population total to arrive at a more accurate esti-
mate. Surveys of pedestrians and vehicular traffic
could also be conducted to further enhance the esti-
mate if they were warranted.

CHARACTERISTICS AVAILABLE FROM THE UTPP

Because the UTPP is a special tabulation designed
for transportation planning, most of the character-
istics it provides are for the at-work population.
As noted previously, the only characteristics avail-
able in the UTPP for nonworking residents are age
and sex. However, this should not seriously limit
the utility of the UTPP as a tool for analysis of
the daytime population because most applications
focus on the characteristics of the work force by
place of work.

The characteristics of the at-work population
that are available in the UTPP include the following:

- Occupation by sex,
- Industry by sex,
- Class of worker by sex,
- Means of transportation to work by earnings,
- Means of transportation to work and carpooling,
- Travel time to work by means of transportation,
- Means of transportation by race and Spanish
  origin,
- Carpool type and vehicle occupancy,
- Number of vehicles used to get to work,
- Persons per vehicle,
- Persons per carpool,
- Means of transportation by household income, and

- Means of transportation by number of vehicles
  available.

USES OF DAYTIME POPULATION ESTIMATES

Certainly the number and characteristics of persons
who work in a given location are of critical impor-
tance for transportation planning. There are, how-
ever, many other uses for these data. Some of these
are listed as follows:

- Transportation planning,
- Marketing,
- Environmental impact analysis,
- Disaster planning,
- Planning for service delivery,
- Labor market analysis,
- Economic development planning, and
- Equal Employment Opportunity studies.

OBTAINING DATA FROM THE UTPP

UTPPs for many SMSAs have been delivered, and pack-
ages for the majority of the remaining metropolitan
areas will be produced within the next year or so.
Interested data users may contact either the agency
that purchased the package or the Census Bureau. A
complete description of the UTPP, a list of pur-
chasers, or information on the cost and availability
of a particular UTPP may be obtained by writing to
the Chief, Journey-to-Work and Migration Statistics
Branch, Population Division, Bureau of the Census,
Washington, D.C. 20233.

Linking the Urban Transportation Planning Package with the Urban Transportation Planning System*

MICHAEL B. CLARKE

ABSTRACT

Methods are described in detail for access-
ing data from the Urban Transportation Plan-
ning Package on a mainframe computer. Spe-
cific procedures are explained for using the
data as part of the Urban Transportation
Planning System.

The purpose of this paper is to aid the user in get-
ting the Urban Transportation Planning Package
(UTPP) into a usable format for computer-assisted

urban travel modeling. The process of using the
census data in a meaningful and easy manner can be
difficult, and it is hoped that the reader will gain
a better understanding of the mechanics of the data
and their application.

This paper is organized in several sections in
order to make the process more easily comprehensible
and at the same time show the differences between
the applications to be covered. Presented first is
a general description of what the user will be con-
fronted with when he receives the UTPP. In this
section procedures the user may find helpful in
using the tape, including how to access and use the
UTPP print program, are detailed. The UTPP is com-
pared with the past data-handling methods contained
in UCEN70. In the next section how and why the user
should reformat the UTPP data for use with the Urban
Transportation Planning System (UTPS) and for use in
microcomputer software packages are discussed. In
the third section the creation of UTPS Z-files

(zonal data) and J-files (trip interchange data) is covered. Building these structures is often complicated by the mere volume of UTPS documentation, and it is hoped that this section of the paper will provide a short and straightforward approach to mastering the process.

The fourth section makes up the major portion of the paper. In it, several examples are presented showing how the UTPP data can be used in modeling trip generation, trip distribution, modal choice, and traffic assignment. All examples show how to incorporate UTPS to aid in the travel demand modeling process.

UTPP TAPE, PRINT PROGRAM, AND COMPARISONS WITH UCEN70

Tape Information

The UTPP user may be rather disconcerted when he first receives the package from the Bureau of the Census. What is delivered is one or two nine-track, standard label tapes (depending on the size of the urban region); a copy of the tape request from the Bureau of the Census; and a data dictionary that describes where each piece of data can be found. The tape request in its entirety tells the user that Parts I through VI of the UTPP for their area are contained on the accompanying tape. In addition, the tape contains the UTPP print program, which enables the user to produce a listing of all or parts of the UTPP data, and a section that contains geocoding data.

In order for the user to access any parts of the UTPP, he should know that the UTPP tape has been created on a Sperry Univac computer system, and as such does not have IBM-compatible data set names. Specifically, the data set names have portions without out separating periods greater than eight characters in length. This can be confirmed by mounting the tape and printing the tape labels using a local program module such as LABELSNIFF, which prints the data set name, record length, block size, and so on.

With this in mind the user can, with relative ease, circumvent the problems associated with having incompatible IBM data set names. By utilizing a printout of the tape labels of the UTPP, the user can create a program setup using the IBM utility program IEBGENER to copy all of the data sets from the original tape to another tape and specify his own specific data set names. A sample IEBGENER setup is shown in Figure 1. The user should note that the key to the whole process is to bypass label processing (BLP) on the original tape. Once IEBGENER has been run and a new tape has been created, the user is left with a new tape useful for production purposes and the original tape from the census, which can serve as a backup.

UTPP Print Program

At this point in UTPP processing the user may want to access the UTPP print program. With it, printouts of all the data contained on the tape or of selected portions can be produced. The print program is contained on the UTPP tape and is easily accessed by using a fairly standard set of Job Control Language (JCL) procedures.

The JCL needed is shown in Figure 2. Along with the JCL, two control cards are input to the program after the //LU06CNTL DD * card. The two control cards are the TABLE card and the ZONE or TRACT card.

TABLE Card

The TABLE card allows the user to print selected tables or all tables from UTPP Parts I, II, III, V, and VI. For Part IV, all tables must be printed. This card begins in card column 1. The following examples show the use and limits of the TABLE card:

1. To request all tables in UTPP Part I:
   ```
   //LU06CNTL DD *
   TABLE I
   ZONE
   ```
2. To request individual tables within UTPP Part I:
   ```
   //LU06CNTL DD *
   TABLE I-3, I-5, I-4
   ZONE
   ```

The second example causes the UTPP print program to print Tables I-3, I-4, and I-5. The user may request up to 12 individual tables on the same TABLE card. Table identifications do not have be in as-

```
         //COPY1 EXEC PGM=IEBGENER
  1    ⎛ //SYSUT1 DD LABEL=(8,BLP),VOL=SER=<Your UTPP tape>,UNIT=<Your tape device>
       ⎨ // DCB=(RECFM=FB,LRECL=2529,BLKSIZE=25290),
       ⎝ // DISP=(OLD,PASS)
  2    ⎛ //SYSUT2 DD DSN=<Your output data set name>,UNIT=<Your tape device>
       ⎨ // DCB=(RECFM=FB,LRECL=2529,BLKSIZE=25290),
       ⎝ // LABEL=(1,SL),DISP=(NEW,PASS),VOL=SER=<Your output tape>
         //SYSPRINT DD SYSOUT=A
         //SYSIN DD DUMMY
         //COPY2 EXEC PGM=IEBGENER
  3    ⎛ //SYSUT1 DD LABEL=(11,BLP),VOL=SER=<Your UTPP tape>,UNIT=<Your tape device>
       ⎨ // DCB=(RECFM=FB,LRECL=15160,BLKSIZE=30320),
       ⎝ // DISP=(OLD,PASS)
  4    ⎛ //SYSUT2 DD DSN=<Your output data set name>,UNIT=<Your tape device>
       ⎨ // DCB=(RECFM=FB,LRECL=15160,BLKSIZE=30320),
       ⎝ // LABEL=(2,SL),DISP(NEW,PASS),VOL=SER=<Your output tape>
```

Line Reference	Explanation
1	READS IN PART I OF THE UTPP DATA
2	WRITES OUT TO NEW TAPE UTPP PART I DATA
3	READS IN PART II OF THE UTPP DATA
4	WRITES OUT TO NEW TAPE UTPP PART II

FIGURE 1 Example of IEBGENER program to copy Parts I and II of UTPP.

```
//YOUR JOB CARD
/*SETUP TAPENUMBER
//STEP1     EXEC PGM=LU06001A,REGION=400K
//STEPLIB   DD  DSN=YOUR.LOAD.LIBRARY,DISP=SHR
//          DD  DSN=YOUR.SUB.ROUTINE.LIBRARY,DISP=SHR
//SYSOUT    DD  SYSOUT=A
//SYSUDUMP  DD  SYSOUT=A
//LU06INPT  DD  DSN=YOUR.INPUT.DATASET,
//              UNIT=TAPE,
//              LABEL=(FILE,TYPE,EXPDT=      ),
//              DCB=(LRECL=    ,BLKSIZE=      ,RECFM= ),
//              DISP=(OLD,KEEP),
//              VOL=SER=TAPENUMBER
//LU06PRNT  DD  SYSOUT=A,DCB=BLKSIZE=133
//LU06CNTL  DD  *

TABLE I
ZONE
//
```

FIGURE 2   JCL needed to run the UTPP print program.

cending order; however, the tables will be printed in ascending order. Last, the user must run the program separately for tables coming from different parts of the UTPP.

For Part IV of the UTPP, the user would always code his TABLE card as follows:

```
        //LU06CNTL DD *
        TABLE IV
        ZONE
```

This is because the program cannot print individual tables from Part IV.

ZONE or TRACT Cards

A ZONE or TRACT card must always be present or the program will fail. This card is placed immediately after the TABLE card and must also begin in column 1. ZONE or TRACT is used depending on how the user's data are formatted. That is, if the user's UTPP is stratified by zones, ZONE would be entered; if it is by tracts, TRACT is entered. The user should be aware of what format was ordered from the Census Bureau.

UCEN70

UCEN70 is a UTPS program that enabled users to access the 1970 census data. This program was used to reformat the data to the zonal level and to interface the data with UTPS programs. Some employment places were miscoded in the 1970 census data because the responses were coded to the home office of a company instead of to the actual job site. UCEN70 was also used to reassign employment places.

UMTA in conjunction with FHWA decided not to produce a similar program for the 1980 census data for two reasons. First, the Census Bureau now produces UTPP tapes that have data already coded to the zonal level, and, second, the Census Bureau has come up with better procedures for handling employmentplace coding and allocation, which made a UCEN80 program unnecessary. It is still necessary, however, to reformat the UTPP data so that they may be read by UTPS programs. All other capabilities of UCEN70 are available in other UTPS programs.

REFORMATTING THE UTPP

The UTPP data are contained within six distinct parts. Each part holds either interchange (matrix-type) data or zonal (trip-end type) data. Each part

has its own record length and block size. All of the data are in a fixed block record format and EBCDIC (card-image) form.

The record lengths in some parts of the UTPP are in excess of the allowable length for constructing UTPS Z-files (zonal data) and J-files (interchange data). The input record length for building Z-files cannot be longer than 9,999 characters and for J-files cannot be longer than 255 characters. Also, the UTPP data are segmented; that is, multiple records (or segments) are used to contain data for one zone or tract. An example showing how the data are usually formatted in the UTPP is given in Figure 3. The number of segments and record lengths varies for each part of the package. In this example, three records, each with a record length of 15,160 characters, and three segments are used for each zone.

UTPP FORMAT:

Identifiers	Data					25239
ZONE#	X	X	X	X	X	X
1						
1						
1						
2						
2						
2						
3						

FIGURE 3   Typical UTPP record.

UTPS cannot read the long record lengths and cannot interpret multiple segments. Therefore, the UTPP data to be input to UTPS must be reformatted onto a data set having a shorter record length and a single record for each zone or tract. This reformatting may be accomplished by running a simple FORTRAN program. An example of such a program is shown in Figure 4. It should be noted that some of the UTPP records have an s coded in numeric fields, meaning that these data have been suppressed. These fields will generate a FORTRAN error message and substitute a value of 0. The exact format information of each part of the UTPP is contained in the data dictionary.

In addition, summary records are contained in the UTPP and should be bypassed. As shown in the example

```
C  SET UP AN ARRAY TO STORE INPUT DATA FOR PROCESSING
      INTEGER*4 ADATA(3)
C  PRINT A HEADER DESCRIBING WHAT WILL BE LISTED
      WRITE(6,50)
   50 FORMAT(5X,'  ZONE',5X,'   TOTALEMP',5X,'
      RETAILEMP') WRITE(6,75)
   75 FORMAT(5X,'------',5X,'---------',5X,'---------')
C  READ ZONE NUMBER, TOTAL EMPLOYMENT, AND RETAIL
C  EMPLOYMENT FROM THE UTPP
  100 READ(1,200,END=666)ADATA
  200 FORMAT(29X,I6,4(80X),5X,I9,54X,I9/)
C  CHECK FOR SUMMARY RECORD (ZONE = 0)
      IF(ADATA(1).EQ.0)GO TO 500
C  WRITE OUTPUT TO A STORAGE UNIT WITH A SHORTER RECORD
      LENGTH WRITE(9,300)ADATA
  300 FORMAT(I6,1X,I9,1X,I9)
C  WRITE ALL OUTPUT DATA TO PRINTER
      WRITE(6,400)ADATA
  400 FORMAT(5X,I6,5X,I9,5X,I9)
  500 CONTINUE
C  CONTINUE PROCESSING UNTIL END OF INPUT DATA
      GO TO 100
  666 END FILE 9
      END
```

FIGURE 4   FORTRAN program to read UTPP and write selected data with shorter record lengths.

in Figure 4, these records can be skipped by checking that the zone number is greater than 0.

Before reformatting the UTPP data, the user must decide which data items will be needed for further processing with UTPS. Because the output record lengths are shorter than the original ones contained in the UTPP, only a subset of the UTPP data can be written on the reformatted records. After the FORTRAN program or other reformatting procedure has been run, the data are in a UTPS-readable compatible format (see Figure 5).

UTPS READABLE FORMAT:

Identifiers	Data
ZONE* 1 2 3 4	X X X X

• Has Non-Segmented Records
• Record Length is Less then 9999 for Z-File
   and Less than 255 for J-File

FIGURE 5 Reformatted UTPP record.

If UTPP data are to be input into a microcomputer, they must often be reformatted again into intermediate files. Once the data have been reformatted into shorter record lengths and do not contain multiple segments, they are downloaded to the microcomputer using a modem in conjunction with a communications package. Common communications software packages for such a procedure include CROSSTALK for CP/M microcomputers and the Hayes Terminal package or Visiterm for Apple computers.

The next step is to decide whether the data format needs to be changed again, which depends on the software to be used. For instance, when VisiCalc, a commercial spreadsheet package, is used, a Data Interchange Format (DIF) file must be created. Visiplot and Supercalc also require intermediate files, but many statistical packages can read the reformatted EBCDIC data as created earlier. Formatting to an intermediate file is usually done by using a PASCAL or a BASIC program. The user should refer to the documentation that accompanies the software for specific format requirements.

CREATING UTPS DATA STRUCTURES

UTPS programs can read and write three types of data formats. These are EBCDIC, Z-file, and J-file. If the UTPP data have been reformatted as described earlier and are still in EBCDIC, it would seem plausible that they could be directly applied in a modeling context. However, within UTPS it is best to have the data stored within either a Z-file or a J-file because the majority of UTPS programs can read and write only these structures. Z-files are used to hold zonal or trip-end data such as the population and number of dwelling units in a zone. J-files hold matrix data such as trip tables and zone-to-zone travel times. Within each of these data structures, a second level of storage exists; for Z-files it is called the List of Attribute Values

(LAV). LAVs are vectors that store data attributed to one variable. There may be many LAVs in a Z-file. Figure 6 shows a Z-file containing three LAVs: one containing the zone number, one containing population, and one containing the number of persons owning one car.

Z-FILE

LAV Zone	LAV Population	LAV Persons Owning One Car
1	12,152	8,612
2	11,000	2,600
3	13,500	3,700
4	14,700	5,700
5	9,468	2,250
6	8,500	3,876
7	26,700	14,116
8	21,500	8,776
9	24,600	19,114
.	.	.
.	.	.
.	.	.
.	.	.

FIGURE 6 Zonal Z-file with LAVs.

The secondary level of storage for J-files is called a TABLE. One J-file may contain up to 255 tables. Each table is a matrix containing a specific set of data. For instance, the first table (J101) might contain home-based work trips, the second table (J102) might contain home-based other trips, and the third table (J103) might contain non-home-based trips.

UTPS programs UMODEL and MBUILD are used to create Z-files and J-files, respectively. Both programs take EBCDIC data as input. The following discussion describes the use of both programs.

Z-File Creation

UMODEL is often viewed as a difficult program to use because it contains several entry points at which the user can insert his own FORTRAN code. In building Z-files, UMODEL is run in the default mode, meaning that no user FORTRAN is entered. The task is therefore relatively simple. A sample UMODEL run to construct a Z-file is shown in Figure 7. In this example, one EBCDIC data set is input and one Z-file is output. The only job parameters needed are the number of zones and information concerning reports. In addition, UMODEL data identification cards are needed to supply the program with all input and output data information. The resulting output of this run will be one Z-file containing seven LAVs: ZONE, HH, INCOME, HH0, HH1, HH2, and HH3. More information about data identification cards and UMODEL can be found in the UMODEL documentation and the UMODEL User's Guide.

J-File Creation

MBUILD is the UTPS program used to construct matrix

```
//UMODEL1 EXEC UMODEL,CORE=256K,
```
Execution card calling UMODEL and specifying memory of 256k bytes.

```
// LIB='URD81.PROGLIB',
```
Specifies program library containing this version of UMODEL.

```
// A1='DSN=UTPP.DATA,VOL=SER=UMTA3',
```
Dataset name and location for input file containing reformatted UTPP EBCDIC data.

```
//       UNITA1='3330-1',
```
Type of storage device: a 3330-1 disk pack.

```
// Z1='DSN=UMTA.UTPP.DATA,VOL=SER=UMTA2',
```
Z- file dataset name and its destination.

```
// SPACEZ1='(TRK,(10))',UNITZ1='3330-1',DISPZ1='(NEW,KEEP)'
```
Space allocation, device type, and disposition of the data.

```
//UMODEL.SYSIN DD *
```
Specifies that the following data (UTPS control cards) are to be read.

UMODEL RUN TO CONVERT CENSUS DATA INTO ZONAL Z FILE FORMAT
UTPS title card identifying this specific run.

&PARAM ZONES=265 &END
Number of transportation analysis zones is 265.

&SELECT REPORT=1,2   &END
Print reports 1 and 2.

& DATA
Read data identification cards.

1P   1   6   1 1 1ZONE   ZONE NUMBER
This is Data Identification Card #1; data item identified is production-end* data; data is located in columns 1 through 6; store in UMODEL X array position #1; data is located on input file A1; output goes to file Z1; give data item the title "ZONE"; data is the zone number.

*For a definition production-end and attraction-end variables, see UMODEL documentation.

FIGURE 7   Conversion of EBCDIC zonal data to Z-file.

2P   10   17   2 1 HH   HOUSEHOLDS
This is Data Identification Card #2; data item identified is production-end data; data is located in columns 10 through 17; store in X array position #2; data is located on input file A1; output goes to Z1; give data item the title "HH"; data is number of households in zone.

3P   21   28   3 1 1INCOME   MEDIAN INCOME
This is Data Identification card #3; data item identified is production-end data; data is located in columns 21 through 28; store in X UMODEL array position #3; data is located on input file A1; output goes to file Z1; give data item title "INCOME"; data is median zonal income.

4P   32   39   4 1 1HH0   HH0
This is Data Identification card #4; data item identified is production-end data; data is located in columns 32 through 39; store in X UMODEL array position #4; data is located on input file A1; output goes to file Z1; give data item title "HH0"; data is zonal households not owning a car (owning 0 cars).

5P   43   50   5 1 1HH1   HH1
This is Data Identification card #5; data item identified is production-end data; data is located in columns 43 through 50; store in X UMODEL array position #5; data is located on input file A1; output goes to file Z1; give data item title "HH1"; data is zonal households owning 1 car.

6P   54   61   6 1 1HH2   HH2
This is Data Identification card #6; data item identified is production-end data; data is located in columns 54 through 61; store in X UMODEL array position #6; data is located on input file A1; output goes to file Z1; give data item title "HH2"; data is zonal households owning 2 cars.

7P   65   72   7 1 1HH3   HH3
This is Data Identification card #7; data item identified is production-end data; data is located in columns 65 through 72; store in X UMODEL array position #7; data is located on input file A1; output goes to file Z1; give data item title "HH3"; data is zonal households owning 3 or more cars.

files (or J-files) from EBCDIC data. MBUILD is one of the simpler UTPS programs to use and as a result the construction of J-files from the UTPP data is fairly easy. In order to build the J-file, the user should be familiar with four key words:

- I denotes location of origin zone number on input records,
- J denotes location of destination zone number on input records,
- K denotes table number, and
- XIJK denotes location of the value to be placed in the matrix cells.

A sample MBUILD setup is shown in Figure 8. In this example, J9 (the output file) contains one table. Input is the reformatted UTPP data. I tells MBUILD that the origin zone number is in columns 4 through 6; J tells MBUILD that the destination zone number is in columns 11 through 13; K tells MBUILD to put all input values into one table, XIJK tells MBUILD to put the data in columns 109 through 113 into the cells of the table.

USING THE UTPP DATA IN TRAVEL DEMAND MODELING

The UTPP contains a great deal of travel information. Much of this information can be used in travel demand modeling within UTPS. In this section methods of using parts of the UTPP in trip generation and trip distribution, calibration of travel models, mode choice, and traffic assignment are presented.

Trip Generation

Parts I and III of the UTPP contain information de-

scribing zonal characteristics such as median income, number of households, automobile ownership, and employment. These data can be used as input to a trip-generation model.

An example of a trip-generation model is the default model in NCHRP Report 187 ([1]). In this model, the number of person trips attracted to and produced from each zone is calculated for three trip purposes: home-based work (HBW), home-based nonwork (HBNW), and non-home-based (NHB). Trip productions are obtained for each zone based on the number of households in the zone by income category. Tables corresponding to different urbanized area population ranges give estimates of average daily person trips per household and the percentage of trips by purpose ([1],pp.13 and 14).

Trip attractions are calculated based on total employment, retail employment, nonretail employment, and the total number of dwelling units. All of these data are aggregated at the zonal level. In addition, areawide control factors are used to achieve an areawide balance between productions and attractions. The equations used in estimating trip attractions are as follows:

HBW trip attractions = F_1 [1.7 (analysis area total employment)],

HBNW trip attractions = F_2 [10.0 (analysis area retail employment) + 0.5 (analysis area nonretail employment) + 1.0 (analysis area dwelling units)], and

NHB trip attractions = F_3 [2.0 (analysis area retail employment) + 2.5 (analysis area nonretail employment) + 0.5 (analysis area dwelling units)].

F_1 = areawide productions for HBW trips ÷ 1.7 (areawide total employment),

```
//MBUILD EXEC MBUILD,CORE=192K,                              1
//       LIB='URD81.PROGLIB',                                2
//    INPUT='DSN=UTPP.P4TRIPS,VOL=SER=UMTA3',                3
//       UNITINP='3330-1',                                   4
//    J9='DSN=UTPP.P4TRIPS,VOL=SER=UMTA1',                   5
//       UNITJ9='3330-1,SPACE=(TRK,(40,25),RLSE)'            6
//MBUILD.SYSIN DD *                                          7
 MBUILD RUN TO CONSTRUCT TRIP TABLE                          8
 &PARAM ZONES=265,LRECL=200,NTABS=1,                         9
    I='IN(4,6)',                                            10
    J='IN(11,13)',                                          11
    K='1',                                                  12
    XIJK='IN(109,113)'    &END                              13
```

Line
Reference   Explanation

1	CALL UTPS PROGRAM MBUILD
2	DEFINE LIBRARY CONTAINING UTPS PROGRAMS
3-4	DEFINE INPUT FILE CONTAINING EBCDIC RECORDS
5-6	DEFINE OUTPUT J-FILE
7	LOCATE SYSTEM INPUT (CONTROL CARDS)
8	RUN IDENTIFICATION CARD

9	PARAMETER CARD:
	   MAXIMUM NUMBER OF ZONES FOR OUTPUT J-FILE IS 265;
	   RECORD LENGTH OF INPUT FILE IS 200 CHARACTERS;
	   MAXIMUM NUMBER OF OUTPUT TABLES IS 1

10	ORIGIN ZONE IS IN COLUMNS 4-6
11	DESTINATION ZONE IS IN COLUMNS 11-13
12	ONE OUTPUT TABLE
13	PERSON TRIPS TO BE STORED IN THE MATRIX ARE INTEGERS (IN) IN COLUMNS 109-113

FIGURE 8 MBUILD run to construct person trip table.

F_2 = areawide productions for HBNW trips ÷ [10.0 (areawide retail employment) + 0.5 (areawide non-retail employment) + 1.0 (areawide dwelling units)], and

F_3 = areawide productions for NHB trips ÷ [2.0 (areawide retail employment) + 2.5 (areawide non-retail employment) + 0.5 (areawide dwelling units)].

To apply this model within UTPS, UTPS program UMATRIX is run using a series of lookup tables to define which coefficients will be applied for each trip-end calculation. The UMATRIX setup assumes that two Z-files have previously been constructed from UTPP data using UMODEL. These two files contain the zonal data to be used in the calculations. Three trip purposes, HBW, HBNW, and NHB, are being estimated. All six output LAVs--home-based work productions, home-based nonwork productions, non-home-based productions, home-based work attractions, home-based nonwork attractions, and non-home-based attractions--are stored on the Z1-file. UMATRIX works in the following manner.

A new LAV, Z1CHECK, is created that is assigned a value of 1 through 13 depending on the average zonal income range as defined in the trip-generation tables described earlier (1). Next a new LAV, Z2NONEMP, is created containing all nonretail employment for each zone. New LAV Z2HH is assigned the total number of households in each zone. Following these preliminary calculations, the various trip-generation calculations by purpose are made. All productions are calculated based on income-related lookup tables. (See UMATRIX documentation for further explanation of lookup tables.) All attractions are based on the data contained in the employment LAVs.

Calibration of a Gravity Model Using the UTPP

A possible use of the UTPP data is to check a locally calibrated gravity model. Three major input data items are needed in the checking process. These are

1. The simulated HBW person trip table produced by the local gravity model, for comparison purposes;
2. The local area highway network; and
3. The UTPP Part IV data containing the home-to-work person trips.

The process used to verify the local model is detailed in the following discussion.

First, the local highway network must be input to UTPS program UROAD to produce a travel-time matrix file. Next, the user would insert intrazonal and terminal times into this file. This can be done using one of several UTPS programs. Also, UTPS program MBUILD must be run to produce a home-to-work trip table based on the UTPP Part IV data, as was described earlier.

Once the home-to-work trip table has been built, it is input to UTPS program UMATRIX to factor the trips to reconcile differences between the trip definitions of the census and those of the trip-generation model. This includes accounting for the work-to-home trip and for such factors as persons having second jobs and sickness and vacations. The user would first double the census-derived person trip table to include work-to-home trips. If the user does this, he is assuming that work-to-home trips equal home-to-work trips. Next, because the census questionnaire asked about the usual trip to work and also to account for second jobs, the user would multiply the trip table by 0.8925. This factor is a default value based on work done at various locations in the Washington metropolitan area. A sample UMATRIX setup to accomplish the foregoing is shown in Figure 9.

Once these two inputs (the census HBW trip table and the travel-time skims) have been constructed, they can be input, along with the simulated HBW person trip table produced by the locally calibrated gravity model, into UTPS program UFMTR to produce a series of trip length frequency comparison plots. An example is shown in Figure 10.

The analyst would then review these plots and determine whether the simulated trip lengths and the census trip lengths match. If the plots do not

```
1    //UMATRIX EXEC UMATRIX,CORE=320K,
     //           LIB='URD81.PROGLIB',
2    //        J1='DSN=UMTA.HTW.TRIPS,VOL=SER=UMTA3',
     //           UNITJ1='3330-1',
3    //        J9='DSN=UMTA.HBW.TRIPS,VOL=SER=UMTA3',
     //           UNITJ9='3330-1',SPACE=(TRK,(10,2),RLSE)'
     //UMATRIX.SYSIN DD *
     UMATRIX RUN TO FACTOR HOME-TO-WORK TRIPS TO HBW
4    &PARAM SIZE=265,J901='J101*2.0*0.8925                    &END
     /*
```

Line Reference	Explanation
1	CALL UTPS PROGRAM UMATRIX
2	INPUT FILE CONTAINING CENSUS HOME TO WORK DATA
3	OUTPUT FILE CONTAINING CENSUS-DERIVED HOME BASED WORK TRIPS
4	DECLARES MAXIMUM ZONE NUMBER AS 265; MULTIPLIES HOME-TO-WORK TRIPS BY 2.0 AND THEN BY .8925

FIGURE 9 UMATRIX run to factor home-to-work trips to home-based work trips.

match well enough, UTPS program AGM would be used to recalibrate the gravity model as follows. Inputs to AGM include

1. Travel-time skims from UROAD,
2. Census HBW person trip table (used for comparison), and
3. Friction factors used in the local gravity model (used as a starting point).

Productions and attractions are derived from the census trip table by AGM through a row and column summing process. AGM applies the input friction factors to estimate a new trip table and then produces trip length frequency plots for both the newly estimated trip table and the input census HBW person trip table. A sample AGM setup is shown in Figure 11. The analyst would then check the plots to see how well the trip lengths in the newly estimated trip table match those in the census trip table. If

the estimated trip lengths do not closely match, a revised set of friction factors would be input into a new AGM run, and the process would be iterated until the census trip lengths are matched closely.

After the trip lengths have been checked for reasonableness, the major movements in the study area should be verified. This would be done by collapsing the census trip table and the newly estimated zonal trip table into larger districts or some other level of aggregation whereby major trip movements—CBD to suburban, CBD to CBD, and so on—could be checked. This collapsing or squeezing of the trip tables is accomplished by running UTPS program USQUEX. An example is shown in Figure 12. If the trip movements are found to be reasonable, the user has completed the checking and recalibration of his gravity model. If, however, the major movements do not match the values derived from the census data, the user may then wish to introduce a set of K-factors into the gravity model to adjust for the iden-

```
1    //UFMTR EXEC UFMTR,CORE=256K,
     //           LIB='URD79.PROGLIB',
2    //        J1='DSN=UMTA.HBW.TRIPS,VOL=SER=UMTA3',
     //           UNITJ1='3330-1',
3    //        J2='DSN=UMTA.LOCAL.HBW.TRIPS,VOL=SER=UMTA3',
     //           UNITJ2='3330-1',
4    //        J3='DSN=UMTA.LOCAL.SKIMS,VOL=SER=UMTA3',
     //           UNITJ3='3330-1',
     //UFMTR.SYSIN DD*
     UFMTR RUN TO PLOT UTPP VS. LOCAL TRIP LENGTHS
5    &PARAM ZONES=265,TABLES=101,201        &END
6    &SELECT REPORT=3        &END
7    &PLOT PAIR=301,101,201,FREQ=T        &END
     /*
```

Line Reference	Explanation
1	CALLS UTPS PROGRAM UFMTR
2	INPUT CENSUS HBW TRIPS
3	INPUT LOCAL MODEL HBW TRIPS
4	INPUT TRAVEL TIME SKIMS
5	DECLARES ZONES AS 265 AND TELLS PROGRAM TO REPORT ON TABLES 101 AND 201 IN PRODUCED REPORTS
6	SELECTS TRIP END SUMMARY REPORT
7	CALLS A COMPARISON FREQUENCY PLOT OF TABLES 101 AND 201 AGAINST SKIM VALUES IN TABLE 301

FIGURE 10 UFMTR setup to produce trip length comparison plots of census and local trips.

```
1    //AGM EXEC AGM,CORE=320K,
     //         LIB='URD81.PROGLIB',
2    //       J1='DSN=UMTA.LOCAL.SKIMS,VOL=SER=UMTA3',
     //         UNITJ1='3330-1',
3    //       J2='DSN=UMTA.HBW.TRIPS,VOL=SER=UMTA3',
     //         UNITJ2='3330-1',
4    //       J9='DSN=UMTA.EST.TRIPS,VOL=SER=UMTA3',
     //         UNITJ9='3330-1',SPACE=(TRK,(10,2),RLSE)
5    //       F='DSN=UMTA.FFACTOR,VOL=SER=UMTA3',UNITF=3330-1
     //AGM.SYSIN DD *
     AGM RUN IN AC TO CALIBRATE CENSUS BASED GRAVITY MODEL
6     &PARAM TABOUT=1,AITER=3,SKIMS=101,TABLES=201,
         ZONES=265     &END
7     &OPTION AC=T      &END
8     &SELECT REPORT=5,8     &END
     /*
```

Line Reference	Explanation
1	CALLS UTPS PROGRAM AGM
2	INPUT TRAVEL TIME SKIMS
3	INPUT CENSUS TRIP TABLE
4	OUTPUT NEWLY ESTIMATED TRIPTABLE
5	INPUT FRICTION FACTORS
6	STATES THAT 1 TABLE IS OUTPUT; USE 3 ITERATIONS IN GRAVITY MODEL APPLICATIONS; SKIMS CAN BE FOUND IN TABLES 101, INPUT TRIP TABLE TO BE USED FOR COMPARISON PURPOSES AND FOR DERIVING PRODUCTIONS AND ATTRACTIONS IS TABLE 201; 265 ZONES
7	REQUESTS APPLICATION/COMPARISON OPTION
8	REQUESTS REPORTS 5 AND 8

FIGURE 11   AGM calibration run.

```
1    //USQUEX EXEC USQUEX,CORE=320K,
     //         LIB='URD81.PROGLIB',
2    //       J1='DSN=UMTA.HBW.TRIPS,VOL=SER=UMTA3',
     //         UNITJ1='3330-1',
3    //       J2='DSN=UMTA.EST.TRIPS,VOL=SER=UMTA3',
     //         UNITJ2='3330-1',
4    //       J9='DSN=UMTA.SQUEEZ.TRIPS,VOL=SER=UMTA3',
     //         UNITJ9='3330-1,SPACE=(TRK,(20,2),RLSE)'
     //USQUEX.SYSIN DD *
     RUN TO SQUEEZE ZONES TO DISTRICTS TO COMPARE MAJOR MOVEMENTS
5     &PARAM ZONES=265,DISTS=8,TABLES=101,201     &END
6     &OPTION SQUEEZE=T     &END
7     &SELECT PRINT=1,-8,REPORT=4     &END
8     &EQUIV DIST=1,Z=1,-83     &END
      &EQUIV DIST=2,Z=84,-95     &END
      &EQUIV DIST=3,Z=96,-107     &END
      &EQUIV DIST=4,Z=108,-110     &END
      &EQUIV DIST=5,Z=111,-186     &END
      &EQUIV DIST=6,Z=187,-193     &END
      &EQUIV DIST=7,Z=194,-230     &END
      &EQUIV DIST=8,Z=231,-265     &END
     /*
```

| Line Reference	Explanation
1	CALL UTPS PROGRAM USQUEX
2	INPUT CENSUS HBW PERSON TRIPS
3	INPUT NEWLY ESTIMATED HBW PERSON TRIPS
4	OUTPUT ESTIMATED TRIPS AT DISTRICT LEVEL
5	ZONES EQUALS 265; 8 DISTRICTS ARE TO BE USED; INPUT TABLES ARE 101 AND 201
6	CALLS SQUEEZING OPTION
7	REQUEST MATRIX ROW REPORT FOR ALL ROWS IN OUTPUT TABLES
8	EQUIVALENCY CARDS WHICH TELL THE PROGRAM THE ZONE-DISTRICT CORRESPONDENCE

FIGURE 12   USQUEX run to squeeze zones to districts.
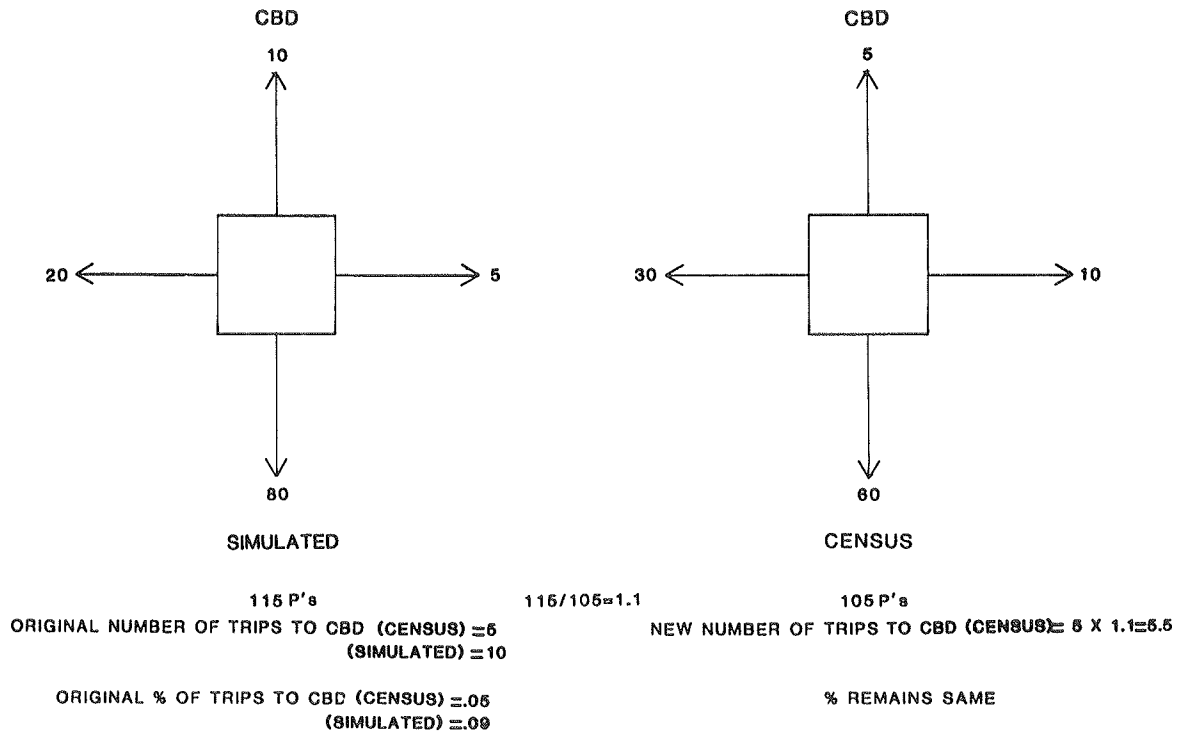
FIGURE 13 Normalization of productions.

tified errors. Once these factors have been created, the gravity model is rerun and F-factors and K-factors are adjusted until both trip lengths and major movements are found to reasonably match the census-derived data.

If the locally modeled trip lengths and the census trip lengths had matched closely, the user would still check the major movements as described earlier. In this case, however, one of the two trip tables must be adjusted so that the trips produced by each district will be the same in both tables. This may be done by running UTPS program UMATRIX to normalize the values in each row of one table so

that they sum to the corresponding zonal productions in the other table. An example is shown in Figures 13 and 14, where the values in the census trip table are normalized to the productions in the local simulated trip table. Once the census trip table has been normalized, both trip tables would be collapsed into districts or some other geographic area, using UTPS program USQUEX to check the major movements. If they are found to be reasonable, the process would be complete. If they are found to be unreasonable, K-factors could be developed. If the user decided to calibrate K-factors, they would be input to AGM and the gravity model would be recalibrated.

```
1    //UMATRIX EXEC UMATRIX,CORE=320K,
     //          LIB='URD81.PROGLIB',
2    //          J1='DSN=UMTA.HBW.TRIPS,VOL=SER=UMTA3',
     //          UNITJ1='3330-1',
3    //          J2='DSN=UMTA.LOCAL.HBW.TRIPS,VOL=SER=UMTA3',
     //          UNITJ2='3330-1',
4    //          J9='DSN=UMTA.NORMAL.HBW.TRIPS,VOL=SER=UMTA3',
     //          UNITJ9='3330-1,SPACE=(TRK,(10,1)RLSE)'
     //UMATRIX.SYSIN DD *
     RUN TO NORMALIZE TO SIMULATED PRODUCTIONS
5     &PARAM SIZE=265,
        J901='J101*(ROWSUM(J201)/ROWSUM(J101))'      &END
     /*
```

Line Reference	Explanation
1	CALL UTPS PROGRAM UMATRIX
2	INPUT CENSUS PERSON TRIPS
3	INPUT LOCAL PERSON TRIPS
3	OUTPUT NORMALIZED PERSON TRIPS
4	ZONES EQUAL 265; FILL TEMPORARY MATRIX WITH ROW SUMMED VALUES IN TABLE 101; FILL TEMPORARY MATRIX WITH ROW SUMMED VALUES IN TABLE 201; FILL TEMPORARY MATRIX WITH NORMALIZING FACTORS; MULTIPLY CENSUS TRIP TABLES BY FACTOR AND OUTPUT AS NEW TRIP MATRIX

FIGURE 14 UMATRIX run to normalize trip tables.

It should be noted that a local simulated trip table is produced by applying a gravity model to simulated productions and attractions (from a trip generation model). The census-derived trip table will have a somewhat different allocation of productions and attractions. A gravity model calibrated to match the trip length frequency distribution from the census-derived trip table should not be expected to produce exactly the same distribution when applied to simulated productions and attractions. The foregoing discussion assumes, however, that the two allocations of productions and attractions are similar enough (on an aggregated level) that a gravity model calibrated to the census-derived data can be used on the simulated data. Similarly, it is assumed that if the existing locally calibrated gravity model produces a simulated trip table that matches the census-derived trip length frequency distribution and major movements reasonably well, the existing gravity model may be accepted as valid.

Mode Choice

Using UTPP data, planners can develop mode-choice models or verify existing locally developed mode-choice models. The UTPP journey-to-work data may be used to build HBW trip tables by mode by running MBUILD and then factoring the tables using UMATRIX. This procedure was described earlier. Once the tables have been built and factored, the user can determine regional mode shares and mode shares at the zonal level using UMATRIX. Through the addition of a preliminary run of USQUEX, mode shares at the district and major movement (district interchange) level may be developed. These mode shares may then be compared with mode shares estimated by a locally calibrated mode-choice model applied to spring 1979 conditions.

Another interesting section of UTPP data applicable to mode-choice analysis is the travel-time values reported by mode. The time values contained in the UTPP are the values perceived by travelers. The user can review the travel-time information in two ways: either run the print program to obtain Table 4 from Part II of the UTPP or develop trip-length frequency plots using UFMTR and build mode-specific skim matrices and trip tables through the use of MBUILD.

Mode-choice models of two types can be developed: A predistribution or trip-end model or a post-distribution interchange model. Information is present in the UTPP that describes trip-end data at both the production and the attraction ends. HBW person trip tables by mode can be developed as described previously. The user can then supply his own highway and transit networks to construct travel-time skims and supply additional trip-end data such as parking cost. As a result, the user would have all of the data needed to calibrate an interchange model. A flow chart describing this process is shown in Figure 15.

A simpler mode-choice method, one often used by smaller urban areas, is the predistribution trip-end or direct generation model. This type of model is much easier and less costly to develop because it does not require any network-based information.

Using the UTPP trip-end data along with transit availability information, the user can develop a transit trip relationship by using automobiles per dwelling unit and income. This is but one example of using the UTPP in a direct generation model. Additional cross tabulations are available in the UTPP data or could be developed. A listing of UTPP tables that contain mode-choice data is given as follows:

Traffic Assignment

Part IV of the UTPP contains mode-specific journey-to-work trip information. As was discussed earlier, the user can build a series of mode-specific HBW trip tables. This information can then be assigned directly to an urban area's highway and transit networks as an aid in locating park-and-ride lots, analyzing bus routing and circulation, evaluating high-occupancy-vehicle lanes, and analyzing selected links. Any analysis conducted on the results of such an application must take into account the sample size (8 percent) and the tendency of the trip table to be "lumpy" (contain many zero values). With these limitations in mind, the user should restrict his use of the data to the analysis of large area-to-area movements and of links carrying high traffic volumes, where significant amounts of travel can accumulate.

CONCLUDING NOTES

It can be readily seen that there are a variety of functions that can be handled using UTPS in conjunction with the UTPP data. In this paper an attempt has been made to clarify the procedures used to access the information, transfer it into a variety of file structures, and to show some sample applications. This paper has been extremely limited, how-
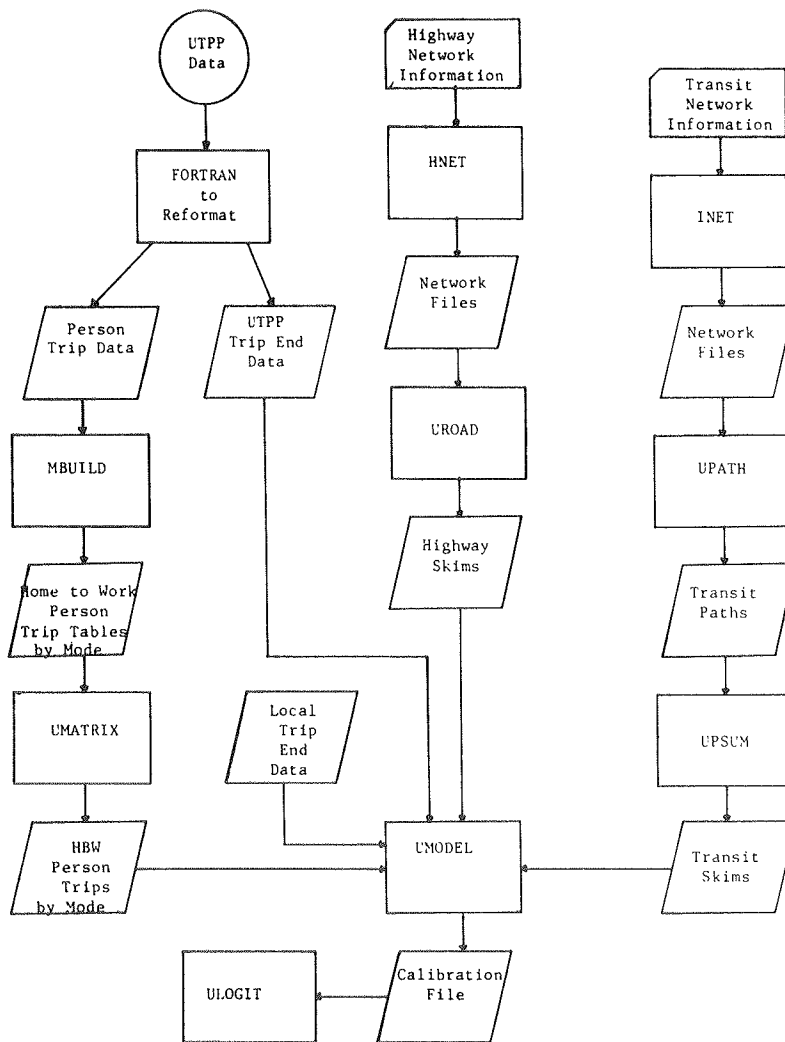
FIGURE 15 Using UTPP data in the calibration of an aggregate logit mode-choice model.

ever, in that only a few examples have been presented. The user should not take these examples as the only possible applications of the UTPP. The UTPP data can be used in any number of ways, subject to the needs and imagination of the user.

material in this paper were previously developed for FHWA under the supervision of William Martin and for the Transportation Systems Center under the supervision of Walter Maling.

REFERENCE

1. Quick Response Urban Travel Estimation Techniques and Transferable Parameters: User's Guide. NCHRP Report 187. TRB, National Research Council, Washington, D.C., 1978.