THE GCARS II SYSTEM

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BY

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JHRP

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PURDUE UNIVERSITY AND
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Technical Paper
THE GCARS II SYSTEM

by
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Joint Highway Research Project

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The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

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Technical Paper
THE GCARS II SYSTEM

To: J. F. McLaughlin, Director
Joint Highway Research Project

September 1969

File No: 1-6-1

From: H. L. Michael, Associate Director
Joint Highway Research Project

Project No: C-36-72A

The attached Technical Paper "The GCARS II System" has been prepared by Dr. A. Keith Turner of our staff as part of the research project "Evaluation of Numerical Surface Techniques Applied to Highway Location Analysis."

The GCARS II System was developed as an experimental version of the GCARS System described in earlier Board reports. It utilizes remote teletype terminals and a new terminal support system, PROCYSY, currently being developed by the Purdue Computer Science Center.

Through the use of this system, an engineer with no previous computer experience can begin requesting his own GCARS analyses after only ten minutes of instruction. The GCARS II System was developed for and successfully used during a "Workshop on Computer Applications in Regional Transportation Planning" held at Purdue May 19-21, 1969.

This report is presented to the Board for the record and for review and comment.

Respectfully submitted,

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N O T I C E

These programs have been tested and are believed to be free of errors. If errors are located, the Joint Highway Research Project would appreciate notification.

Send comments to:-

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ABSTRACT

The GCARS II System represents a more advanced, experimental version of the GCARS System. GCARS II utilizes a new teletype support system, termed "PROCSY", which is currently being developed at Purdue.

The use of the teletype terminals allows the engineer to formulate his request for an analysis in a simple natural fashion by answering a series of questions programmed into the system. This "inter-active mode" of job submittal allows an engineer with no previous computer experience to learn to use the GCARS techniques after only ten minutes of instruction.

The GCARS II System was developed for use in a short course held at Purdue in May 1969. The participants successfully utilized the system to request desired analyses. At the present time GCARS II only includes the generation of alternatives phase of the GCARS System and only handles prepared data for two test areas. Expansion of the system could easily be accomplished however through the development of additional PROCSY computer programs.

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The development of the GCARS II System would have been impossible without the assistance and cooperation of the personnel of the Purdue Computer Science Center. The author wishes to express his appreciation to Mr. John Steele, Associate Director, for agreeing to make extra computer time available to this project. The author is also indebted to his wife, Sandra Turner, and Mr. R. M. Paddock who, as Systems Programmers, had primary responsibility for the development of PROCSY. Without their help and encouragement GCARS II, the first operating system to use PROCSY, could not have been developed at this time.

THE GCARS II USERS MANUAL

By

A. Keith Turner

INTRODUCTION

Comparatively few highway engineers have either the time or the inclination to learn the computer programming languages and procedures in common use today. The "high-level" languages such as FORTRAN, COBOL, and ALGOL are much easier to use than the more basic "machine-languages"; however their use still requires considerable training. As a consequence, although many engineers realize the potential role of the computer in their areas of interest, the actual computer usage generally is inhibited by the difficulties encountered.

The problem is essentially one of communication. Many simplified languages have been proposed or developed in recent years to alleviate this problem. With these languages man-machine communications are simplified and utilize, as far as possible, the normal vocabulary of the person formulating the problem. The training problem is thus reduced and the computer becomes a more understandable and "friendlier black-box" capable of undertaking a number of easily formulated commands.

Such systems become especially appealing once conversations or "dialogs" between the man and the machine are built into the system. This is most often accomplished through the use of remote terminals connected to computers on a real-time basis; the monitoring computer is previously programmed to ask a set of questions. By responding to these questions a relative novice can be led step-by-step through the analysis requesting procedure. Such a system is termed "interactive"; and may be quite complex or quite simple, depending on the overall system design.

PURPOSE OF GCARS II

The GCARS System (1,6) was developed to aid location engineers in discovering optimal highway location alternatives in terms of selected highway location factors alone or in combinations. Its chief advantage lay in its ability to economically and rapidly generate a series of alternatives for each of a large number of factor combinations. If this objective was to be readily realized, some means of making the computer accessible and understandable to the average location engineer was desirable.

In response to this objective a modified version of the GCARS System termed GCARS II has been developed to provide a more convenient method of requesting and utilizing the GCARS System. The system is entirely experimental and utilizes certain computer configurations (the PROCSY System) which are unique to Purdue University. Thus, unlike the GCARS System which can be utilized with minor modifications on a variety of computers, the GCARS II System represents a specialized use and is machine-dependent. The GCARS II System allows an engineer unfamiliar with any computer programming languages to request and utilize that portion of the GCARS System which generates a series of alternatives. Control parameters are entered at a remote teletype terminal in response to specific requests for them initiated by the controlling computer programs. Results of the analyses are returned to the terminal.

THE PROCSY CONCEPT

Purdue University is currently developing a system to connect the regional campuses, many smaller colleges, and some high schools throughout Indiana to the central computer facility at the Lafayette Campus. The System is called the "Purdue Remote Online Computing System", or PROCSY

for short. PROCSY is now in its final testing stages and the GCARS II System as presently developed represents one of its first applications.

PROCSY is a remote terminal support system which supplies jobs to the CDC 6500 computer located at the Purdue University Computer Sciences Center. It allows remote creation, submission and retrieval of jobs which are executed as part of the normal batch job load on the CDC 6500 central computer. The IBM 7094 computer is also utilized by PROCSY to supervise the terminal operations.

In addition to preparing and retrieving jobs, the remote terminal user may create, edit, and store his own files. These may contain large data arrays or long programs which would be impractical to enter through the slow teletype terminals each time they are required. File creation and editing is performed in an interactive mode utilizing the IBM 7094 computer, whereas job execution is performed in a batch or non-interactive mode on the CDC 6500 computer. As far as the CDC 6500 computer is concerned, jobs submitted from the terminals are indistinguishable from locally submitted jobs (although they are given a higher priority). Thus job turnaround times will be a function of the batch system loads and will vary from execution to execution. Figure 1 shows how the two computers are interconnected during operation of GCARS II under PROCSY.

The remote terminal user may utilize any or all system features available to the local CDC 6500 batch user. PROCSY allows the generation and submission of multiple jobs from any terminal. A second job can be generated while waiting for the completion of the first.

DESCRIPTION OF PROCSY

GCARS II utilizes only a few of the capabilities of PROCSY. The following is a brief description of these features. Since it is

THE GCARS II SYSTEM

A SYSTEM OPERATING UNDER PROCSY

FIGURE 1. FLOWCHART OF THE GCARS II SYSTEM.

undergoing continual modification and expansion, the reader is advised to contact the Computer Center personnel for details before attempting to implement any new applications.

Definitions of PROCSY Terms

Any description of PROCSY involves the use of many specialized terms. The most important of these are summarized in Table 1.

Design of PROCSY

The basic building block of PROCSY (as far as a user is concerned) is the OPERATOR. An OPERATOR is an instruction which is processed directly by PROCSY. As shown in Table 1, there are two types of OPERATORS:

1. PRIMITIVE OPERATORS
2. DEFINITION OPERATORS

The PRIMITIVE OPERATORS are shown in Table 2, the DEFINITION OPERATORS, which have more restricted uses, are shown in Table 3. Inspection of Table 2 will reveal that many of the PRIMITIVE OPERATORS are concerned with the ability of the local terminal user to create, edit, or remove his own files (containing programs or data).

Combinations of OPERATORS can be assembled and given a name to form COMMANDS. There are two types of COMMANDS:

1. SYSTEM COMMANDS
2. USER-DEFINED COMMANDS

The available SYSTEM COMMANDS are shown in Table 4. These allow the terminal user to quickly request and accomplish various commonly required operations. If he needs to repetitatively perform certain additional functions (each perhaps involving several OPERATORS) he can assemble his own string of PRIMITIVE and/or DEFINITION OPERATORS. This becomes a

TABLE I
DEFINITIONS FOR PROCSY TERMS

TERMS USED IN THE 'PROCSY' DOCUMENTATION AND THEIR MEANINGS.

ALPHANUMERIC CHARACTER	A CHARACTER IN THE SET A - Z AND/OR 0 - 9.
ARGUMENT	A PARAMETER FOR AN OPERATOR WITHIN A COMMAND DEFINITION. THE USE OF THIS WORD IS MERELY TO DISTINGUISH BETWEEN THE PARAMETERS TO OPERATORS WITHIN THE COMMAND DEFINITION FILE, AND THE PARAMETERS IN THE COMMAND CALL ITSELF.
BATCH	A NON-INTERACTIVE(SEE) MODE OF JOB EXECUTION IN WHICH THE USER HAS NO MEANS OF COMMUNICATING WITH OR AFFECTING THE EXECUTION OF A JOB IN THE BATCH SYSTEM.
BATCH SYSTEM	THE 'MACE' OPERATING SYSTEM. THE MECHANISM WHICH SUPERVISES AND CONTROLS THE FLOW OF JOBS THROUGH THE COMPUTER SYSTEM, A CONTROL DATA CORP. 6500.
CATALOG	A DIRECTORY CONTAINING THE NAMES AND LOCATIONS OF ALL FILES ASSOCIATED WITH A GIVEN TERMINAL.
COMMAND	A HIGH LEVEL PROCSY INSTRUCTION, WHICH IS THE NAME OF A FILE AND WHICH IS DEFINED BY A SEQUENCE OF INSTRUCTIONS, SUCH AS: <ol style="list-style-type: none"> 1. PRIMITIVE OPERATORS, AND/OR 2. DEFINITION OPERATORS, AND/OR 3. A COMMAND (POSSIBLY ITSELF...COMMANDS ARE RECURSIVE.) THERE ARE TWO TYPES OF PROCSY COMMANDS: <ol style="list-style-type: none"> 1. SYSTEM (OR PUBLIC, OR GLOBAL) COMMANDS - DEFINED AT THE MONITOR TERMINAL, AVAILABLE FOR DISPLAY AND USE AT ALL TERMINALS WHENEVER PROCSY IS UP. 2. USER-DEFINED (OR PRIVATE, OR LOCAL) COMMANDS - DEFINED AT THE USER TERMINAL, AND AVAILABLE TO ONLY THAT TERMINAL UNTIL LOG-OFF. LOCAL REDEFINITION OF A SYSTEM COMMAND WILL REPLACE THAT COMMAND FOR THAT TERMINAL ONLY. SINCE A COMMAND NAME IS A FILE-NAME, ONLY THE FIRST 5 CHARACTERS ARE SIGNIFICANT. THE PROCSY SYSTEM COMMANDS ARE LISTED AND DEFINED IN THE HELP FILE NAMED 'COMMANDS'.
COMMAND DEFINITION FILE	THE FILE CONTAINING THE SEQUENCE OF PROCSY INSTRUCTIONS (OPERATORS AND/OR COMMANDS) WHICH DEFINE A COMMAND. SEE COMMAND.
CTRL-B	A SPECIAL SIGNAL CHARACTER GENERATED BY DEPRESSING THE KEY MARKED 'CTRL' AND THEN STRIKING THE 'B' KEY. THIS CHARACTER IS USED TO RESET THE TERMINAL AND RETURN TO COMMAND INPUT MODE. IT MAY BE ISSUED AT ANY POINT IN TIME. IF A RESPONSE IS NOT IMMEDIATE, 1 SECOND, THE SYSTEM IS PERFORMING A NON-INTERRUPTABLE FUNCTION SUCH AS FILE COPYING.
CTRL-C	SAME AS 'CTRL-B' EXCEPT IT ADDITIONALLY TOGGLES THE MODE OF TERMINAL COMMUNICATIONS BETWEEN HALF-DUPLEX AND FULL-DUPLEX. IT IS USEFUL WHEN CHARACTERS TYPED IN DO NOT PRINT, OR WHEN ECHO CHARACTERS PRINT.

TABLE 1 (cont'd)

DAYFILE	AN ACCOUNTING FILE CONTAINING INFORMATION REGARDING THE EXECUTION OF THE JOB.
DEFINITION OPERATOR	SEE OPERATOR.
EDITING INSTRUCTION	A PROCSY INSTRUCTION WHICH BEGINS WITH A POUND-SIGN (#), AND WHICH MAY BE USED WITHIN THE COMMANDS 'EDIT' AND 'FIX', OR WITHIN THE PRIMITIVE OPERATORS 'OCCREATE' AND 'OEDIT'. THE POUND-SIGN AND THE FIRST LETTER OF THE NAME ARE SIGNIFICANT, EXCEPT IN #EOP AND #EOF. THEY ARE LISTED AND DEFINED IN THE HELP FILES NAMED 'EDIT' AND 'OEDIT'.
FILE	A COLLECTION OF LINE IMAGES ENTERED BY A TERMINAL OR CARD READER OR GENERATED BY JOB EXECUTION.
FILE-NAME	AN ALPHANUMERIC CHARACTER STRING WHOSE FIRST CHARACTER IS ALPHABETIC. ONLY THE FIRST FIVE CHARACTERS ARE SIGNIFICANT.
INTERACTIVE	THE CAPABILITY FOR A USER TO COMMUNICATE WITH A JOB OR THE SYSTEM DURING EXECUTION OF THE JOB OR SYSTEM FUNCTION.
MONITOR TERMINAL	THE CONTROL TERMINAL, THE SUPERVISOR, WHICH CONTROLS THE *PROCSY* SYSTEM AND WHICH IS ABLE TO COMMUNICATE WITH ALL OTHER TERMINALS.
NULL	NOT PRESENT, EMPTY.
OPERATOR	A PROCSY INSTRUCTION PROCESSED DIRECTLY BY THE PROCSY SYSTEM. ALL COMMANDS ARE DEFINED IN TERMS OF THESE OPERATORS. ONLY THE FIRST 3 LETTERS OF THE NAME ARE SIGNIFICANT. THERE ARE TWO TYPES: <ol style="list-style-type: none"> 1. PRIMITIVE OPERATORS - LEGAL AFTER THE FOUR DOTS OF WITHIN COMMAND DEFINITION FILES. MOST OF THEM BEGIN WITH THE LETTER O. 2. DEFINITION OPERATORS - LEGAL ONLY WITHIN COMMAND DEFINITION FILES. THEY ARE LISTED, DEFINED IN THE HELP FILE NAMED 'OPERATORS'.
PARAMETER	A STRING OF UP TO 6 ALPHANUMERIC CHARACTERS, USED IN COMMAND CALLS, DELIMITED BY NON-ALPHANUMERIC SEPARATOR CHARACTERS, INCLUDING BLANKS. THE AMPERSAND-SIGN (&) IS THE FLAG-CHARACTER FOR PARAMETER SUBSTITUTION. FOR FURTHER DETAILS, SEE THE HELP FILES ON 'MACRO' AND 'PARAMETERS'.
PRIMITIVE OPERATOR	SEE OPERATOR.
SEPARATOR CHARACTER	- ANY NON-ALPHANUMERIC CHARACTER(SEE) INCLUDING BLANK.
SYSTEM COMMAND	SEE COMMAND.
USER-DEFINED COMMAND	SEE COMMAND.

TABLE 2

PROCSY PRIMITIVE OPERATORS

BROADCAST-ESTABLISH TERMINAL TO MONITOR COMMUNICATION.

CTPL-B -ACTIVATE TERMINAL FOR USE.
 -REQUEST USER ACCOUNTING DATA.
 -INITIALIZE ALL USER DATA AREAS.
 -RETURN TERMINAL CONTROL TO COMMAND MODE.

NOTE: IF AT ANY TIME THE TERMINAL DOES NOT PRINT DATA AS IT IS ENTERED, TYPE A CTPL-C TO SWITCH FROM FULL DUPLEX MODE TO HALF DUPLEX.

FILES -DISPLAY THE CONTENTS OF THE USERS FILE CATALOG.

JORCARD -INITIALIZE BATCH JOB CONTROL CARD FILE.
 -FILE IS NAMED 'JORCA'.
 -ENTERS AS THE FIRST LINE A JOB CARD IMAGE FOR THE JOB.

LOGOFF -TERMINATE TERMINAL OPERATIONS.

OACCESS -RETRIEVE JOB OUTPUT FROM BATCH JOB EXECUTION.
 -REFORMATS DATA AS IT IS TRANSFERRED.

OCREATE -GENERATE A LOCAL USER FILE.

ODELETE -REMOVE A FILE FROM THE USERS FILE CATALOG.

ODISPLAY -DISPLAY CONTENTS OF A FILE TO THE USER.

ODIT -ALLOWS ALTERATIONS TO A LOCAL USER FILE.

OHOLD -INACTIVATE A TERMINAL WITHOUT USER LOGOFF.

OIOUPE -GENERATE A LOCAL FILE CONTAINING THE CURRENT STATUS OF ALL JOBS ASSOCIATED WITH THE INCLUDING TERMINAL.

OINSERT -INSERT A CONTROL CARD IMAGE INTO THE JORCARD FILE.

ORENAME -RENAME A FILE WITH A NEW NAME.

OSEND -SEND A JOB TO THE BATCH SYSTEM INPUT QUEUE.

QMSG -SENDS A CHARACTER STRING TO USER TERMINAL.

QXMIT -TRANSMITS A SET OF FILES TO THE BATCH SYSTEM.

QXCOUNT -SEND A CHARACTER STRING TO USER TERMINAL.
 -DOES NOT PERFORM AUTOMATIC CARRIAGE RETURN AT END OF MESSAGE STRING.

USERS -PRINTS NUMBER OF TERMINAL USERS.

TABLE 3
PROCSY DEFINITION OPERATORS

EXCHANGE	-EXCHANGE ENTRIES IN THE PARAMETER TABLE.
GOTO	-SKIP TO MATCHING LABEL IN DEFINITION.
IFEQ	-IF ARGUMENT 1 EQUALS ARGUMENT 2, SKIP TO LABEL SPECIFIED BY ARGUMENT 3.
IFGT	-SKIP IF 0 GREATER THAN 1.
IFLT	-SKIP IF 0 LESS THAN 1.
IFNE	-SKIP IF 0 IS NOT EQUAL TO 1.
CTL	-ALLOW USED TO SPECIFY ACTION TO BE TAKEN WHEN A CTRL-R CHARACTER IS READ.
LAB	-LABEL MARKER.
PAPAMS	-WAIT FOR USER ENTRY OF NEW PARAMETER DATA.
NOTES:	
- ONLY THE FIRST THREE CHARACTERS OF THE OPERATOR NAME ARE REQUIRED, ANY EXTRA CHARACTERS ARE NOT CHECKED OR VALIDATED.	

TABLE 4

PROCSY SYSTEM COMMANDS

FORTRAN	- FOR CREATION, SUBMISSION AND RETRIEVAL OF SINGLE FORTRAN JOBS.
FIX	- TO MAKE CORRECTIONS IN SOURCE FILES GENERATED BY THE ABOVE COMMANDS.
HELP	- TO PROVIDE ADDITIONAL INFORMATION REGARDING SPECIFIC COMMANDS AND CONCEPTS WITHIN THE 'PROCSY' SYSTEM. (EX. HELP FORTRAN)
SUBMIT	- TRANSMITS A JOB TO BATCH, PRINTING OUTPUT ON THE BATCH PRINTERS IF IT IS NOT 'COLLECTED'.
STATUS	- OBTAIN THE STATUS OF ALL JOBS AND FILES ASSOCIATED WITH A TERMINAL.
COLLECT	- ACCESSES AND DISPLAYS OUTPUT FROM JOBS SUBMITTED.
BATCH	- SENDS A JOB TO BATCH, AND RETRIEVES OUTPUT AT THE TERMINAL.
MACRO	- ALLOWS CREATION OF A NEW USER-DEFINED COMMAND.
DISPLAY	- DISPLAYS A LOCAL FILE OR A SYSTEM COMMAND.
EDIT	- ALLOWS EDITING OF LOCAL DATA FILES.
INDEX	- LISTS NAMES OF AVAILABLE INFORMATION FILES.
NEWS	- LISTS CURRENT NEWS ITEMS.
PTSS	- ALLOWS USE OF 'PTSS' SYSTEM COMMANDS.
RELEASE	- RELEASES LOCAL FILES.
TELL	- ALLOWS CREATION OF FILE OF MESSAGES FOR MONITOR.
TERM	- DISPLAYS TERMINAL IDENTIFICATION INFORMATION.

NOTES:

ONLY THE FIRST 5 LETTERS OF THE COMMAND NAMES ARE CHECKED.

COMMAND DEFINITION FILE and is essentially analogous to a FORTRAN program or subroutine. Each COMMAND DEFINITION FILE must be given a unique name which is a USER-DEFINED COMMAND. Once such a file has been created, entering the USER-DEFINED COMMAND will cause the series of OPERATORS within the file to be performed.

The reader should note that:

- 1) DEFINITION OPERATORS can only be used during the development of such COMMAND DEFINITION FILES.
- 2) By using the appropriate PRIMITIVE OPERATORS, a terminal user can display and edit (i.e. change or correct) any portion of any of his own USER-DEFINED COMMANDS or any SYSTEM COMMAND.
- 3) Although he may modify any SYSTEM COMMAND, he can only modify it for his own terminal ("locally") and only while he is using the terminal. A user cannot permanently change any SYSTEM COMMAND.
- 4) Just as in FORTRAN programs where one program or subroutine can call others, one COMMAND can call on other COMMANDS.
- 5) Information can be transferred to or returned from COMMAND DEFINITION FILES by means of PARAMETERS associated with the COMMAND.

DESIGN OF THE GCARS II SYSTEM

The GCARS II System consists of twenty-one specially created FILES which are subdivided into seven COMMAND DEFINITION FILES and fourteen DATA FILES. These FILES are stored on a disk pack. Their names and functions are summarized in Table 5. Figure 2 shows the flow of control during the first analysis. The file 'LOAD' is used only once during a use of GCARS II since it aids in

TABLE 5

GCARS II COMMAND-DEFINITION FILES

(A) COMMAND DEFINITION FILES

<u>NAME</u>	<u>PURPOSE</u>
LOAD	TO MAKE THE GCARS II SYSTEM AVAILABLE AT THE TERMINAL.
GCARS	TO SELECT DESIRED TEST AREA AND TO INITIALIZE CONTROL CARDS. (CALLS EITHER 'NORTH' OR 'SOUTH' ACCORDING TO SELECTION).
NORTH	TO LIST AVAILABLE FACTORS FOR NORTH TEST AREA AND TO ACCEPT WEIGHT FOR EACH FACTOR.
SOUTH	TO LIST AVAILABLE FACTORS FOR SOUTH TEST AREA AND TO ACCEPT WEIGHT FOR EACH FACTOR.
COMPRS	TO PREPARE CONTROL CARDS FOR APPROPRIATE DATA FILES FROM DISK PACK; TO ACCEPT ORIGIN-DESTINATION CODES AFTER DISPLAYING "ORDES" DATA FILE; TO REQUEST NUMBER OF ALTERNATIVES; TO OBTAIN NAME FOR JOB.
MPATH	TO GENERATE ALTERNATIVES FOR SELECTED FACTOR COMBINATIONS (CONTAINS MODIFIED VERSIONS OF GCARS FOR TRAN ROUTINES).
PATH	TO ACCESS JOBS FROM OUTPUT QUEUE FOR DISPLAY AT TERMINAL.

(B) SUPPORTING DATA FILES

<u>NAME</u>	<u>CONTENTS</u>
ORDES	CODE NUMBERS OF SELECTED ORIGINS AND DESTINATIONS.
NTPO	VALUE MATRIX - NORTH AREA EARTHWORK COSTS.
NSOIL	VALUE MATRIX - NORTH AREA PAVEMENT CONSTRUCTION COSTS.
NLAND	VALUE MATRIX - NORTH AREA R-O-W ACQUISITION COSTS.
NPOT	VALUE MATRIX - NORTH AREA O-D POPULATION TOTALS.
NPDEN	VALUE MATRIX - NORTH AREA O-D POPULATION DENSITIES.
NTRIP	VALUE MATRIX - NORTH AREA O-D TRIP ENDS.
NRoad	VALUE MATRIX - NORTH AREA NON-DUPLICATION OF ROAD NETWORKS.
STPO	VALUE MATRIX - SOUTH AREA EARTHWORK COSTS.
SSOIL	VALUE MATRIX - SOUTH AREA PAVEMENT CONSTRUCTION COSTS.
SIAND	VALUE MATRIX - SOUTH AREA R-O-W ACQUISITION COSTS.
STOWN	VALUE MATRIX - SOUTH AREA TOWN POPULATIONS.
SPDEN	VALUE MATRIX - SOUTH AREA POPULATION DENSITIES.
SRoad	VALUE MATRIX - SOUTH AREA NON-DUPLICATION OF ROAD NETWORKS.

FIGURE 2. FLOW OF CONTROL THROUGH THE GCARS II SYSTEM.

initiallizing the System. The file 'MPATH' contains a modified version of all the GCARS alternative generating programs in relocatable binary format. Thirteen files contain the value matrices for the available highway location factors in the North and South Test areas. The contents of these files are listed in Appendix A.

Possible Expansion

The GCARS II System can be expanded to include other portions of the GCARS System by developing the appropriate COMMAND DEFINITION FILES. New test areas could be added by modifying the present 'LOAD' COMMAND DEFINITION FILES and adding new SUPPORTING DATA FILES containing the necessary data and paralleling the functions provided by the present 'NORTH' and 'SOUTH' files. New factors or Origins and Destinations for the present test areas can be added by modifying 'ORDES' and the 'NORTH' OR 'SOUTH' files as necessary.

METHOD OF OPERATION OF GCARS II

Operation of a Teletype Terminal

Table 6 summarizes how a terminal connected to the PROCSY System should be activated, and how typing errors can be corrected.

Important GCARS II and PROCSY COMMANDS

The important SYSTEM and USER-DEFINED COMMANDS utilized during the normal operation of GCARS II are:

- 1) STATUS
- 2) LOAD
- 3) GCARS
- 4) PATH

These words can only be entered after the terminal has typed four dots

TABLE 6

TERMINAL OPERATING PROCEDURES

L O G O N

1. TO TURN A TERMINAL ON (ANY TERMINAL CONNECTED TO THE IBM/7094) FOR *PROCSY* USE,
 - 1) THE DIAL ON THE LOWER RIGHT CORNER MUST BE IN THE 'LINE' POSITION.
 - 2) IF THERE IS A SWITCH UNDER THE TERMINAL, IT MUST BE PUSHED AWAY FROM THE USER.
 IF A TERMINAL IS ALREADY ON WHEN *PROCSY* COMES UP, A HEADING LINE WILL BE PRINTED AT THE TERMINAL:
 PROCSY*VERSION DATE
 WHERE 'VERSION DATE' IS IN THE FORM MM/DD/YY.
2. WHEN *PROCSY* IS UP, IN ORDER TO USE IT THE USER MUST START BY TYPING A SPECIAL PAIR OF KEYS,
 'CTRL' 'R'
 FIRST THE 'CTRL', AND WHILE HOLDING IT DOWN, THE 'R' KEY.
3. *PROCSY* WILL RESPOND BY PRINTING THE TERMINAL NUMBER, DATE, AND TIME, FOLLOWED ON THE NEXT LINE BY A REQUEST FOR THE USER'S NAME, AS FOLLOWS:
 TERMINAL NN, MM/DD/YY NN.MM.SS
 NAME?
4. THE USER TYPES IN HIS LAST NAME AS IT APPEARS ON THE ACCOUNTING SYSTEM FOR THE CDC 6500, FOLLOWED BY THE CARRIAGE RETURN KEY, 'RETURN' ('CR'). *PROCSY* WILL THEN RESPOND BY PRINTING A REQUEST FOR THE USER JOB CODE, AS FOLLOWS:
 CODE?
5. THE USER TYPES IN HIS 4 OR 5 DIGIT JOB CODE AS IT APPEARS ON THE ACCOUNTING SYSTEM FOR THE CDC 6500, FOLLOWED BY THE 'CR' KEY, AND *PROCSY* WILL THEN PRINT FOUR DOTS

 INDICATING THAT IT IS READY FOR ANY OF THE *PROCSY* COMMANDS OR OPERATORS.

EXAMPLE:

```

'CTRL' 'R'
TERMINAL AV, 05/12/68 10.17.30
NAME? SMITH 'CR'
CODE? 12345 'CR'
.... (YOU READY FOR ANY *PROCSY* COMMAND OR OPERATOR)
  
```

NOTES:

- IF AT ANY TIME THE TERMINAL DOES NOT PRINT THE CHARACTERS TYPED IN, THE USER SHOULD TYPE A SPECIAL PAIR OF KEYS
 'CTRL' 'C'
 (IN THE SAME MANNER AS CTRL R), TO SWITCH THE MODE OF THE TERMINAL FROM FULL-DUPLEX TO HALF-DUPLEX.
- #### L O G O F F

1. IN ORDER TO LOG OFF FROM A TERMINAL, A USER MUST TYPE THE *PROCSY* OPERATOR 'LOGOFF', OR 'LOG'.
2. IF THE PREVIOUS USER AT THE TERMINAL HAS NOT LOGGED OFF, AND THEREFORE THE FIRST 'CTRL-R' YOU TYPE RETURNS THE FOUR DOTS, YOU SHOULD LOG HIM OFF BEFORE LOGGING YOURSELF ON.

TABLE 6 (cont'd)

BASIC INFORMATION

1. LINE ENTERING -
 PROCSY SIGNIFIES THAT IT IS WAITING FOR INPUT BY PRINTING, FOR EXAMPLE
 - A) - FOUR DOTS, IN CONTROL MODE,
 - B) NAME? - A WORD FOLLOWED BY A QUESTION MARK, IN COMMAND MODE,
 - C) 00001.000 - A LINE NUMBER, IN 'OCREATE' MODE,
 - D) ? - A QUESTION MARK, IN 'OEDIT' MODE,
2. LINE TERMINATION -
 AFTER THE LAST CHARACTER OF THE LINE HAS BEEN TYPED, THE USER TYPES A CARRIAGE RETURN KEY NAMED 'RETURN' TO MOVE THE CARRIAGE TO THE BEGINNING OF THE NEXT LINE.
3. CHARACTER ERASING -
 THE USER MAY ERASE (OR BACKSPACE, OR CORRECT) A CHARACTER WITHIN A LINE BY TYPING AN EXCLAMATION POINT AFTER THE CHARACTER TO BE CORRECTED. N CONSECUTIVE EXCLAMATION POINTS ERASE THE PRECEDING N CHARACTERS.
4. LINE ERASING -
 TO ERASE AN ENTIRE LINE AND BEGIN IT AGAIN, TYPE THE KEY NAMED 'BUR OUT'.
5. MAXIMUM CHARACTERS PER LINE -
 THERE ARE 72 PRINT POSITIONS PER LINE AT THE STANDARD MODEL 33 TELETYPE TERMINAL, BUT THE USER CAN OVERTYPE THE 72ND POSITION (BEFORE TYPING A CARRIAGE RETURN KEY) TO ENTER UP THROUGH 80 CHARACTERS PER LINE. IF 80 CHARACTERS ARE ENTERED, AN AUTOMATIC CARRIAGE RETURN TO THE NEXT LINE IS GENERATED.
6. NUMBER OF SIGNIFICANT CHARACTERS -
 NOT EVERY CHARACTER TYPED BY A USER IS SIGNIFICANT.
 FILE NAMES - ONLY THE FIRST 5 CHARACTERS OF A FILE-NAME ARE SIGNIFICANT. SINCE *PROCSY* COMMANDS ARE NAMES OF FILES, THEIR FIRST 5 CHARACTERS ARE SIGNIFICANT.
 OPERATORS - ONLY THE FIRST 3 CHARACTERS OF PRIMITIVE OPERATORS AND DEFINITION OPERATORS ARE SIGNIFICANT. (SEE THE HELP FILE NAMED 'GLOSSARY' FOR DEFINITIONS.)
7. IN GENERAL, THE LETTER 'O' IS RESERVED AS AN INITIAL LETTER FOR *PROCSY* USE SUCH AS FOR BASIC OPERATORS AND FOR INTERNAL FILE NAMES. USERS SHOULD AVOID NAMING THEIR FILES USING A FIRST LETTER OF 'O', FOR THEIR OWN PROTECTION.
8. SPECIAL CHARACTERS -
 POUND SIGN (#) - USED FOR EDITING LINES IN FILES.
 (SEE HELP FILES 'EDIT' AND 'OEDIT'.)
 AMPERSAND SIGN (&) - USED FOR PARAMETER SUBSTITUTIONS.
 (SEE HELP FILES 'MACRO' AND 'PARAMETERS'.)

"STATUS" is a SYSTEM COMMAND which allows the terminal user to determine the current status of all jobs he has submitted from his terminal, for example:

```
.... STATUS  
STATUS AT 09.50.45  
(JOB 1) IS IN OUTPUT QUEUE.  
(JOB 2) IS EXECUTING.  
(JOB 3) IS IN INPUT QUEUE.
```

LOCAL FILES:

JOB CA

....

This example shows (1) the time of the STATUS request in hours, minutes and seconds, (2) the status of the three jobs which have been sent previously from this terminal, (3) any local files attached to this terminal (at the moment there is only one, "JOBCARD", containing accounting information).

On the basis of this request the user now knows that JOB 1 is completed and its answers can be displayed at the terminal as soon as is desirable, JOB 2, is being executed at that moment (and thus should be ready soon), and that JOB 3 is awaiting its turn in the batch input queue.

"LOAD" is a GCARS II USER-DEFINED COMMAND used only once during the start up of the GCARS II System. Its use is demonstrated in Figure 3.

"GCARS" is a GCARS II USER-DEFINED COMMAND which allows the user to begin a new GCARS II analysis problem. Its use is demonstrated in Figure 4.

"PATH" is a GCARS II USER-DEFINED COMMAND which allows the user to begin displaying the answers to a completed GCARS II analysis. Its use is demonstrated in Figure 5.

TURN ON TERMINAL
PRESS "CONTROL-B" KEYS

```

TERMINAL AT, 06/14/69 09.49.31
NAME? TURNER
CODE? 3402
.... JOB,CM10000,T10,P10
.... QIN'CLEAR.'
.... QIN'MOUNT(GCARS)'
.... QIN'ATTACH(LOAD,GCARS)'
.... QIN'REWIND(LOAD)'
.... QIN'COPYBF(LOAD)'
.... QIN'#EOR'
.... QSE LOAD
.... STATUS
  STATUS AT 09.52.38.
(LOAD)) IS EXECUTING.

```

LOCAL FILES:

JOB CA

```

.... STATUS
  STATUS AT 09.54.48.
(LOAD ) IS IN OUTPUT QUEUE.

```

LOCAL FILES:

JOB CA

```

.... QAC LOAD,NO,FO,TR,HRO
.... LOAD
FILE GCARS   LOADED
FILE COMPRS  LOADED
FILE NORTH   LOADED
FILE SOUTH   LOADED
FILE ORDES   LOADED
FILE PATH    LOADED
....

```

CONTINUE ON FIGURE 4A

FIGURE 3. GCARS II ACTIVATION PROCEDUES.

CONTINUE FROM FIGURE 3

.... GCARS

CHOOSE TEST AREA - NORTH OR SOUTH?
SOUTH

SOUTH TEST AREA
AVAILABLE FACTORS..

1. EARTHWORK COSTS
2. PAVEMENT CONSTRUCTION COSTS
3. RIGHT OF WAY ACQUISITION COSTS
4. POPULATION OF TOWNS
5. POPULATION DENSITIES
6. NON-DUPLICATION OF ROAD NETWORKS

ENTER WEIGHTING PARAMETER FOR EACH FACTOR
PARAMETER MUST BE A NONZERO INTEGER
A CARRIAGE RETURN MEANS FACTOR WILL BE IGNORED
EARTHWORK COSTS?
2

PAVEMENT CONSTRUCTION COSTS?
3

RIGHT OF WAY ACQUISITION COSTS?
1

POPULATION OF TOWNS?
1

POPULATION DENSITIES?

NON-DUPLICATION OF ROAD NETWORKS?

SOUTHERN TEST AREA

*	CODE NUMBER	ORIGIN OR DESTINATION
*	00019	NORTH TERMINUS ROUTE 37
*	01097	SOUTH TERMINUS ROUTE 37
*	00342	WEST TERMINUS E-W CORRIDOR
*	00434	EAST TERMINUS E-W CORRIDOR
*		

ENDSOUTH

SELECT ORIGIN BY CODE NUMBER
00019

SELECT DESTINATION BY CODE NUMBER
01097

ENTER THE NUMBER OF ALTERNATIVES TO BE GENERATED
6

ENTER A UNIQUE 5 CHARACTER JOB NAME
TRNR1

.... STATUS
STATUS AT 09.57.39.
(TRNR1) IS IN INPUT QUEUE.

LOCAL FILES:

JOBCA

....

CONTINUE ON FIGURE 4B

FIGURE 4A. TYPICAL GCARS II JOB SUBMITTAL
FOR SOUTH TEST AREA

CONTINUE FROM FIGURE 4A

.... GCARS

CHOOSE TEST AREA - NORTH OR SOUTH?
NORTH

NORTH TEST AREA

AVAILABLE FACTORS..

1. EARTHWORK COSTS
2. PAVEMENT CONSTRUCTION COSTS
3. RIGHT OF WAY ACQUISITION COSTS
4. ORG - DES ZONE POPULATION TOTALS
5. ORG - DES ZONE POPULATION DENSITIES
6. ORG - DES ZONE TRIP ENDS
7. NON-DUPLICATION OF ROAD NETWORKS

ENTER WEIGHTING PARAMETER FOR EACH FACTOR
PARAMETER MUST BE A NONZERO INTEGER
A CARRIAGE RETURN MEANS FACTOR WILL BE IGNORED
EARTHWORK COSTS?

2

PAVEMENT CONSTRUCTION COSTS?

2

RIGHT OF WAY ACQUISITION COSTS?

4

O-D ZONE POPULATION TOTALS?

O-D ZONE POPULATION DENSITIES?

O-D ZONE TRIP ENDS?

1

NON-DUPLICATION OF ROAD NETWORKS?

1

NORTHERN TEST AREA

* CODE NUMBER	ORIGIN OR DESTINATION
* 00277	NORTH TERMINUS US 52
* 00799	SOUTH TERMINUS US 52
* 00039	NORTH TERMINUS ROUTE 43
* 00785	SOUTH TERMINUS ROUTE 43
* 00148	EAST TERMINUS ROUTE 25
* 00627	WEST TERMINUS ROUTE 25

ENDNORTH

SELECT ORIGIN BY CODE NUMBER

00148

SELECT DESTINATION BY CODE NUMBER

00627

ENTER NUMBER OF ALTERNATIVES TO BE GENERATED

5

ENTER A UNIQUE 5 CHARACTER JOB NAME

TRNR2

.... STATUS

STATUS AT 09.59.25.

(TRNR1) IS EXECUTING.

(TRNR2) IS IN INPUT QUEUE.

LOCAL FILES:

JDDCA

....

CONTINUE ON FIGURE 5

FIGURE 4B TYPICAL GCARS II JOB SUBMITTAL
FOR NORTH TEST AREA.

```

          CONTINUE FROM FIGURE 4B
..... STATUS
    STATUS AT 10.01.11.
    (TRNR1) IS IN OUTPUT QUEUE.
    (TRNR2) IS EXECUTING.
    (TRNR3) IS IN INPUT QUEUE.

LOCAL FILES:

JOB CA

..... PATH

JOB NAME?
    TRNR1

NEW OR OLD?
    NEW

OUTPUT FOR TRNR1 SHOWN ON FIGURE 6A
                                AND 6B

```

FIGURE 5. GCARS II JOB ACCESSING PROCEDURES

Activation of GCARS II

The procedure for activating a terminal and preparing to submit the first GCARS II analysis request is shown in Figure 3. The terminal must first be activated by following the steps outlined for "LOG ON" in Table 6. Once a valid name and account code have been entered the terminal will print four dots. It is now ready to accept the first of eight PROCSY PRIMITIVE OPERATORS, as shown in Figure 3. The final line QSE LOAD sends a job called LOAD (obtained from the disc pack) for execution. This job (COMMAND-DEFINITION FILE) loads the remaining GCARS II files from the disc pack.

The user should use the SYSTEM COMMAND "STATUS" to determine when the GCARS II files have been loaded (i.e. when (LOAD) is in the output queue). In the example shown in Figure 3 the first two "STATUS" COMMANDS show (LOAD) is executing, but the third "STATUS" COMMAND shows that it has been completed and is in the output queue.

NOTE: The elapsed time in the example is approximately 2 minutes. This is typical for the first terminal using GCARS II on any particular day, since (LOAD) requests the operator to mount the GCARS disc pack and this involves a delay. Later terminals will complete this step in only a few seconds.

The user must next use the PRIMITIVE OPERATOR "QAC" (i.e. QACCESS) to access the job "LOAD" and then the GCARS II USER-DEFINED COMMAND "LOAD" to complete the activation cycle. The terminal should then return with the answers shown in Figure 3, indicating that the necessary GCARS II COMMAND-DEFINITION FILES have been loaded.

The terminal will then type four dots indicating it is ready for a new input request. It is now ready for the first GCARS II analysis request.

Submitting a GCARS II Analysis

Figure 4 shows the terminal communications developed during the submission of GCARS II analysis requests.

An analysis request is initiated by the user entering the GCARS II USER-DEFINED COMMAND "GCARS" after the four dots (these may be the same four dots found at the bottom of Figure 3, or another set). The terminal will then reply with "CHOOSE TEST AREA - NORTH OR SOUTH?" To which the user must type (at present) either "NORTH" or "SOUTH" as shown in Figure 4A. Figure 4A reproduces the format of an actual analysis performed on a terminal. It should be noted that all lines entered by the user are indented one column. The reader is invited to follow through Figure 4A to see how the information is entered.

NOTE: (1) The listed origins and destinations are included merely as a convenience. Any valid origin - destination pair may be requested. The code number for any desired matrix location can be computed as follows:

$$\text{code number} = (Y-1) * \text{NCOL} + X$$

where X = column coordinate of point

Y = row coordinate of point

NCOL = number of columns in matrix.

(2) The name requested at the bottom of Figure 4A will be assigned to this request. It must be unique at this terminal.

The terminal will type out four dots after the job name has been entered. This indicates that this analysis request is completed. The user normally would type the SYSTEM COMMAND "STATUS" to check on the successful entry of TRNR1 to the batch input queue, as shown at the very bottom of Figure 4A.

Since TRNR1 is in the input queue and no other jobs sent from this terminal are completed (because it was the first requested analysis), the user can enter a second GCARS II analysis request (or perform any other PROCYS operation he desires). This is shown in Figure 4B. In this case the North test area, rather than the South, is being analyzed. Otherwise, the two analysis requests are performed in a similar fashion. This second request is called TRNR2. (Note that each GCARS II request begins with the "GCARS" USER-DEFINED COMMAND and ends when a job name is assigned).

When the "STATUS" SYSTEM COMMAND is entered, the user now finds that TRNR1 is executing while TRNR2 is in the input queue (see bottom of Figure 4B). Since no job is yet ready to have its output displayed, a third job TRNR3 could now be entered. (This GCARS II request is not shown).

Obtaining GCARS II Output at the Terminal

Figure 5 shows how a GCARS II job request output is returned to the terminal for display. The SYSTEM COMMAND "STATUS" shows TRNR1 is in the output queue. At this point the GCARS II USER-DEFINED COMMAND "PATH" is entered. In response to the question "JOB NAME?" the user types in TRNR1. Since this job's output has not been displayed before, the user next types in NEW. The terminal will then produce the standard job output shown in Figure 6.

When all the standard output has been received, the terminal will type four dots and await the entry of a new COMMAND or OPERATOR. Suppose the user next types in the "STATUS" SYSTEM COMMAND as shown in Figure 7. This shows that TRNR2 is in the output queue. It also shows TRNR1 as a "local file". This is the reason for the "NEW or OLD?" question previously.

CONTINUE ON FIGURE 6B

FIGURE 6A. OUTPUT FOR TRNR1

CONTINUE FROM FIGURE 6B

```

..... STATUS
  STATUS AT 10.30.20.
  (TRNR2) IS IN OUTPUT QUEUE.
  (TRNR3) IS IN INPUT QUEUE.

```

LOCAL FILES:

```

JOBCA
TRNR1

```

..... PATH

```

JOB NAME?
  TRNR2

```

```

NEW OR OLD?
  NEW

```

OUTPUT FOR TRNR2 SHOWN IN FIGURE 8A
AND 8B

FIGURE 7. METHOD OF ACCESSING A SECOND
JOB.

Suppose the user wished to obtain a second copy of the output for TRNR1.

This would be accomplished by the following:

.... PATH

JOB NAME?

TRNR1

NEW OR OLD?

OLD

(A Second copy of the TRNR1 output would be produced).

Figure 8 shows the output obtained for TRNR2, obtained in response to the commands shown in Figure 7.

Obtaining GCARS II Output on the Printer

If the terminal user submits one or more GCARS II analysis requests but does not have a chance to get the answers displayed at his terminal, they will automatically be diverted to the printer at the termination of PROCSY.

These jobs will appear identical to the standard output formats obtained at the terminal. They can be picked up at the output window in the Computer Science Center. The jobs may be identified by adding the two letter code name of the terminal to the five letter job name assigned to the job. For example:

The terminal is AV

The job name is TRNR1

The job output will be AVTRNR1

NOTE: (1) Any jobs whose output has even partially been printed at the terminal will not be diverted to the printer in this way.

(2) The use of the "LOGOFF" PRIMITIVE OPERATOR does not prevent another user at the same terminal, using the

CONTINUE FROM FIGURE 7

THE GCAPS SYSTEM
PURDUE UNIVERSITY VERSION

SEARCH ACTIVITY - PREPARATION OF THE UTILITY SURFACE.
 AREA BEING ANALYZED IS NORTH

WEIGHT	FACTORS UTILIZED
2.00	EARTHWORK COST FACTOR
2.00	PAVEMENT CONSTRUCTION COST FACTOR
4.00	RIGHT OF WAY ACQUISITION COST FACTOR
1.00	10-D ZONE TRIP ENDS (SERVICE FACTOR)
1.00	10-D ZONE TRIP ENDS (SERVICE FACTOR)
1.00	10-D ZONE TRIP ENDS (SERVICE FACTOR)
1.00	10-D ZONE TRIP ENDS (SERVICE FACTOR)
1.00	10-D ZONE TRIP ENDS (SERVICE FACTOR)

SEARCH ACTIVITY - GENERATION OF ALTERNATIVES.

REPEATED USE OF A MODIFIED VERSION OF THE BRITISH
 ROAD RESEARCH LABORATORY MINIMUM PATH ALGORITHM
 GENERATES AS MANY AS SEVEN ALTERNATIVES.

THE GENERATED ALTERNATIVES

CHOICE NUMBER	PATH TOTAL	RELATIVE PATH VALUE	NUMBER OF LINKS
1	887.712	1.000	41
2	942.152	1.061	41
3	982.362	1.107	41
4	1011.000	1.139	43
5	1033.446	1.164	45

CONTINUE ON FIGURE 8B

FIGURE 8A. OUTPUT FOR TRNR2

CONTINUE FROM FIGURE 8A

MAP OF GENERATED ALTERNATIVES.

5 CHOICES ARE SHOWN.
EACH IS LOCATED BY A STRING OF NUMBERS WHICH
CORRESPOND TO THE CHOICE NUMBER.

THE ALTERNATIVES ARE DEFINED ON A NETWORK
HAVING 25 COLUMNS BY 33 ROWS.

FIGURE 8B. OUTPUT FOR TRNR2 (continued)

"QACCESS" PRIMITIVE OPERATOR or the "COLLECT" SYSTEM COMMAND to retrieve any or all of the jobs. If they are retrieved in this way they will not appear on the printer. This is a present weakness in PROCYSY which has not been corrected.

REFERENCES

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APPENDIX

A

GCARS II - PROGRAMS

APPENDIX A LISTING OF GCARS II COMMAND-DEFINITION FILES

LOAD

```

.... QDI LOAD,SUP

JOB CM20000,T10,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(GCARSS,GCARS)'
QIN'REWIND(GCARSS)'
QIN'COPYBR(GCARSS)'
QIN'AEOR'
QSE GCARS
JOB CM20000,T10,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(COMPRS,GCARS)'
QIN'REWIND(COMPRS)'
QIN'COPYBR(COMPRS)'
QIN'AEOR'
QSE COMPRS
JOB CM20000,T10,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(NORTH,GCARS)'
QIN'REWIND(NORTH)'
QIN'COPYBR(NORTH)'
QIN'AEOR'
QSE NORTH
JOB CM20000,T10,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(SOUTH,GCARS)'
QIN'REWIND(SOUTH)'
QIN'COPYBR(SOUTH)'
QIN'AEOR'
QSE SOUTH
JOB CM20000,T10,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(ORDES,GCARS)'
QIN'REWIND(ORDES)'
QIN'COPYBR(ORDES)'
QIN'AEOR'
QSE ORDES
JOB CM20000,T10,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(PATH,GCARS)'
QIN'REWIND(PATH)'
QIN'COPYBR(PATH)'
QIN'AEOR'
QSE PATH
QAC,GCARS,NO,TR,FO,HRO
QTM'FILE GCARS LOADED'
QAC,COMPRS,NO,TR,FO,HRO
QTM'FILE COMPRS LOADED'
QAC,NORTH,NO,TR,FO,HRO
QTM'FILE NORTH LOADED'
QAC,SOUTH,NO,TR,FO,HRO
QTM'FILE SOUTH LOADED'
QAC,ORDES,NO,TR,FO,HRO
QTM'FILE ORDES LOADED'
QAC,PATH,NO,TR,FO,HRO
QTM'FILE PATH LOADED'
AEOR

```

GCARS

```

JOB CMS2000,T200,P10
QIN'CLEAR.'
QIN'MOUNT(GCARS)'
QIN'ATTACH(MPATH,GCARS)'
QIN'REWIND(MPATH)'
QIN'COPYBF(MPATH,MYFILE)'
QIN'REWIND(MYFILE)'
QTM'CHOOSE TEST AREA - NORTH OR SOUTH? '
QTM' '
PAR
  IFE,5P0=,NORTH,LABL01
  IFE,5P0=,SOUTH,LABL02
  QTM'ILLEGAL TEST AREA 5P0= '
  GOTO EXIT
LARB01
NORTH
LARB02
SOUTH
ΔEOR

```

NORTH

```

QTM'NORTH TEST AREA'
QTM'AVAILABLE FACTORS..'
QTM' 1. EARTHWORK COSTS'
QTM' 2. PAVEMENT CONSTRUCTION COSTS'
QTM' 3. RIGHT OF WAY ACQUISITION COSTS'
QTM' 4. ORG - DES ZONE POPULATION TOTALS'
QTM' 5. ORG - DES ZONE POPULATION DENSITIES'
QTM' 6. ORG - DES ZONE TRIP ENDS'
QTM' 7. NON-DUPLICATION OF ROAD NETWORKS'
QTM' '
QTM'ENTER WEIGHTING PARAMETER FOR EACH FACTOR'
QTM'PARAMETER MUST BE A NONZERO INTEGER'
QTM'A CARRIAGE RETURN MEANS FACTOR WILL BE IGNORED'
QTM'EARTHWORK COSTS? '
QTM' '
PAR
  IFE,5P0,0,LARB01
  EXC,0,6
  QTM'PAVEMENT CONSTRUCTION COSTS? '
  QTM' '
  PAR
    IFE,5P0,0,LARB01
    EXC,0,1
    QTM'RIGHT OF WAY ACQUISITION COSTS? '
    QTM' '
    PAR
      IFE,5P0,0,LARB01
      EXC,0,2
      QTM'0-0 ZONE POPULATION TOTALS? '
      QTM' '
      PAR
        IFE,5P0,0,LARB01
        EXC,0,3
        QTM'0-0 ZONE POPULATION DENSITIES? '
        QTM' '
        PAR
          IFE,5P0,0,LARB01
          EXC,0,4
          QTM'0-0 ZONE TRIP ENDS? '
          QTM' '
          PAR
            IFE,5P0,0,LARB01
            EXC,0,5
            QTM'NON-DUPLICATION OF ROAD NETWORKS? '
            QTM' '
            PAR
              IFE,5P0,0,LARB01
              EXC,0,6

```

NORTH (cont'd)

```

QIN'ATTACH(HTOPO,GCARS)'  $P0
QIN'REWIND(HTOPO)'        $P0
QIN'COPYRF(HTOPO,TAPE8)'  $P0
QIN'ATTACH(NSOIL,GCARS)'  $P1
QIN'REWIND(NSOIL)'        $P1
QIN'COPYRF(NSOIL,TAPE8)'  $P1
QIN'ATTACH(HLAND,GCARS)'  $P2
QIN'REWIND(HLAND)'        $P2
QIN'COPYRF(HLAND,TAPE8)'  $P2
QIN'ATTACH(NPTOT,GCARS)'  $P3
QIN'REWIND(NPTOT)'        $P3
QIN'COPYRF(NPTOT,TAPE8)'  $P3
QIN'ATTACH(HPOEN,GCARS)'  $P4
QIN'REWIND(HPOEN)'        $P4
QIN'COPYRF(HPOEN,TAPE8)'  $P4
QIN'ATTACH(NTRIP,GCARS)'  $P5
QIN'REWIND(NTRIP)'        $P5
QIN'COPYRF(NTRIP,TAPE8)'  $P5
QIN'ATTACH(HROAD,GCARS)'  $P6
QIN'REWIND(HROAD)'        $P6
QIN'COPYRF(HROAD,TAPE8)'  $P6
QIN'RETURN(GCARS)'
QIN'REWIND(TAPE8)'
QIN'REL,52000.'
QIN'LOAD(MYFILE)'
QIN'EXECUTE.'

QIN'AEOR'
COMPRS,$P0=,$P1=,$P2=,$P3=,$P4=,$P5=,$P6=,,,NO
LARL01
OTH'ILLEGAL WEIGHTING PARAMETER'
NORTH
AEOR

```

SOUTH

```

QTM'SOUTH TEST AREA'
QTM'AVAILABLE FACTORS..'
QTM'  1. EARTHWORK COSTS'
QTM'  2. PAVEMENT CONSTRUCTION COSTS'
QTM'  3. RIGHT OF WAY ACQUISITION COSTS'
QTM'  4. POPULATION OF TOWNS'
QTM'  5. POPULATION DENSITIES'
QTM'  6. NON-DUPLICATION OF ROAD NETWORKS'
QTM'
QTM'ENTER WEIGHTING PARAMETER FOR EACH FACTOR'
QTM'PARAMETER MUST BE A NONZERO INTEGER'
QTM'A CARRIAGE RETURN MEANS FACTOR WILL BE IGNORED'
QTM'EARTHWORK COSTS? '
QTM'
PAR
IFE,$P0,0,LARL01
EXC,0,5
OTH'PAVEMENT CONSTRUCTION COSTS? '
QTM'
PAR
IFE,$P0,0,LARL01
EXC,0,1
OTH'RIGHT OF WAY ACQUISITION COSTS? '
QTM'
PAR
IFE,$P0,0,LARL01
EXC,0,2
OTH'POPULATION OF TOWNS? '
QTM'
PAR
IFE,$P0,0,LARL01
EXC,0,3
OTH'POPULATION DENSITIES? '
QTM'
PAR

```

SOUTH (cont'd)

```

IFE, $P0, 0, LARL01
EXC, 0, 4
QTM'NON-DUPLICATION OF ROAD NETWORKS? '
QTM' '
PAR
IFE, $P0, 0, LARL01
EXC, 0, 5
QIN'ATTACH(STOPO, GCARS)' $P0
QIN'REWIND(STOPO)' $P0
QIN'COPYBF(STOPO, TAPE8)' $P0
QIN'ATTACH(SSOIL, GCARS)' $P1
QIN'REWIND(SSOIL)' $P1
QIN'COPYRF(SSOIL, TAPE8)' $P1
QIN'ATTACH(SLAND, GCARS)' $P2
QIN'REWIND(SLAND)' $P2
QIN'COPYRF(SLAND, TAPE8)' $P2
QIN'ATTACH(STOWN, GCARS)' $P3
QIN'REWIND(STOWN)' $P3
QIN'COPYRF(STOWN, TAPE8)' $P3
QIN'ATTACH(SPDEN, GCARS)' $P4
QIN'REWIND(SPDEN)' $P4
QIN'COPYBF(SPOEN, TAPE8)' $P4
QIN'ATTACH(SROAD, GCARS)' $P5
QIN'REWIND(SROAD)' $P5
QIN'COPYRF(SROAD, TAPE8)' $P5
QIN'RETURN(GCARS)'
QIN'REWIND(TAPE8)'
QIN'RFL, 52000.'
QIN'LOAD(MYFILE)'
QIN'EXECUTE.'
QIN'AEOR'
COMPRS, $P0=, $P1=, $P2=, $P3=, $P4=, $P5=, , , , , SO
LARL01
QTM'ILLEGAL WEIGHTING PARAMETER'
SOUTH
AEOR

```

COMPRS

```

QIN'$P0.'
QIN'$P1.'
QIN'$P2.'
QIN'$P3.'
QIN'$P4.'
QIN'$P5.'
QIN'$P6.'
QIN'0.0'
IFE, $P9=, SO, LARL01
QDI, OPDES, NORTH, ENDSOR, SUP
GOTO LARL02
LARL01
QDI, OPDES, SOUTH, ENDSOU, SUP
LARL02
QTM'SELECT ORIGIN BY CODE NUMBER'
QTM' '
PAR
EXC, 0, 1
QTM'SELECT DESTINATION BY CODE NUMBER'
QTM' '
PAR
IFN, $P0, $P1, LARL03
QTM'ILLEGAL DESTINATION'
QTM'SELECT DESTINATION BY CODE NUMBER'
QTM' '
PAR
IFN, $P0, $P1, LARL03
GOTO EXIT
LARL03
EXC, 0, 2
QTM'ENTER THE NUMBER OF ALTERNATIVES TO BE GENERATED'
QTM' '

```

COMPRS (cont'd)

```

PAR
QIN'EP1'
QIN'EP2'
QIN'EP0'
QIN'ZFOR'
QTM'ENTER A UNIQUE 5 CHARACTER NAME '
QTM' '
PAR
QSE EP0=MPATH
GOTO EXIT
ZFOR

```

ORDES

```

.... QDI ORDES,SUP

```

```

SOUTHERN TEST AREA
*   CODE NUMBER   ORIGIN OR DESTINATION
*
*   00019         NORTH TERMINUS ROUTE 37
*   01097         SOUTH TERMINUS ROUTE 37
*   00342         WEST TERMINUS E-W CORRIDOR
*   00434         EAST TERMINUS E-W CORRIDOR
*
ENDSOUTH
NORTHERN TEST AREA
*   CODE NUMBER   ORIGIN OR DESTINATION
*
*   00277         NORTH TERMINUS US 52
*   00799         SOUTH TERMINUS US 52
*   00039         NORTH TERMINUS ROUTE 43
*   00785         SOUTH TERMINUS ROUTE 43
*   00148         EAST TERMINUS ROUTE 25
*   00627         WEST TERMINUS ROUTE 25
*
ENDNORTH
ZFOR

```

PATH

```

.... QDI PATH,SUP

```

```

QTM'JOB NAME? '
QTM' '
PAR
EXC,0,1
QTM'NEW OR OLD? '
QTM' '
PAR
IFE,EP0,OLD,LARL01
QDE,EP1=MPATH
QAC,EP1=MPATH,NO,TR,HR0
LARL01
QDI EP1=MPATH,,SUP
GOTO EXIT
ZFOR

```