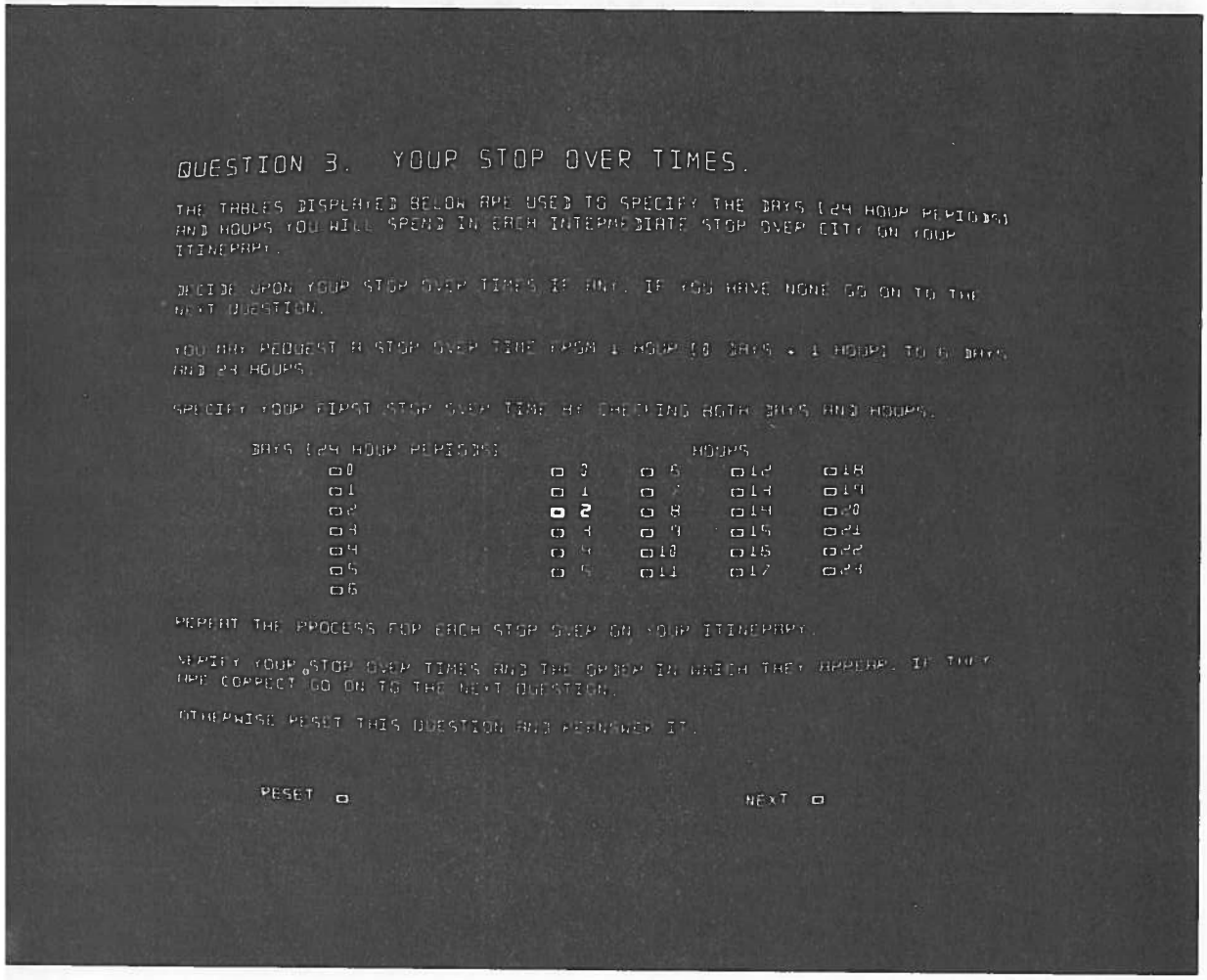

Figure 10.- Stopover Time Frame

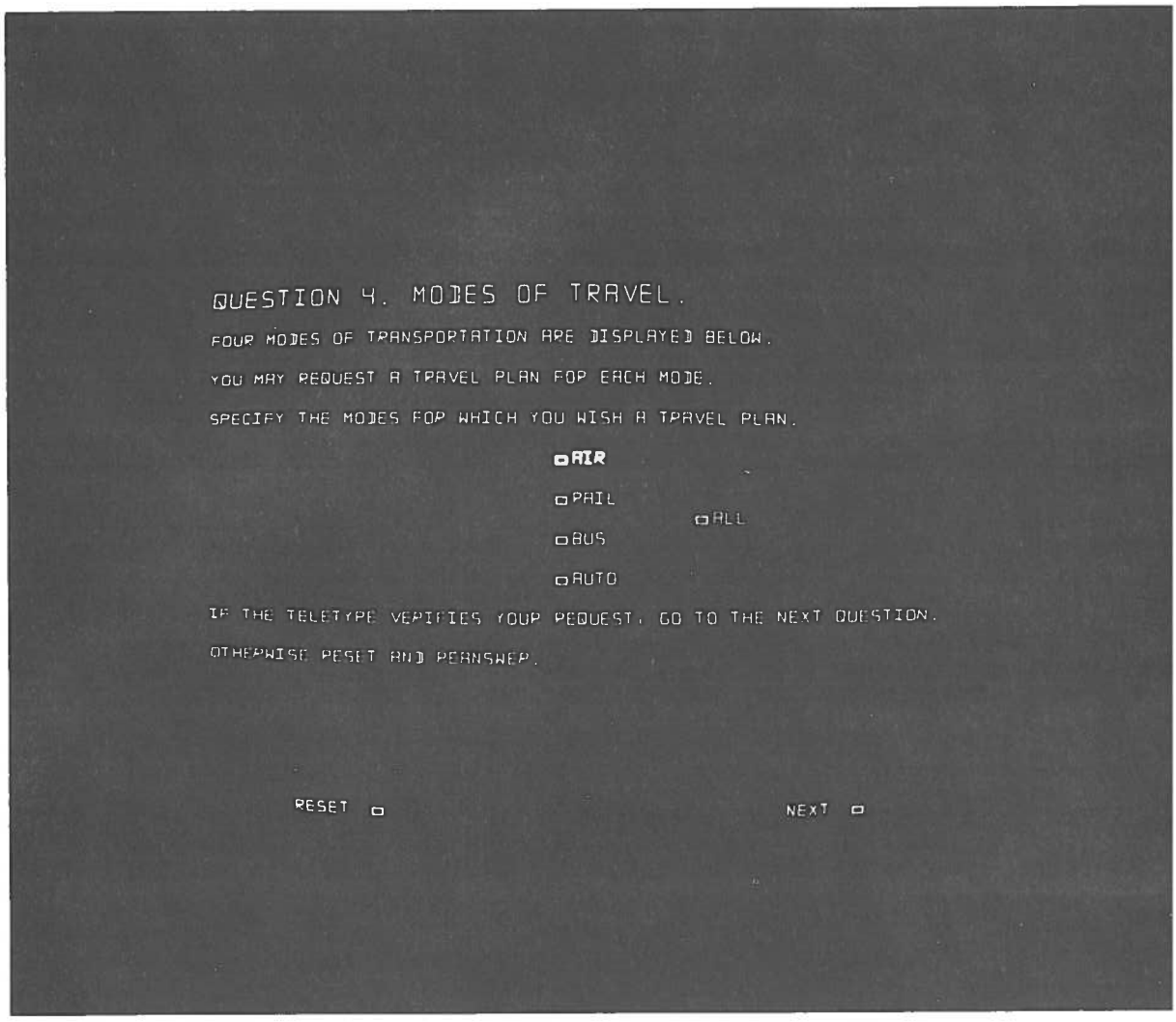

Figure 11,- Modes of Travel Frame

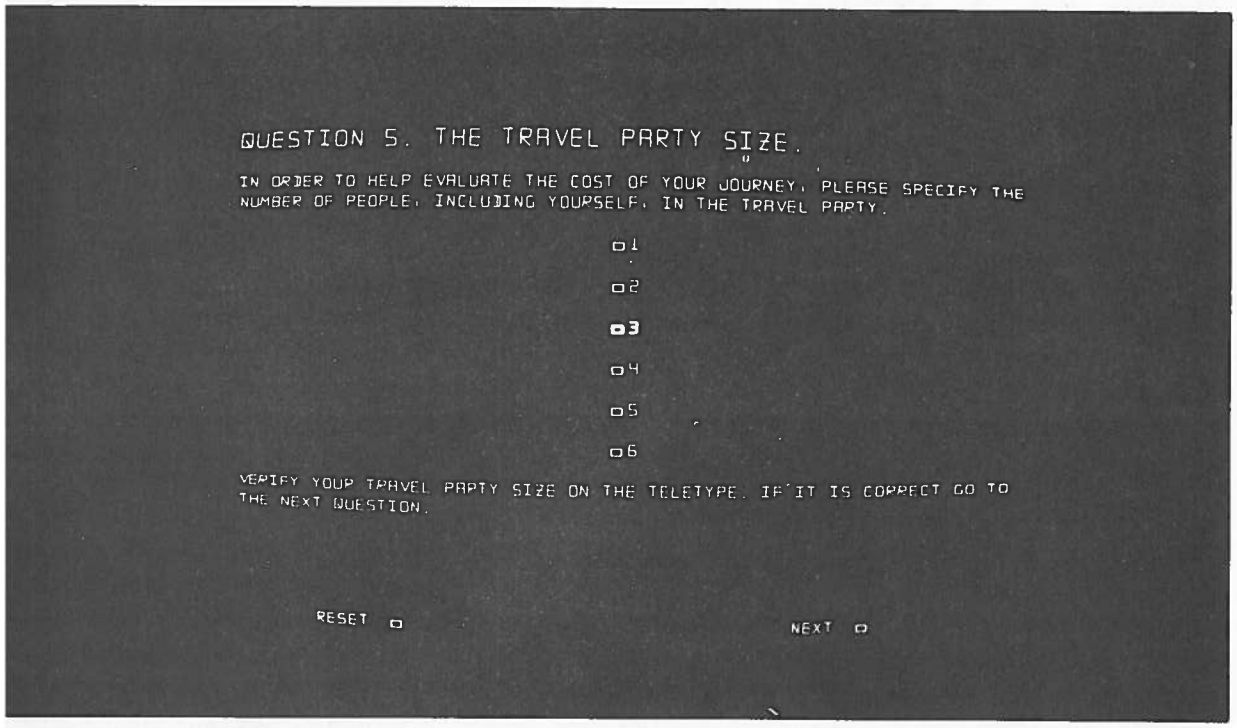

Figure 12.- Travel Party Size Frame

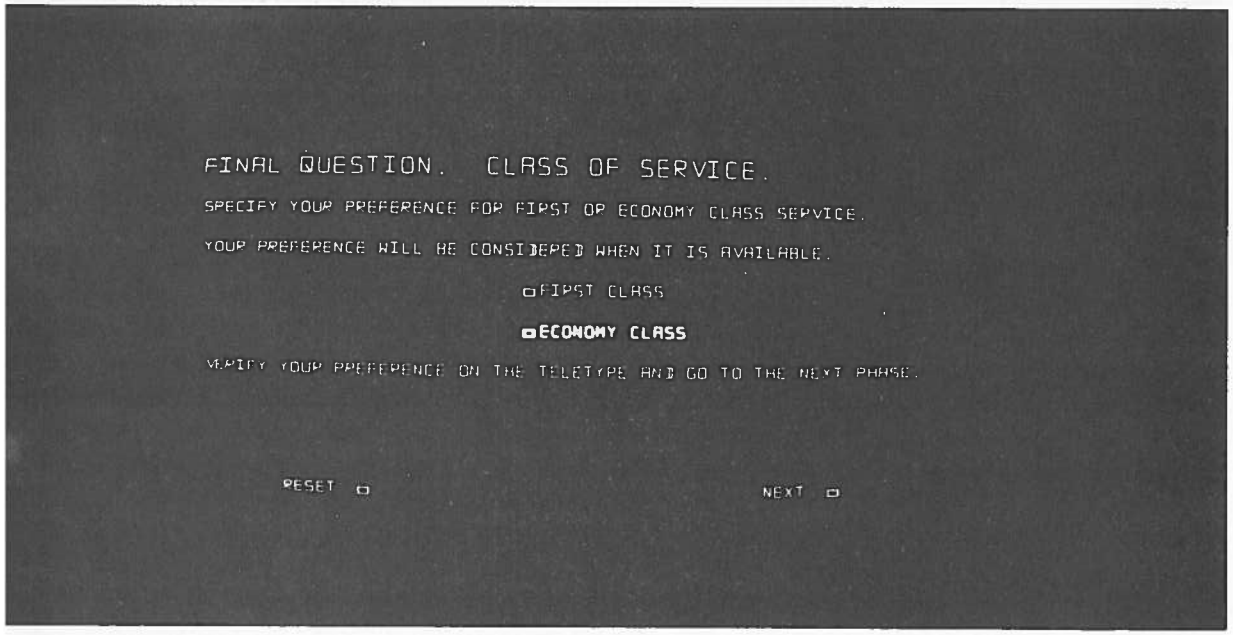

Figure 13.- Class of Service Frame

(2) Data.- A map or table comprised of light-pen sensitive information is presented. The user specifies his travel requirements by activating the light pointed at his choice. Character size is normal. Character brightness is intensified when light-pen specified.

(3) Close/Reset.- This component has two light-pen sensitive labels: RESET and NEXT. The user may reset the frame in case he has made an error of wishes to change his selection. He passes to the next question by activating NEXT. Character size is normal. Character brightness is normal until it has been light-pen specified.

(b) Tutorial Components.

(1) Question and Answer Instructions.- This component is a development of the information requested and the manner in which it is to be specified. Character size and brightness are normal.

(2) Verification and Close Instructions.- This component instructs the user to verify the information he has specified and to reset the frame and change it if incorrect. It also re-enforces the frame change procedure. Character size and brightness are normal.

The hard copy record is produced by the teletype machine. First, a permanent record of user specified information is printed which may be verified. Second, messages are typed to inform and instruct the user in the event that the input information is inconsistent.

The Operational Structure and Procedure for each frame is shown in Figure 14.

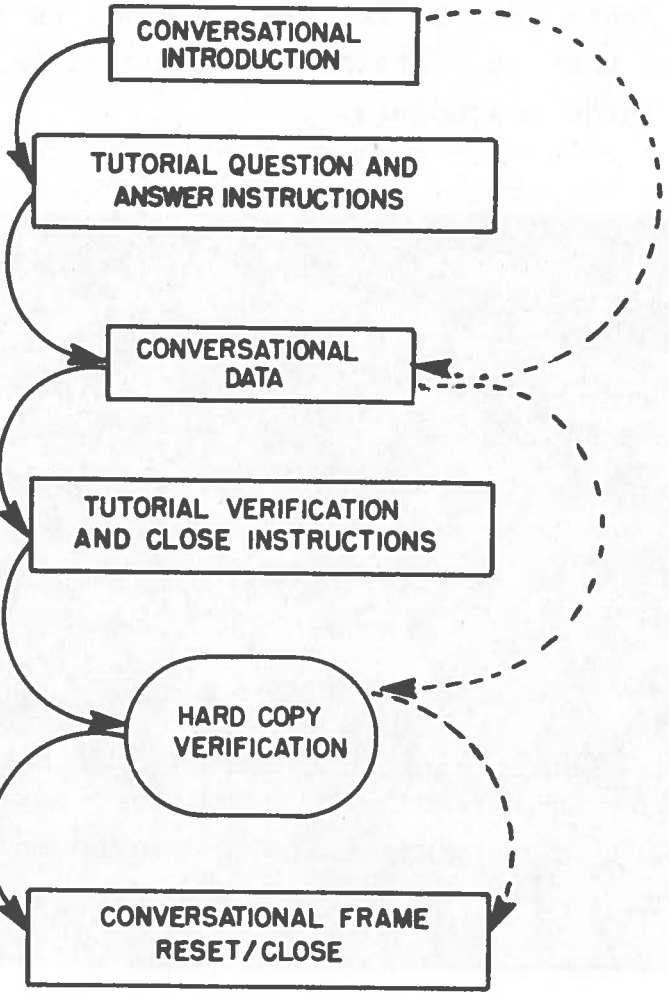

Figure 14.- Operational Structure and Usage

. Final Frame.- The final frame serves two purposes. First, t allows the user to reset the TRIP 1 operating system to the irst operational frame. This means that the user can change ll of his travel specifications without obtaining an unwanted ravel plan and without going through the introductory frames gain. Second, it gives the user final information and allows im time to specifically request hard copies of his travel plan. ne screen is blanked when the travel plans are requested to void diverting the user's attention from the teletype.

The final frame used in the TRIP 1 model is shown in Figure 15. Note that it contains a warning on TRIP model limitations in large characters.

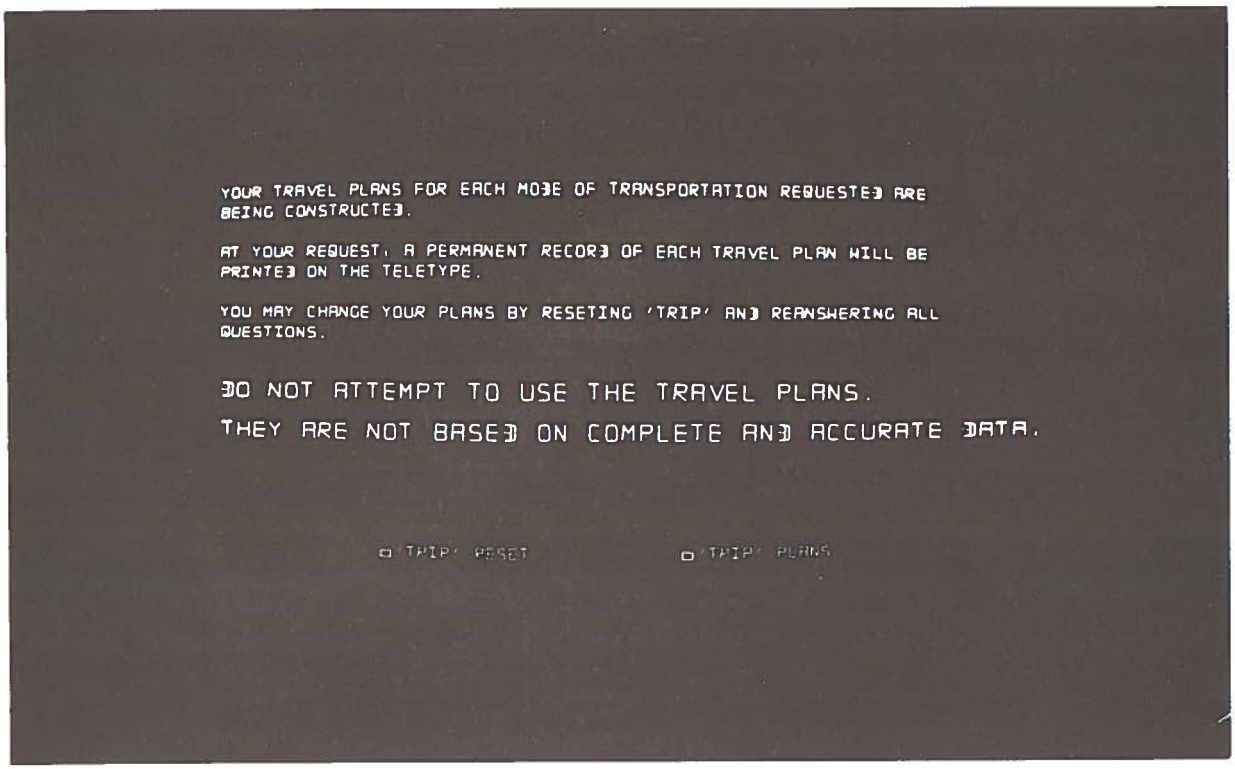

Figure 15.- Final Frame

4. Hard Copy Records.- The hard copy record of the TRIP 1 operating system has two functions. First, it maintains, on a frame basis, the information specified by the user with the light-pen. Second, it warns the user when an inconsistency is detected in the information he has specified and instructs an appropriate action to be taken.

The object of the warning messages is to inform the user of an inconsistency, potential or actual, in his information when it is detected. This prevents confusion at a later time when the problem is no longer easily remembered or corrected.

A list of computer warning messages in TRIP 1 is given below:

ITINERARY

YOU HAVE NOT SPECIFIED A CITY FROM WHICH YOU WILL START. PLEASE DO SO.

YOU HAVE NOT YET SELECTED A DESTINATION. PLEASE DO SO. YOU HAVE SPECIFIED TOO MANY STOPOVERS. RESET AND RE-ANSWER.

DEPARTURE TIME

YOU HAVE CHOSEN 2 STARTING DAYS. RE-SET AND RE-ANSWER
YOU HAVE CHOSEN 2 STARTING HOURS. RE-SET AND RE-ANSWER
YOU HAVE CHOSEN AN AND PM FOR STARTING TIMES. RE-SET AND RE-ANSWER.
PLEASE SPECIFY THE DEPARTURE DAY.
PLEASE SPECIFY THE DEPARTURE HOUR.
PLEASE SPECIFY AM OR PM.

STOPOVER TIMES

CHECK ONE AND ONLY ONE BOX FOR DAYS AND ONE FOR HOURS FOR EACH STOPOVER. RESET AND RE-ANSWER THIS QUESTION.
CHECK ONE AND ONLY ONE BOX FOR HOURS AND ONE FOR DAYS FOR EACH STOPOVER. RESET AND RE-ANSWER THIS QUESTION.
YOU HAVE SPECIFIED TOO MANY STOPOVERS. RE-SET AND RE-ANSWER.

TRAVEL MODES

YOU HAVE SELECTED ONE MODE OF TRANSPORTATION TWICE. RESET AND RE-ANSWER.
YOU HAVE NOT SELECTED ANY MODES OF TRANS-PORTATION. PLEASE DO SO.

TRAVEL PARTY SIZE

YOU HAVE SELECTED MORE THAN ONE TRAVEL PARTY SIZE. RESET AND RE-ANSWER.
YOU HAVE NOT YET SPECIFIED THE TRAVEL PARTY SIZE. PLEASE DO SO.

CLASS OF SERVICE

YOU HAVE CHOSEN TWO CLASSES OF SERVICE. RE-SET AND RE-ANSWER.
YOU HAVE NOT SELECTED A SERVICE PREFERENCE. IF THIS QUESTION IS NOT PERTINENT, YOU MAY CONTINUE NOW.

A sample hard copy record of a user transaction with TRIP 1 is shown below:

```
ITINERY:

   BOSTON
   NEW YORK
   PHILADELPHIA
   WASHINGTON

DEPARTURE TIME

   MONDAY
   10:00  AM

STOP OVER TIMES

   NEW YORK          1 DAYS   12 HOURS
   PHILADELPHIA      0 DAYS    8 HOURS

MODE OF TRAVEL

   AIR
   AUTO

TRAVEL PARTY SIZE

   THE TRAVEL PARTY SIZE IS 3

CLASS OF SERVICE

   FIRST CLASS SERVICE IS PREFERRED
```

5. Frame-to-Frame Operation.- The basic function of the frame-to-frame operation is to allow the user to proceed from one frame to the next with a minimum of confusion. This is accomplished by two features. First, the user cannot go on to the next frame until he has specified the necessary information for the frame on which he is working, Second, in order to go on to the next frame, the user must overtly call for it.

The effect of these two features is to minimize the interference between the user's activities and different frames. That is, each frame stands out to the user as an independent entity.

Since user's activities with certain frames are dependent on his activities with prior frames, it may be necessary to reinforce the user with the information he has previously specified. The hard copy record should satisfy this requirement, but experience has shown it is not effective as set up here, since the teletype is out of the user's visual range when he is working with the CRT frames. Future design can correct this problem.

The frame-to-frame operation of this model does not prepare the user for the material of the next frame; it simply prepared him for its appearance. The first statement in the frame does prepare him for the material on the frame effectively.

The preparation of the user for the next frame is given some consideration; however, in the order of occurrence of the frames. In the present order, the user specifies where he is travelling, when, and how, followed by specification of cost related data. Most users have found this ordering quite natural.

The final point to be discussed under frame-to-frame operation is that tutorial content and re-enforcement are diminished as the user proceeds through the TRIP operating system. The present rate of diminution is effective. However, future studies should determine if faster diminution would speed up the process without increasing errors.

C. Travel Plan Generator

The TRIP 1 travel plan generator is hidden from the user. It accepts the user's travel specifications from the operating system, reads the appropriate air or auto travel tables from the disc storage device into core memory, and performs the clerical searching and bookkeeping necessary to compile a suitable travel plan. This is all done in less time than it takes the user to turn to the teletype device to read the travel plan. Herein lies the great value of the TRIP concept. The user concentrates on his travel needs and wishes alone while the computer compiles his travel plans in seconds.

The travel plan generator for TRIP 1 has two programs: (1) the air travel plan program, and (2) the auto travel plan program. These programs fit into the travel plan generator structure as shown in Figure 16.

1. The Air Travel Plan Program.- The air travel plan program compiles a travel plan for an air journey according to the user's travel specifications. A sample air travel plan is shown below.

```
AIR TRAVEL PLAN FROM BOSTON TO WASHINGTON
    BY WAY OF NEW YORK AND PHILADELPHIA

LEAVE BOSTON ON TUESDAY AT 1000 AM
ARRIVE NEW YORK ON TUESDAY AT 1245 PM
EA FLIGHT NO. 0 LEAVES LOGAN AIRPORT ON
TUESDAY AT 1100 AM
ARRIVES LA GUARDIA AIRPORT ON TUESDAY AT 1200 AM

NUMBER OF STOPS......0

CLASS OF SERVICE.....ECONOMY

MEALS................NONE

AIR FARE.............. 21.00

LEAVE NEW YORK ON TUESDAY AT 845 PM
ARRIVE PHILADELPHIA ON TUESDAY AT 1125 PM
NA FLIGHT NO. 431 LEAVES KENNEDY AIRPORT
ON TUESDAY AT 1000 PM
ARRIVES INTERNATIONAL AIRPORT ON TUESDAY AT 1040 PM

NUMBER OF STOPS......0

CLASS OF SERVICE.....FIRST

MEALS................NONE

AIR FARE.............. 18.90

LEAVE PHILADELPHIA ON WEDNESDAY AT 325 AM
ARRIVE WASHINGTON ON WEDNESDAY AT 757 AM
EA FLIGHT NO. 589 LEAVES INTERNATIONAL
AIRPORT ON WEDNESDAY AT 630 AM
ARRIVES NATIONAL AIRPORT ON WEDNESDAY AT 712 AM
NUMBER OF STOPS......0

CLASS OF SERVICE.....FIRST

MEALS................NONE

AIR FARE.............. 18.90

THE ELAPSED TIME FOR THIS JOURNEY IS 0 DAYS,
21 HOURS 57 MINUTES THE TOTAL AIR FARE FOR
THIS JOURNEY IS 58.80
```

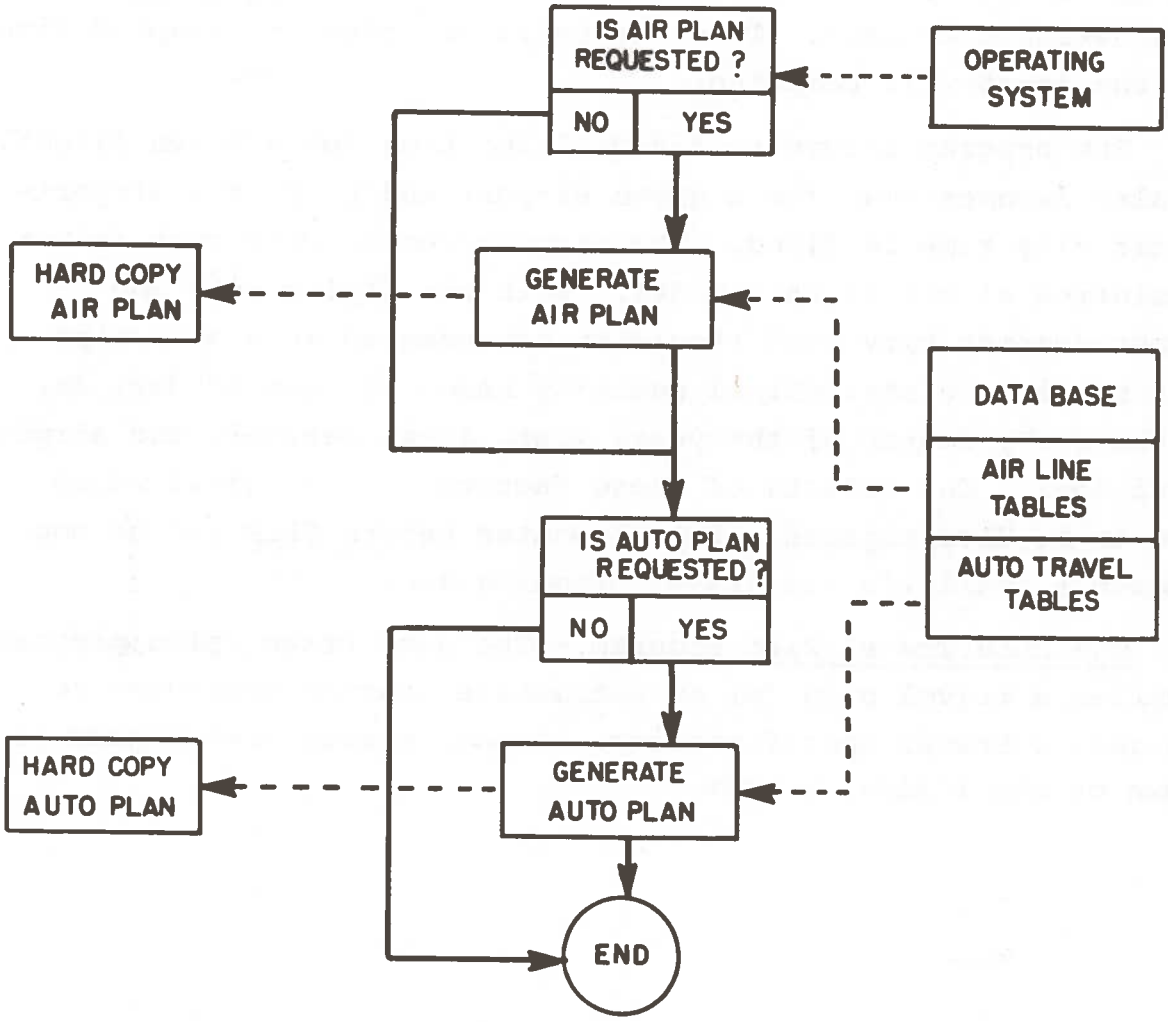

Figure 16.- TRIP 1 Travel Plan Generator

The user's itinerary is broken into origin-destination city pairs. The air travel tables for the first city pair are read from the disc into core memory. The program computes the center city/center city leave and arrive times and the airport/airport leave and arrive times. Then air line, flight number, number of stops, class of service, meal service, and total air fare for the travel party is computed. This is done for each origin-destination city pair. Then the total air fare and elapsed time for the journey is computed.

The program assumes a fixed flying time for a given flight. It also assumes that for a given airport and city, the airport-center city time is fixed. The airport/center city cost is not considered at all in this model. Both the flying time and airport/center city time should be represented as a mean time plus or minus a statistical quantity based on time of day, day of the week, season of the year, year, local weather, and airport conditions. The effects of these factors on air travel would have to be investigated and implemented before TRIP can be considered a realistic air travel planning aid.

2. The Auto Travel Plan Program.- The auto travel plan program compiles a travel plan for an automobile journey according to the user's travel specifications. A sample auto travel plan is shown on the following page.

```
AUTOMOBILE TRAVEL PLAN FROM BOSTON TO WASHINGTON
    BY WAY OF NEW YORK AND PHILADELPHIA
LEAVE BOSTON ON TUESDAY AT 1000 AM
ARRIVE NEW YORK ON TUESDAY AT 240 PM
DISTANCE 215 MILES.
OPERATING COST AT 3 CENTS PER MILE 6.45
COST OF TOLLS 2.65
TOTAL COST OF THIS LEG OF JOURNEY 9.10

NEAVE NEW YORK ON TUESDAY AT 1040 PM
ARRIVE PHILADELPHIA ON WEDNESDAY AT 1250 AM
DISTANCE 93 MILES.
OPERATING COST AT 3 CENTS PER MILE 2.79
COST OF TOLLS 2.65
TOTAL COST OF THIS LEG OF JOURNEY 5.44

LEAVE PHILADELPHIA ON WEDNESDAY AT 450 AM
ARRIVE WASHINGTON ON WEDNESDAY AT 755 AM
DISTANCE 136 MILES.
OPERATING COST AT 3 CENTS PER MILE 4.08
COST OF TOLLS 1.80
TOTAL COST OF THIS LEG OF JOURNEY AT 5.88

THE TOTAL COST OF THIS JOURNEY IS 20.42
THE ELAPSED TIME FOR THIS JOURNEY IS 0 DAYS,
21 HOURS AND 55 MINUTES  OK.
```

The auto travel table is read from the disc into core memory. The user's itinerary is broken into origin-destination city pairs and for each pair leave and arrive times, distance, operating cost (at three cents per mile), cost of tolls, and total cost are computed. Then the total cost and elapsed time for the entire journey are computed.

This program assumes that the automobile travel time for a given origin-destination city pair is a constant. This is not correct of course in practice. The automobile travel time between two cities should be represented by a mean time and statistical

variance which depends on many factors including time of day, day of the week, season of the year, year, and local road and weather conditions. The effects of these factors on automobile travel for each origin-destination pair would have to be investigated and implemented for realistic use of the TRIP system.

D. Data Base

The TRIP 1 data base consists of air and automobile travel tables broken down by origin-destination city pairs. The cities are numerically coded as follows:

Washington	1
Philadelphia	2
New York	3
Boston	4

The origin-destination city pair code K is obtained from:

$$K = J + [I-1]$$

where I and J are the numerical codes of the origin and destination city, respectively.

The automobile travel table is saved on disc in a two-dimensional array, IAUTO(K,L). The K variable refers to the city pair code:

IAUTO(K,1) = center city/center city distance in miles
IAUTO(K,2) = center city/center city time in military units
IAUTO(K,3) = city pair toll costs in cents

The IAUTO(K,L) array is read from disc into an array ITAB(K,L) in core memory by the auto travel plan program.

One air travel table for each city pair is saved on the disc in the arrays IAIR1(L,P), IAIR2(L,P),..., IAIR 12(L,P). In order to access these arrays, the city pair code, K ($1 \leq K \leq 16$), is converted to a code, KEY, ($1 \leq KEY \leq 12$), by eliminating the useless city pair codes for which the origin and destination cities are

the same. The IAIR arrays are read from disc into ITAB(L,P) in core memory one array at a time as needed. For each city pair, the L variable refers to scheduled flights ordered by departure time from the first flight of the day to the last flight of the day. The P variable refers to a vector of descriptive quantities for the flight. That is, for the first city pair and the Lth scheduled flight we have:

IAIR1(L,1) = Scheduled departure time in military units.
IAIR1(L,2) = Scheduled departure airport code number.
IAIR1(L,3) = Scheduled arrival time in military units.
IAIR1(L,4) = Scheduled arrival airport code number.
IAIR1(L,5) = Airline code number.
IAIR1(L,6) = Flight number.
IAIR1(L,7) = Number of stops.
IAIR1(L,8) = Class of service code number.
IAIR1(L,9) = Equipment code number.
IAIR1(L,10)= Meal service code number.

The airport code number is defined as follows:

Washington	Dulles	1
	Friendship	2
	National	3
Philadelphia	International	4
	Northeast	5
New York	Kennedy	6
	La Guadia	7
	Newark	8
Boston	Logan	9

The airline printout code and code numbers are as follows:

American	AA	1
Allegheny	AL	2
Braniff	BN	3
Delta	DL	4
Eastern	EA	5

National	NA	6
Northeast	NE	7
Northwest	NW	8
Transworld	TW	9
United	UA	10

The class of service code numbers are as follows:

First Class Service	Propeller First Class	1
	Jet First Class	2
	Jet Night Coach First Class	3
	Jet Standard Service	4
Economy Class	Propeller Coach	5
	No reservation Service	6
	Jet Coach	7
	Jet Night Coach	8
Both Class Services	Jet, First and Coach	9
	Jet, Night Coach, First and Coach	10

The meal service code numbers are as follows:

No Meal Service	0
Breakfast	1
Dinner	2
Lunch	3
Snack	4

An equipment code is not used in this program.

Air fares are saved in core memory in an array called AC(L,N), where L refers to the origin-destination city pair and N refers to the class of service.

Auto travel tables were drawn from "Northeast Corridor Transportation Facts and Statistics"[1*]. Air travel tables were drawn from the "Official Airline Guide"[2].

*References: See Section VII.

V. GENERAL DISCUSSION OF RESTRICTIONS

The restrictions on any TRIP model can be described in three general categories:

(A) Operating System Restrictions
(B) Travel Plan Generator Restrictions
(C) Data Base Restrictions

A. Operating System Restrictions

The basic information* which can be meaningfully obtained by the operating system is predetermined by travel plan generator and data base restrictions. The method of obtaining this information is restricted by the communications terminal and computer capabilities, and the effort put into the operating program development.

B. Travel Plan Generator Restrictions

The travel plan generator has as a basic restriction, the size and quality of the data base. After the data base has been prescribed, the travel plan generator is restricted by the computer capabilities, the effort put into the travel plan program development, and the time allowed for travel plan computation. This latter factor is important even with modern computers. For instance, the problem of determining an itinerary from among five cities which is optimum with respect to distance traveled, cost, time, or some combination of these items can take three minutes to solve. The computation time increases rapidly with the number of cities.

C. Data Base Restrictions

The data base is restricted by computer storage capacity and development effort required. Complete intercity transporta-

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*This does not include additional information which might be obtained for a transportation study data base.

tion tables can be very large. Their size can be greatly magnified by the inclusion of descriptive data. The intra city travel information for each city in the system must be included if complete trip costs and times are to be computed. Both the inter-city and intra-city tables should have a statistical structure, as previously discussed, if realistic travel plans are to be produced. In general, the effectiveness of a TRIP system will be determined by the capability of the computer and communication hardware and the effort put into computer program and data base development. The former is essentially an economic choice. The latter is based on economics and scheduling.

TRIP 1 was severely restricted in all catagories. The inter-city data are incomplete in the sense that all available auto routes and air flights are not included. The intra-city data are comprised of a fixed time allowance for airport-center city travel. The travel plan generator cannot generate mixed mode journeys or optimal itineraries. The operating system can only ask a fixed set of questions in a fixed order.

VI. USER COMMENTS AND EXPERIENCE

In spite of these severe restrictions, TRIP 1 has proven to be an effective study model. Approximately thirty users liked the TRIP concept and enjoyed experimenting with TRIP 1. In fact, many of them had to be asked to free the computer for other projects. This group included computer specialists, transportation personnel, human factors specialists, and secretaries.

There were two user's who felt negatively about TRIP 1. One felt that it had too much verbiage, the other that is was too complicated. The former essentially equated minimum verbiage to simplicity. In the context of a self-contained system with a broad user profile, neither assumption follows. The fact that the inexperienced user completely reads every frame and the experienced user only reads a bare minimum of the operational

frames has previously been discussed. It can be shown that, for the inexperienced user, TRIP 1 can be made more complicated and take longer to use by the removal of a few arbitrarily chosen sentences or phrases. Similarly, experience with the stopover time frame has shown that the addition of the phrase "do not include intra-city travel time" will simplify the user's procedure and prevent errors that would not be detected until the air travel plan was printed out.

Preliminary experience with a variety of users who are completely familiar with the computer equipment and the TRIP model showed that all six operational frames are exercised in less than 40 seconds. Users who are totally unfamiliar with the computer equipment and the TRIP system have proceeded through all six frames in approximately two and one half minutes. The longest time required was three and one half minutes.

Although much can be done to improve TRIP 1, usage to date indicates the technical feasibility of the TRIP concept.

VII. REFERENCES

1. "Northeast Corridor Transportation Facts and Statistics," Peat, Marwick, Livingston and Co., Document Number NECTP-212, prepared for Northeast Corridor Transportation Project, December, 1969.

2. "Official Airline Guide," Quick Reference, North American Edition, January 15, 1970.