Commuter Information System: A New Ride-Sharing Tool

Lawrence Glazer, William Courington, Daniel Barnett, and Samuel Ross, Crain and Associates, Menlo Park, California
Robert Redmond and Perry Davison, Federal Highway Administration, U.S. Department of Transportation

The Commuter Information System is a new package of computer programs, for use by local agencies or organizations, that provides ride-sharing information to commuters on an individual basis. The system includes three functional components: (a) a state-of-the-art car-pool matching program; (b) a bus-pool and van-pool planning program; and (c) a transit information system that informs applicants of transit routes that can serve their commuting needs. Because the system is modular, any component can be used independently, and because it is highly user oriented, it is applicable to a wide range of local situations. All programs were written in COBOL. The development effort was based on a nationwide survey of major ride-sharing efforts. Before the system was distributed, the city of Dallas tested and evaluated the entire package using live data. The Commuter Information System is being distributed by the Federal Highway Administration. It is intended to be a standardized data-processing tool for ride-sharing agencies as the Urban Transportation Planning System is for transportation planning agencies. It is applicable to transportation system management projects, U.S. Environmental Protection Agency regulations, and energy conservation efforts.

The Commuter Information System (CIS) is a package of computer programs that were developed in 1975 and 1976 as a compatible successor to the Federal Highway Administration (FHWA) car-pool matching program. In designing the new system, the users of the FHWA program as well as the users of other programs were surveyed to determine their needs and capabilities. The CIS design reflects the results of the survey: It satisfies the identified needs of most users without overtaxing their resources. The design also incorporates most of the desirable features of the many car-pool programs that preceded it.

In general, CIS is designed to support local efforts to increase vehicle occupancy rates during peak-period commuting hours. This is done primarily by encouraging ride sharing (car pooling, transit, and van pooling) as an alternative to the 1 person/automobile syndrome that has been predominant in commuter transportation for many years.

The scope of the system is limited to providing information that is helpful to the local ride-sharing project and to the members of the community that it serves. Figure 1 shows the fundamental activities involved in using CIS to supply commuters with ride-sharing information. A commuter who desires such information fills out an application form and forwards it to the local ride-sharing agency. Applications vary somewhat depending on local circumstances; a typical application is shown in Figure 2.

The application data are keypunched onto cards for processing by the CIS computer programs. The result of this processing can be a car-pool match list, a transit trip list, or both. These printouts are returned to the applicant who can use them to join an existing car pool, to form a new car pool, or to ride the transit system to work.

Activities related to the use of CIS, which are shown on the right side of Figure 1, are necessary to a successful ride-sharing effort but they are not sufficient. The crucial items are those that help to motivate commuters to fill out the application and then to use the information that the system provides, but such incentives and disincentives are beyond the scope of CIS.

GRID SYSTEM

The ability of CIS to produce car-pool and transit information for applicants depends on the computer's "knowing" the geographic locations of applicants' trip origins and destinations, usually their homes and places of employment. This is necessary in car-pool matching in order to group people who both live and work near each other. Similarly, to provide transit information CIS must know which transit routes are near the origin and destination points of the applicant's trip. In other words, some sort of meaningful geographic code must be assigned to each applicant's home and work locations and to transit routes. The process of determining the correct location code and assigning it to the applicant and to transit records is known as geocoding.

The geographic coding system used in CIS is a grid system characterized by a uniform numbered grid overlaid on a map of the region served by the ride-sharing project. An example of such a grid map is shown in Figure 3. Every location in the region must fall into one of the squares or cells of the grid. These cells are typically 0.8 to 3.2 km (0.5 to 2 miles) on a side. Each cell is uniquely identified by a number formed from the cell's column (x-axis position) and row (y-axis position) numbers. For example, the cross-hatched square in Figure 3 has the cell number 009-004.

Every applicant record is geocoded before it is entered into the system; that is, the cells containing the home and work locations (called the home cell and the work cell) are determined and made a part of the applicant record. Applicant records can be geocoded manually by using a grid map or automatically by using computer programs such as the ADMATCH program of the U.S. Bureau of the Census. Transit routes must be map-geocoded.

Geocoding applicants and transit routes in this manner allows the CIS computer programs to match applicants who live and work close to each other as well as to pick out transit routes that are near the applicant's home and work locations.

The geocoding system also makes it easy for CIS to produce density matrixes for use in planning bus-pool and van-pool routes. A density matrix (Figure 4) is essentially a schematic map of a region in terms of grid-cell population and shows the distribution of origins for all commuters with a common destination. Areas that show high concentrations may be promising for bus-pool or van-pool routes. The density matrix can also be used for evaluating scheduled bus service.

GENERAL CHARACTERISTICS OF COMMUTER INFORMATION SYSTEM

CIS consists of three major components:

1. A car-pool matching system that contains many (optional) sophisticated features;
2. A bus-pool and van-pool planning system based largely on the density matrix; and

Figure 1. CIS activities.

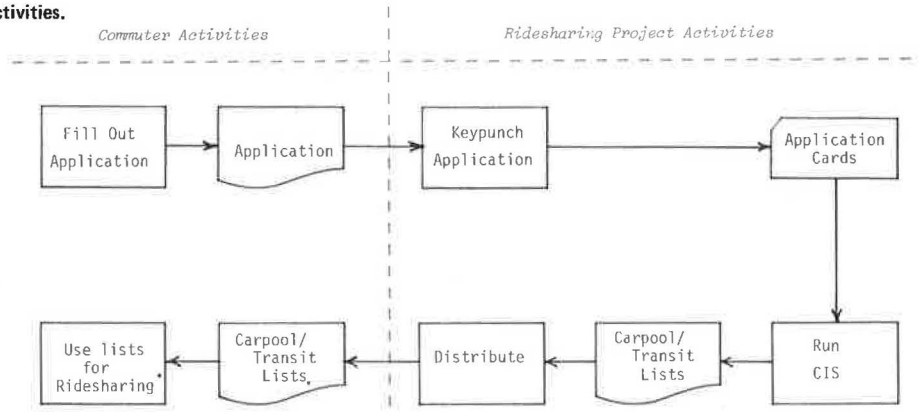


Figure 2. Typical CIS application form.

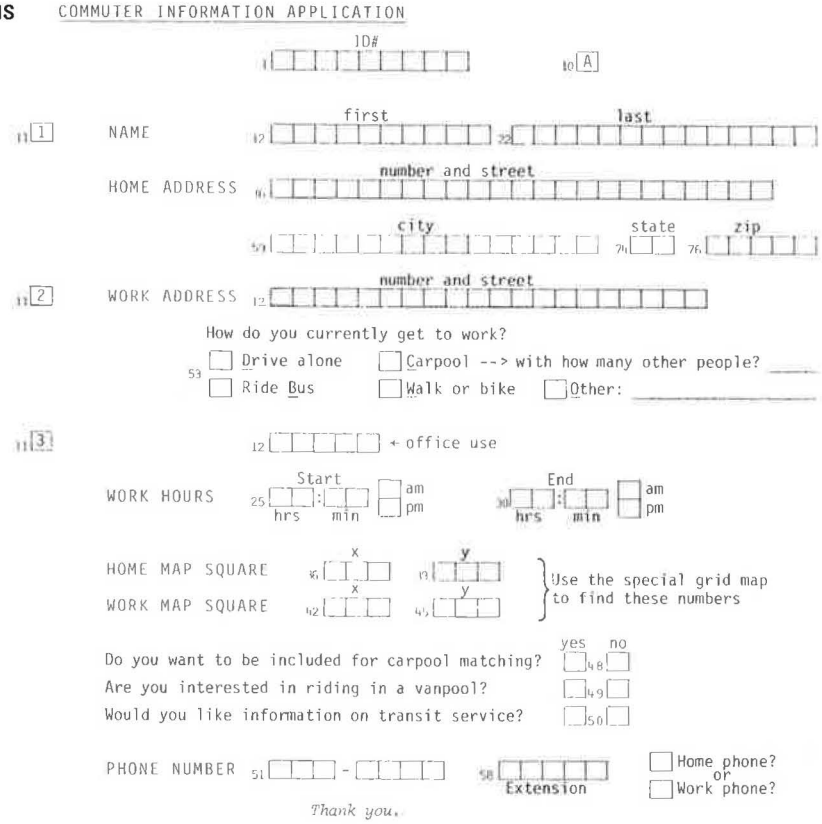
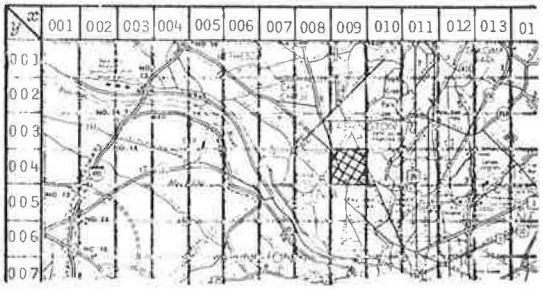


Figure 3. Portion of grid map.



3. A transit information system that informs commuters about the transit routes that serve their commuting needs.

CIS is highly modular. The user can select a basic car-pool matching package with relatively simple operating characteristics or a configuration with more extensive capabilities, depending on local objectives and resources. The transit information system can also be used without the car-pool matching program. CIS is fully compatible with existing data bases that are in the standard geocoding and file format of the FHWA car-pool matching program, the predecessor to CIS.

The package is programmed in COBOL according to the 1974 standard (full implementation) of the American National Standards Institute. It is intended to be operable on most medium-scale computers regardless of manufacture.

DESCRIPTION OF PROGRAMS

The eight computer programs that make up CIS can be divided into the following two groups:

1. The routine processing programs, which include

Figure 4. Numeric density matrix.

COMMUTER INFORMATION SYSTEM
NUMERIC DENSITY MATRIX

DATE: 12/ 7/76 REQUEST # 00

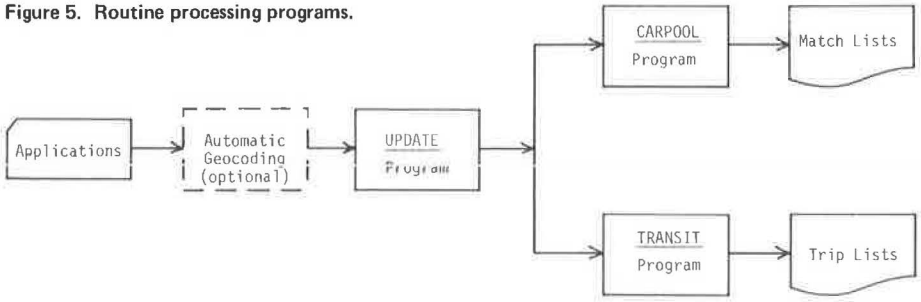
NUMBER OF PEOPLE PER HOME GRID CELL, ACCORDING TO THE FOLLOWING CRITERIA:

START TIME RANGE: 12:00AM -11:59PM
END TIME RANGE: 12:00AM -11:59PM

NUMERIC DISPLAY OF DALLAS MASTER FILE
ALL WORK CELLS AND ALL TIME RANGES HAVE BEEN COMBINED INTO ONE MATRIX.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
0																																		
		1		1								1													5		36	324	18	3	1	2		2	
2																		1			1			1		4	16		1					
													1			1						2		1				1		1	4	6	2	5
4														2								1								10	26	2		
														1									1	1	7	5		3	2	14	27	1	1
6				2	2				1					1	1	1	2	3	1	3		2	2		1	2	24	15	34	27	2		
													1					1			2	2		5	9	1	7	69	43	15	1		
8													1	1		1		2		4	5			3	2		1	48	113	15	16		
												1	1					1			32	5	2	1				35	85	52	32		
10											1		3							4	8	3	1	3		1		15	52	149	93		
																1							2	1		1	11	94	119	74		
12												1	3					4	1	3				7	1	3	5	60	106	75		
										3				1		3	3	1	3				6	4	2	1	2	39	160	123		
14				1					1	2	1				4	2		2		2	5	2	2	11	1	2	34	52	19	1	1	56	47	35
		1													2	1	7	3	2	20	7	6	20	49	2	5	92	217	135	15	1	1	40	27
16		1				1								1	2	1	7	4	23	26	32	14	28	99	3	8	29	91	86	76	11	4	14	58
		1			1	2					1			8	10		12	9	24	33	12	10	1	3		5	24	101	78	36	12	7	10	14
18							2		2	1	1		2	3	3	2	3	1	2		1		1	1	1	5	34	158	128	81	2	2	14	4
								3	4	4	1	5	1	4	1	1	1	2	1				1	2	3	1	5	36	23	14	58	44	83	37
20		1	2	1		2	9	3				2	3			1		1	3	1		5	29	13	9	14	9	5	43	7	17	9	17	26
		1	1	1	1	1	3	3	6	2		1			11	6	10	5	1		3	50	28	55	10	61	73	91	41	36	6	101	201	16
22			1	4	3	5	1	2	2		2	1	1	3	4	3	12	15	14	2	18	63	90	47	23	58	117	35	39	51	171	221	85	196
		5	6	1		12	4	8	4	3	4	3	2	4	6	8	4	7	1	2	30	61	121	141	42	26	97	29	2	24	66	163	159	199
24		5	2	5	7	2	2	1	7	3	7		2	1	6	1	2	1	2	11	29	81	130	90	62	20	155	33	1	13	172	185	144	213
			1	1	3	2		2	7	4	4	3	3	3	7		3	1	3	15	6	47	39	67	8	4	130	29	2	29	111	187	220	200
26		3			1		1	6	1	2	5	3		2	2		1	4	6		5	11	33	10	7	6	13	1	2	2	32	20	67	283
				2	1			4	8	4	1	1	1	3	13	3	1	3	4	2	2	8	2	5	3	5	2	4	9	64	72	20	48	108
28			1					19	3	3	2	1	3	1	3	2	1	2	1	3	3	5	1		4	1	12	8	28	197	136	9	35	76
							4	2	1		4	1	4	2	1	1	1		1		1	3	1			4	3	2	8	50	83	7	6	3
30								1			1		2	4						1	1	2	2	3	3	6	1		8	22	15		13	13
												1	2	1	1					3		1	3	4	5	1		1	6	3	5	2	45	97
32								1			1	1	1	3		1	1					2	6	1		1		1	17	10	5	12	44	66
										4		1					1					2	3	3	4	3	4	5	29	15	3	4	27	53
34												1			1			2			1	4	1	4	3	2	6	36	11	3	1	4	7	11
		1									1	19	1			2	1	4	1	1	2	9	9	1	1	5	4	75	3	5	4	19	3	3

Figure 5. Routine processing programs.



those for file update, car-pool matching, and transit information; and

2. The special processing programs, which include those that produce density matrixes, master lists, and miscellaneous lists and also build files.

Routine Processing Programs

Figure 5 shows that the automatic geocoding capability is an optional "front end" that must be locally supplied. This approach permits the use of most of the numerous automatic geocoding systems currently in use. The output of automatic geocoding must include x-y coordinates, which the UPDATE program translates into map squares (grid cells). The design also permits a mixture of automatic and manual geocoding within a local installation.

For those who do not choose to implement automatic geocoding, the map grid-cell numbers are coded on the application forms, which are keypunched and input to the UPDATE program. This program edits all incoming data and makes additions, changes, and deletions to the (indexed) master file, which can be permanently stored on a disk pack if desired. All updates require punching only the field to be changed and not the entire record.

The CARPOOL program, which produces match lists, includes a home-end search, a work-end search, a route-to-work search, and an extended time search. The extent of these searches is controlled by the user, depending on available computer time. The cost per match list is relatively independent of the number of applications processed, which makes feasible frequent, even daily, runs. The user can also define additional

matching parameters, to a limited degree, by using control cards. Flexible work hours are supported. Each match is ranked by "quality," and the best matches are printed at the top of the match lists. The user can limit the lists to a specified number of names—the best available matches. For those applicants who receive poor lists, the program can automatically generate a new match list if more matches become available at a later date. This option is also controllable by the user.

The match lists are simpler in appearance and thus more readable than in previous systems (Figure 6). The format of the match lists permits total machine handling and mailing, if that is desired. All match lists destined for employers are grouped by employer number; within each employer group they are ordered in an employer-determined sequence (e.g., department number) to facilitate in-house distribution. All match lists from the general public are sorted by zip code to take advantage of bulk mail rates. The standard format includes a "turnaround" document that can be returned to the ride-sharing agency when applicant data change, simplifying updating. Match lists can be produced on command for specified employers, work cells, or individuals.

The TRANSIT program informs applicants of the transit routes that serve their particular commuting needs. This capability is intended to supplement, not replace, existing information services. The telephone information services and the normal promotional and public-relations activities currently performed by transit agencies will still be needed. Figure 7 shows the TRANSIT printout—the trip list—which includes the transit agency name; the route number, the name, and the frequency of the service; and approximately where to board, where to transfer, and where to alight. A maximum of two transfers is permitted for each direction of the commute trip. The system is multimodal, and special service such as express buses and park-and-ride can be handled in most cases as well. The printout includes up to three routings for each direction of the commute trip. These will generally be the "best" three unless there are a large number of very similar alternatives.

Although TRANSIT is a first-generation system for which there are few precedents, it handles most of the wide range of configurations and circumstances that exist in transit operations today. Certainly, a more comprehensive system is possible, but a high level of transit information is provided for the relatively limited resources required by the user in assembling and maintaining the data base.

CIS allows a maximum of 999 grid cells on each axis. This is primarily intended to permit the use of a "fine" map-grid system with uniform squares in the range of 0.3 to 0.6 km (0.25 to 0.5 mile) on a side. (The extensive search routines eliminate the need for multidensity map grids.) The fine grid provides two major benefits: (a) better distance resolution for improving the quality of car-pool matching and (b) less ambiguity in identifying the closest transit routes for each applicant. On the other hand, the fine grid may have some drawbacks, such as printing of new maps and changeover problems. For these reasons, use of the fine grid is optional, although highly desirable. All regular grid systems used in the FHWA car-pool matching program will work under CIS, but the benefits of the fine grid may not be realized. For those who do wish to change over, all data from the FHWA program are compatible and can be converted automatically by a program included in the CIS package.

Special Processing Programs

The CIS special processing programs provide the capability to purge old records, print two kinds of master lists, print two types of density matrixes, and do file building such as converting the existing data base into the new master file format used by CIS. Except for the conversion program, which is run only once, these programs are typically run on an as-needed basis. Three of these programs are shown in Figure 8.

The SELECT program is a powerful tool that allows the user to extract copies of records from the master file on the basis of a wide range of parameters. The selected records are in a standard format that permits them to be input to almost every other program in CIS for processing. For example, all records for a certain employer can be selected and run into CARPOOL for production of new match lists, or all records from a given geographic (home) area can be selected and processed by TRANSIT to inform residents of a new express bus service. Retrieval can be done on the basis of almost every field within the master file record, in almost any logical combination.

In producing density matrixes, the SELECT program is first used to extract all records with a specified work cell (or cells). These records are then used by the DENSITY program to print density matrixes on the basis of user-specified time intervals (begin time, end time, or both). A major new feature is the optional "shaded" density matrix (Figure 9), which greatly reduces the size of the printout to eliminate "cutting and pasting."

Van-pool planning with CIS is a three-step process: shaded density matrix, numeric density matrix, and letters. The shaded density matrixes are used as a first screening step and are followed by a smaller numeric density matrix to focus in on the promising areas that were found on the shaded matrix. After a tentative van-pool or bus-pool route has been identified from the numeric density matrix, the third step is to notify potential candidates by selecting their records from the master file by work cell(s) and work time(s). These records are then used by the PRINT program to generate personalized letters describing the new service or to produce mail labels for use with form letters.

By using the PRINT program, a listing of the master file in order of work cells can be produced for reference purposes and manual car-pool matching. To expedite manual searching using the master list, the DENSITY program can be used to print a shaded density matrix that corresponds to every work cell in the master list. This can greatly facilitate manual route-to-work searches, for example.

Selective purging of the master file can also be done. Because the last transaction date is automatically kept in the master file, old records can be selected and used by the PRINT program to punch out delete cards, which are read back into the UPDATE program on the next processing cycle. As an additional refinement, the PRINT program can be used to print letters that ask all candidates for deletion if they want to remain on file. Depending on the wishes of the user agency, CIS can then be used to automatically delete all nonrespondents automatically or to delete only those respondents who specifically request it.

The CONVERT program is provided for automatic conversion of existing files of the FHWA car-pool matching program into the new CIS format. Files that use a nonuniform grid system or are not in the standard FHWA format may require special handling or programming by the user. A special program, TRANLOAD, is also included to build the files that describe the local transit

Figure 6. Match list.

```
                                  COMMUTER INFORMATION SERVICE
000027420,YYY,00                OFFICE OF TRANSPORTATION PROGRAMS
022,022/037,018                    CITY OF DALLAS                          EMPLOYER: 0    0
RUN DATE: 12/20/76                                                        LOCATION:

     PERRY      SANDERS
                                                 WORK HOURS        PHONE NUMBER       SMK DRV  WORK ADDRESS
     27420 FIRST AVENUE
                                                 8:00AM- 4:30PM    002-7420 WORK             X  992 RICHARDS LANE
     FALLS CHURCH    VA 22000

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - CUT HERE - - - - - - - - - - - - - - - - - - - - - - - - -

   THE FOLLOWING PEOPLE LIVE AND WORK NEAR YOU.   THE BETTER MATCHES ARE LISTED FIRST.

    NAME                    HOME ADDRESS          WORK HOURS   PHONE NUMBER       SMK DRV  WORK ADDRESS

JAMES       SMITH       17193 MAIN STREET        8:00- 4:30   001-7193 WORK           X    55 PLAZA SQUARE
BILL        MILLER      21961 FIRST AVENUE       8:00- 4:30   002-1961 WORK     X     X    51 PLAZA SQUARE
BOB         MAY         35026 WASHINGTON LANE    7:50- 4:30   002-5026 WORK     X     X    525 HILL STREET
WAYNE       REED        22632 MAIN STREET        7:40- 4:30   002-2632 WORK           X    751 HILL STREET
JANE        MILLS       23699 SECOND AVENUE      7:30- 4:30   002-3699 WORK           X    55 PLAZA SQUARE
RUTH        WHITE       17012 MAIN STREET        8:00- 5:00   001-7012 WORK                91 KING ROAD
RALPH       HINES       08162 ROBIN LANE         8:00- 5:00   000-8162 WORK           X    992 RICHARDS AVENUE
JOHN        WEST                                 8:00- 4:45   002-9858 WORK     X     X    92 LEE LANE
ALICE       JONES       35901 SOUTH ROAD         8:00- 5:00   003-5801 WORK                47 PLAZA SQUARE
RITA        HOFFMAN     11907 ROBIN LANE         8:00- 5:00   001-1907 WORK           X    45 PLAZA SQUARE
SUE         JOHNSON     34827 SOUTH ROAD         7:45- 5:00   003-4827 WORK     X     X    93 KING ROAD
JOE         PARKS       13644 ROBIN LANE         7:30- 5:00   001-3644 WORK                114 QUEENS STREET


    1. THIS IS A LISTING OF OTHERS WHO LIVE IN YOUR NEIGHBORHOOD
       (OR NEAR YOUR ROUTE TO WORK) AND ARE INTERESTED IN CARPOOLING.
       IF YOU DO NOT WISH TO CARPOOL NOW, SAVE THIS LIST FOR FUTURE
       REFERENCE.

    2. AN "X" IN COLUMN "SMK" MEANS THAT PERSON SMOKES.
       AN 'X' IN COLUMN 'DRV' MEANS THAT PERSON WILL DRIVE
       HIS CAR.  THE PERSON'S WORK ADDRESS IS PRINTED IF IT IS KNOWN.

    3. IF YOU HAVE RECEIVED ANY INCORRECT OR OBSOLETE INFORMATION, OR
       YOUR INFORMATION CHANGES, PLEASE CONTACT US SO WE MAY UPDATE OUR
       RECORDS.  MARKING THE CHANGED INFORMATION ON THE UPPER PORTION
       OF THIS LIST AND RETURNING IT TO US WILL ENABLE US TO SERVE
       YOU BETTER.
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Figure 7. Trip list.

```
                                  COMMUTER INFORMATION SERVICE                RUN DATE: 04/13/76
000022632,0480,1020             OFFICE OF TRANSPORTATION PROGRAMS             EMPLOYER:      282
192,134/184,143                    CITY OF DALLAS                             LOCATION:

     WAYNE      REED                LISTED BELOW ARE UP TO THREE TRANSIT ROUTES FOR BOTH OF YOUR WORK
                                    COMMUTING TRIPS.  FOR ADDITIONAL INFORMATION CALL DALLAS TRANSIT
     22632 MAIN STREET              SYSTEM, 826-2222, FOR BUS SCHEDULES; OR DALLAS CARPOOL PROGRAM,
                                    741-1354, FOR CARPOOL OR VANPOOL INFORMATION.
     DALLAS          TX 75214

+- - - - - - - H O M E   T O   W O R K - - - - - - -+  +- - - - - - - W O R K   T O   H O M E - - - - - - -+
+                                                  +  +                                                  +
+ BOARD DTS WYNNEWOOD/DOWNTOWN BUS                 +  + BOARD DTS SKILLMAN/DOWNTOWN BUS                   +
+   WHICH RUNS APPROXIMATELY EVERY 10 MINUTES      +  +   WHICH RUNS APPROXIMATELY EVERY 15 MINUTES      +
+   ALONG SKILLMAN/LIVE OAK                        +  +   ALONG BECKLEY                                  +
+ GET OFF ALONG BECKLEY/TWELFTH                    +  + GET OFF ALONG BRYAN/LIVE OAK                     +
+- - - - - - - - - - - - - - - - - - - - - - - - - +  +- - - - - - - - - - - - - - - - - - - - - - - - - +
+                                                  +  +                                                  +
+ BOARD DTS WYNNEWOOD/DOWNTOWN BUS                 +  + BOARD DTS SKILLMAN/DOWNTOWN BUS                   +
+   WHICH RUNS APPROXIMATELY EVERY 10 MINUTES      +  +   WHICH RUNS APPROXIMATELY EVERY 15 MINUTES      +
+   ALONG SKILLMAN/LIVE OAK                        +  +   ALONG BECKLEY                                  +
+ GET OFF ALONG BECKLEY/TWELFTH                    +  + GET OFF ALONG BRYAN/LIVE OAK                     +
+- - - - - - - - - - - - - - - - - - - - - - - - - +  +- - - - - - - - - - - - - - - - - - - - - - - - - +
+                                                  +  +                                                  +
+ BOARD DTS WYNNEWOOD/DOWNTOWN BUS                 +  + BOARD DTS SKILLMAN/N.W. HIGHWAY BUS               +
+   WHICH RUNS APPROXIMATELY EVERY 10 MINUTES      +  +   WHICH RUNS APPROXIMATELY EVERY 15 MINUTES      +
+   ALONG SKILLMAN/LIVE OAK                        +  +   ALONG BECKLEY                                  +
+ TRANSFER AT MAIN & ST PAUL                       +  + GET OFF ALONG BRYAN/LIVE OAK                     +
+   TO DTS BECKLEY BUS                             +  +- - - - - - - - - - - - - - - - - - - - - - - - - +
+   WHICH RUNS APPROXIMATELY EVERY 10 MINUTES      +
+ GET OFF ALONG COMMERCE/BECKLEY                   +
+- - - - - - - - - - - - - - - - - - - - - - - - - +


    THE ABOVE TRANSIT LIST DECREASES IN QUALITY OF SERVICE TO YOU
    FROM TOP TO BOTTOM.  IF ONLY ONE ROUTE SERVES YOUR WORK TRIP, IT MAY
    BE REPEATED.  THE SECOND AND THIRD ROUTES WHILE FEASIBLE MAY NEVER-
    THELESS BE TOTALLY UNDESIRABLE FOR YOUR TRANSIT NEEDS
```

service. CONVERT and TRANLOAD are shown in Figure 10.

OTHER INFORMATION

A highly detailed description of CIS is given in the CIS user's guide, which, in its final form, will eventually be available from the Federal Highway Administration. This document presents highly technical material for the computer staff and, in separate sections, relatively non-technical material for the ride-sharing staff. It will give the potential user a very clear picture of the costs and

Figure 8. Special processing programs.

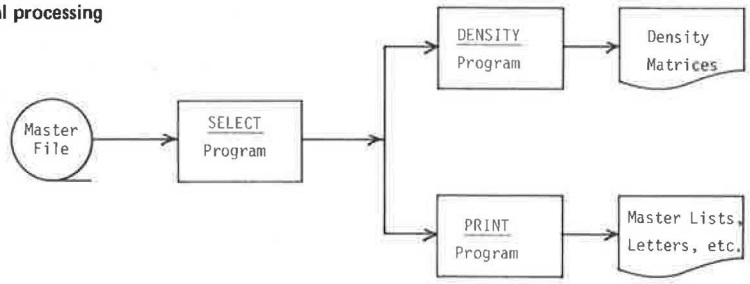


Figure 9. Shaded density matrix.

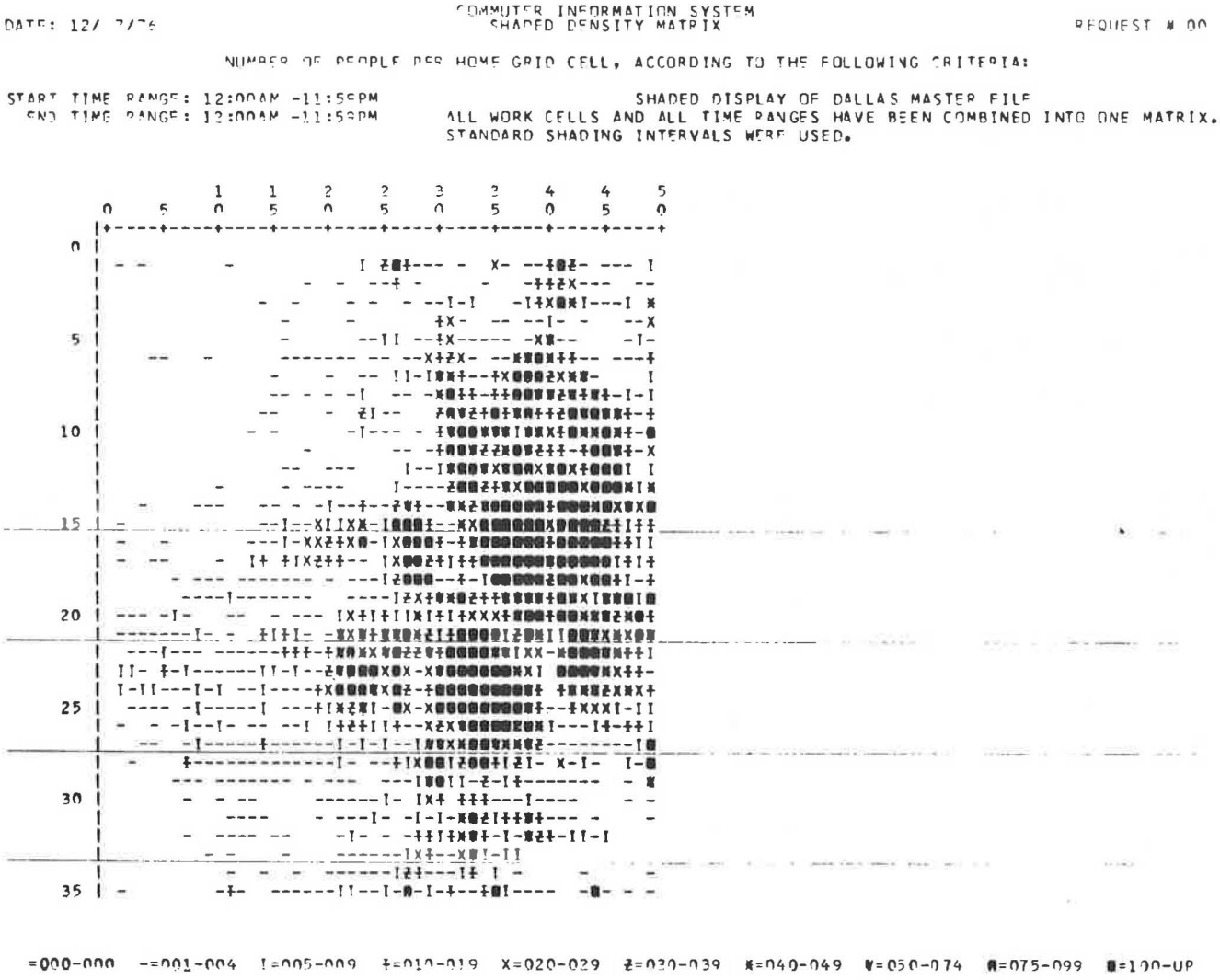
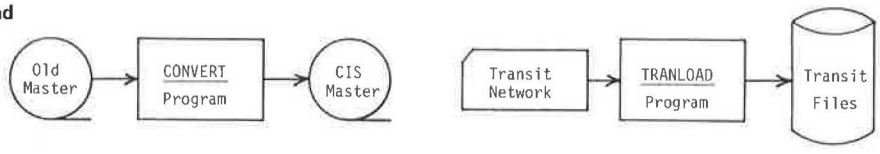


Figure 10. CONVERT and TRANLOAD programs.



benefits of using this new package, which is considerably more complex than the original FHWA car-pool matching program. Ride-sharing agencies contemplating the use of CIS should obtain and carefully study the CIS user's guide before requesting the computer program tape.

SUMMARY AND CONCLUSIONS

The Commuter Information System is a state-of-the-art ride-sharing tool. It includes an advanced car-pool matching capability, an improved van-pool planning package, and a new transit information system to inform commuters of transit routes that can serve their commuting needs.

CIS is highly user oriented because it is modular and has a great number of user-selectable options. Thus, it is applicable to the wide range of local circumstances that were identified in the extensive survey of ride-sharing projects conducted at the beginning of the design effort. The entire package was pilot tested by a typical user agency, the city of Dallas, who felt that the system met their needs and worked well and will voluntarily continue using it. A small number of applicants were also surveyed; they felt that the printouts were easy to understand and that there were no significant errors or omissions.

CIS is distributed and supported by the Federal Highway Administration with the anticipation that it will become a standardized data-processing tool for ride-sharing projects nationwide. These efforts toward increased vehicle occupancy are required in many urban areas by U.S. Environmental Protection Agency regulations. Ride-sharing efforts will also be a major part of transportation system management projects as well as transportation-related energy-conservation efforts.

Providing high-quality information to commuters about their ride-sharing opportunities is "a link in the chain." It is a necessary but not a sufficient condition for making better use of existing transportation facilities by increasing vehicle occupancy.

Impact of Dial-A-Ride on Transportation-Related Energy Consumption in Small Cities

William R. Hershey, Sverdrup and Parcel and Associates, Inc.

Dial-a-ride is a door-to-door public transportation concept similar to taxi service except that passengers share the vehicle (usually a 12 to 20-passenger bus) with other riders. This paper examines energy consumption of dial-a-ride systems in three small Michigan cities. Fuel consumption per effective passenger kilometer (shortest distance between a passenger's origin and destination) is derived from aggregate fuel and ridership data and average trip-length data in the test cities. The analysis also predicts dial-a-ride user behavior and energy consumption in the absence of dial-a-ride. Results show that the introduction of dial-a-ride into test communities in Michigan has caused a net increase in transportation-related fuel consumption. Inducement of new trips, low vehicle occupancies, circuitous routing, poor vehicle fuel economy, and diversion of passengers from more energy-efficient modes are seen to be principal reasons for the significant energy costs of dial-a-ride. The future potential of dial-a-ride is discussed in the context of increasing energy prices, and several methods of reducing its energy intensiveness are presented. Despite the pessimistic estimates presented, energy consumption is only one of many factors that must be considered in determining the feasibility and desirability of dial-a-ride for a particular site.

Dial-a-ride is increasingly suggested as an effective public transportation option for suburban areas. As with any publicly financed venture, local policy makers must carefully weigh the costs and benefits of this popular and rapidly proliferating door-to-door transportation service. Monetary costs are usually thoroughly considered, but energy costs are often ignored. (Throughout this paper, energy cost is intended to mean the quantity of energy consumed and not the monetary cost of energy.) It is important to consider energy in terms other than present dollar costs because future energy prices and availability are highly unpredictable. Energy prices will almost certainly rise faster than such general economic indicators as the wholesale and consumer price indexes.

Other papers have technically assessed dial-a-ride's use of energy, but the news media and the public remain generally misinformed (1, 2). Many people assume that because dial-a-ride is public transportation it is energy efficient. A recent Associated Press release in California (3) stated:

> The aim of Dial-A-Ride is twofold: First, to save fuel by convincing people who normally would drive that they can switch to public transit without inconvenience. Second, to provide transportation for people who don't have a car and don't want to take a taxi.

In typical installations, however, dial-a-ride does not save fuel. On the contrary, the introduction of dial-a-ride into test communities in Michigan has resulted in a net increase in transportation-related fuel consumption. The principal reasons for this are the inducement of trips that would (or could) not have been made without the new service, the low average load factor (number of passengers per vehicle), circuitous routing, poor vehicle fuel economy, and the diversion of passengers from more energy-efficient modes.

This analysis consists of two main parts. The first part is based on empirical data from dial-a-ride operations in three small Michigan cities—Holland, Ludington,