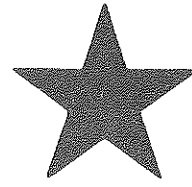


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Transportation Analysis & Research

MICHIGAN'S STATEWIDE
TRANSPORTATION MODELING SYSTEM

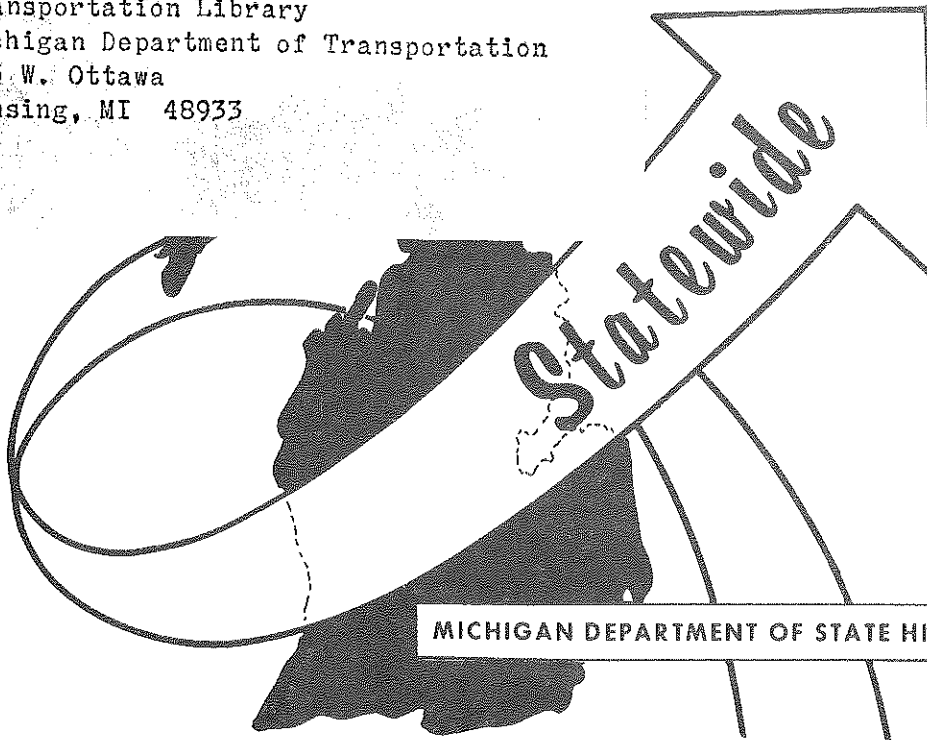
VOLUME II-A

**EFFICIENT NETWORK UPDATING
WITH INTERACTIVE GRAPHICS**

STATEWIDE TRANSPORTATION
PLANNING PROCEDURES

MAY, 1976

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BUREAU OF TRANSPORTATION PLANNING

**MICHIGAN'S STATEWIDE
TRANSPORTATION MODELING SYSTEM**

VOLUME II-A

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**STATEWIDE TRANSPORTATION
PLANNING PROCEDURES**

MAY, 1976

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April 15, 1976

Mr. Sam F. Cryderman, Deputy Director
Bureau of Transportation Planning
Michigan Department of State Highways
and Transportation
State Highways Building, P.O. Drawer K
Lansing, Michigan 48904

Dear Mr. Cryderman:

The Highway Planning Division is pleased to present Volume II-A in the Statewide Transportation Modeling System Series. This report documents an important innovation to transportation planning procedures: a system to create alternate regional transportation networks utilizing interactive computer graphics.

In recent years, the bulk of effort in the Statewide Modeling System has been to develop extensive procedures to model travel, social, economic, and environmental impacts of alternate transportation plans. Thus, it is not surprising that the slowest step in the impact modeling process has become the detailed manual coding necessary to create alternate transportation networks. The Statewide network updating system is designed to eliminate manual coding and in the process it makes network creation faster, more accurate, and less costly. Such an increase in productivity is necessary if transportation planning is to keep pace with information demands from fourteen planning regions.

This report, and the interactive network updating system described therein, reflect the efforts of Messrs. Terry L. Gotts and Lawrence G. Scott of the Statewide Transportation Planning Procedures Section, under the supervision of Mr. Richard E. Esch.

Sincerely,

R. J. Lilly, Administrator
Highway Planning Division



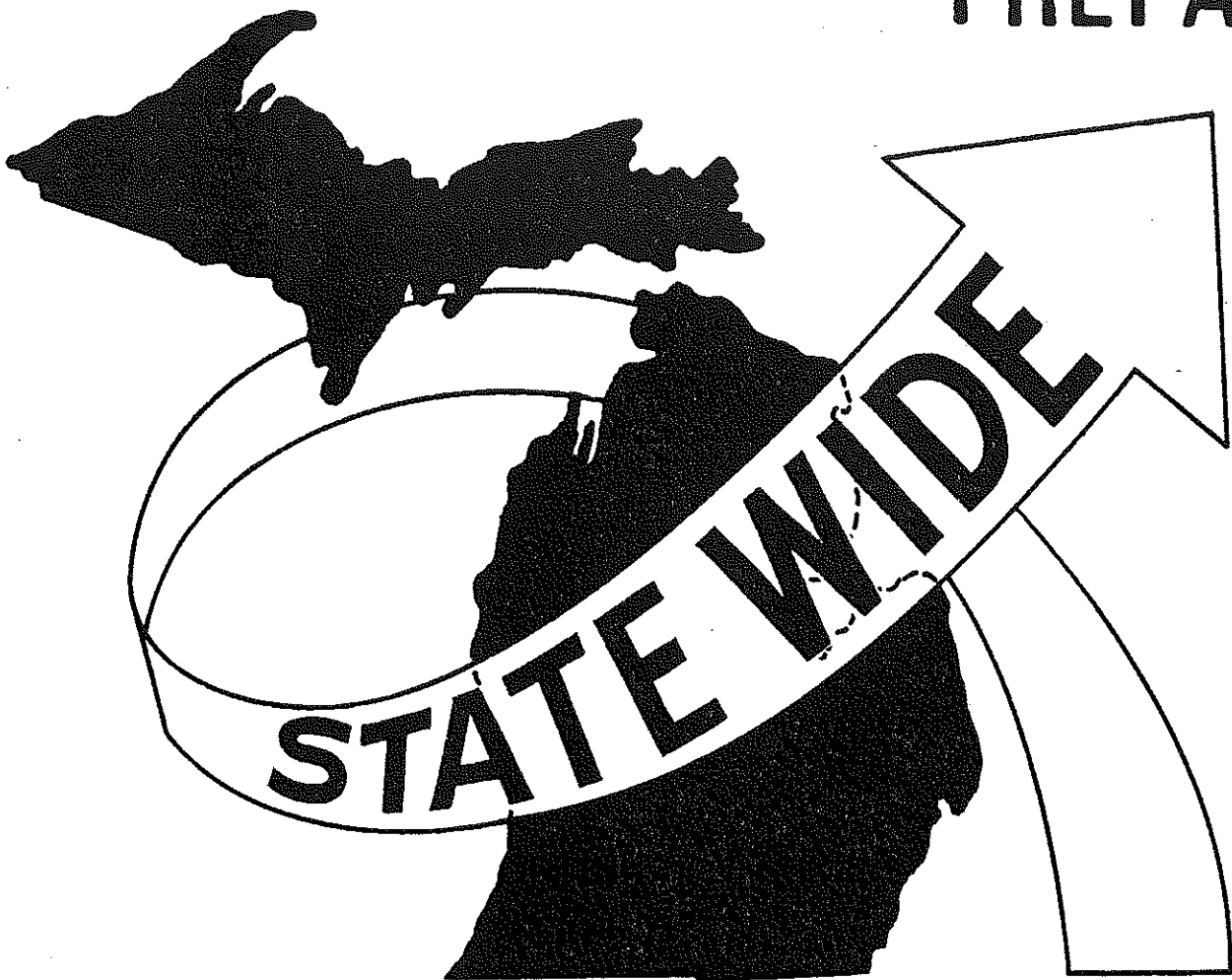
EFFICIENT NETWORK UPDATING WITH INTERACTIVE GRAPHICS

by Terry L. Gotts
and Lawrence G. Scott

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PREFACE



PREFACE

Governments face a challenge in meeting the political realities of the 1970s. On the one hand, legislation and public expectations demand thorough planning and implementation of an expanding range of governmental responsibilities. At the same time, the economic realities of the foreseeable future indicate a governmental "belt-tightening", with personnel and budgets being maintained or cut back rather than increased.

Michigan's Department of State Highways and Transportation faces just such a challenge in its Bureau of Transportation Planning. Although budget and personnel are not rapidly expanding, the requirements on the Department's planning process, from federal legislation, the Department's Action Plan, and concerned citizens, have grown tremendously. The Department must now consider many alternatives and modes and must examine an ever widening range of impacts - travel, social, economic, environmental - for every major transportation project it undertakes. This new planning process is being tested in the Northwest Regional Transportation Study; when complete, it will be adopted by all fourteen regional planning sections within the Department.

The logical response to increasing responsibilities and decreasing resources is to increase productivity. The Statewide Transportation Planning Procedures Section has implemented a system to increase the productivity of personnel who use the Statewide Transportation Modeling System to analyze and compare alternate transportation networks. The Statewide

interactive network updating system described herein:

- (1) decreases workload,
- (2) decreases elapsed time, and
- (3) increases accuracy

thereby allowing the Michigan Department of State Highways and Transportation to more efficiently plan, design, and construct a transportation system.

The network updating system should be seen to be appreciated, not read about.

The system utilizes **interactive graphics**, which means the user and the system respond to each other to create picture displays. The dynamics of such a system cannot be adequately captured in words, or even in the copies of system displays presented in the "System Applications" section. The reader is therefore encouraged to arrange a live demonstration if possible.

This is Volume II-A in the Statewide Series of reports. Previous reports in the series are listed on the following page.

STATEWIDE SYSTEM APPLICATION REPORTS

- VOLUME I - OBJECTIVES AND WORK PROGRAM
- VOLUME I-A - REGION 4 WORKSHOP TOPIC SUMMARIES
- VOLUME I-B - SINGLE AND MULTIPLE CORRIDOR ANALYSIS
- VOLUME I-D - PROXIMITY ANALYSIS
- VOLUME I-E - MODEL APPLICATION: COST-BENEFIT ANALYSIS
- VOLUME I-F - AIR AND NOISE POLLUTION
- VOLUME I-G - PSYCHOLOGICAL IMPACT MODEL
- VOLUME I-H - LEVEL OF SERVICE MODEL
- VOLUME I-I - STATEWIDE SOCIO-ECONOMIC AND TRANSPORTATION RESOURCES
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- VOLUME I-K - EFFECTIVE SPEED MODEL
- VOLUME I-L - SYSTEM IMPACT ANALYSIS GRAPHIC DISPLAY
- VOLUME I-M - MODELING GASOLINE CONSUMPTION
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- VOLUME II-A - EFFICIENT NETWORK UPDATING WITH INTERACTIVE GRAPHICS
- VOLUME II-B - TREE PLOTTING WITH INTERACTIVE GRAPHICS
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- VOLUME III - SEGMENTAL MODEL
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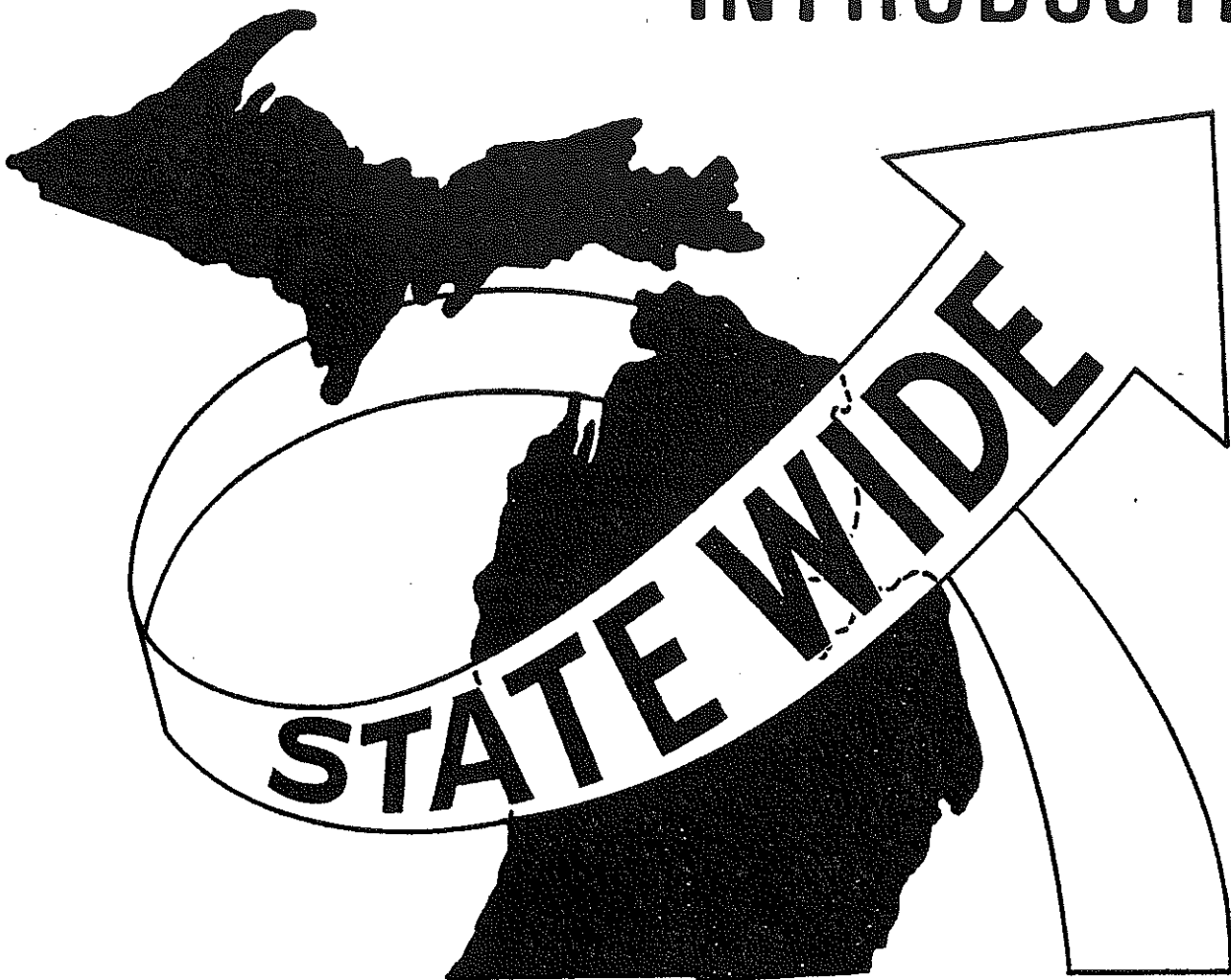
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STATEWIDE SYSTEM REFERENCE HANDBOOKS

- REFERENCE HANDBOOK #1 - STATEWIDE BUS TICKET SURVEY TRAVEL CHARACTERISTICS
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- REFERENCE HANDBOOK #3 - MINOR ORIGIN & DESTINATION TRAVEL CHARACTERISTICS - PART A

INTRODUCTION



INTRODUCTION

As a result of Federal legislation enacted since 1970, it is no longer enough for a transportation agency to say, "We think there ought to be a new road, and it's going to be built right here." First, with increased pressures on state funds, the need for a new road must be justified. If that need can be shown, a number of possible alternatives are proposed, including doing nothing at all or satisfying the transportation deficiency with modes of travel other than the automobile. The social, economic, and environmental impacts of each alternate must be estimated. And the people who live in the region - who must ultimately live with the final solution - must be involved in each step. Based on the evaluations of the first set of alternatives, new alternates may be proposed, and the whole cycle repeated until a consensus is reached. Only at that point can concrete be laid on the ground, if a new road is part of the agreed-upon solution.

However, this process has posed great problems for transportation planning agencies. The difficulties are not based on intent: everyone agrees that tax money should not be spent unnecessarily, and that money spent should be put to the best use. The basic problem is the large amount of manual work and time necessary to define and select the transportation choices for one alternate. First, maps have to be drawn. Then, new roads must be hand-coded so that a computer program can merge them into the "base" network model. Next, another program plots the new network and someone must study the plot to catch any coding mistakes; for instance, if a person is working with hundreds of numbers, it is possible for him to

think "3256" and write "3526". If inaccuracies are found, the changes are coded up, the network updated, plots recreated and the network is edited once again. The whole process takes one to two weeks. Only when it is finished can a traffic assignment be run for the alternate.

So with present manual methods of network updating, the emphasis on public involvement is, in a sense self-defeating. The public realizes that becoming a part of the transportation planning process is in their own interest and are responding enthusiastically. But when Mr. and Mrs. Smith ask "What would be the effect of moving the proposed road ten miles to the east?", the response "We'll let you know in six months" is unacceptable. They want to know while they're still interested in the answer. As more and more enthusiastic Mr. and Mrs. Smiths start asking questions, the planning machinery begins to bog down - elapsed time between questions and answers keeps growing and public enthusiasm declines. The end result is interested but frustrated private citizens who have questions but feel they can't get answers, and well-meaning but frustrated transportation planners who would love to answer the questions but can't get to them for two months.

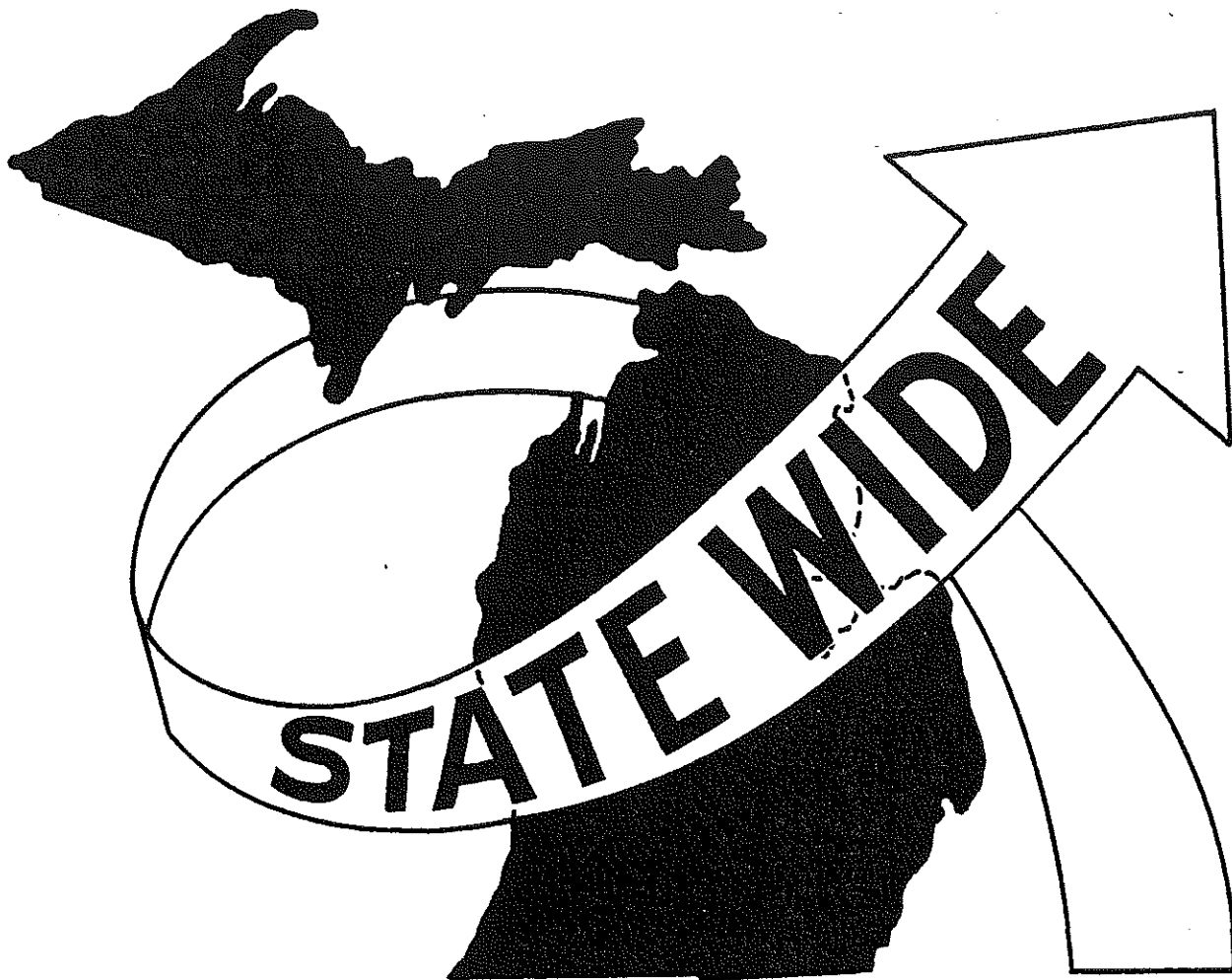
Clearly, a system is needed to cut down the elapsed time between questions and answers. Such a system would have the dual benefit of freeing up manpower for more in-depth impact evaluation, because in this case reducing tedious hand-coding is a big part of cutting elapsed time.

The interactive network updating process documented here goes a long way toward satisfying both objectives. It can eliminate up to eighty percent of the labor and ninety-five percent of the elapsed time needed to evaluate a highway alternate. Moreover, unlike manual coding methods, the interactive

technique is pleasant, almost fun, to use, so there is less chance of "mind-wandering" errors.

This report will deal with the development and applications of an operational interactive network updating process, written in FORTRAN-IV and implemented on a Tektronix 4014-1 graphic computer terminal. The process was developed jointly by Control Data Corporation and the Michigan Department of State Highways and Transportation.

HARDWARE REQUIREMENTS



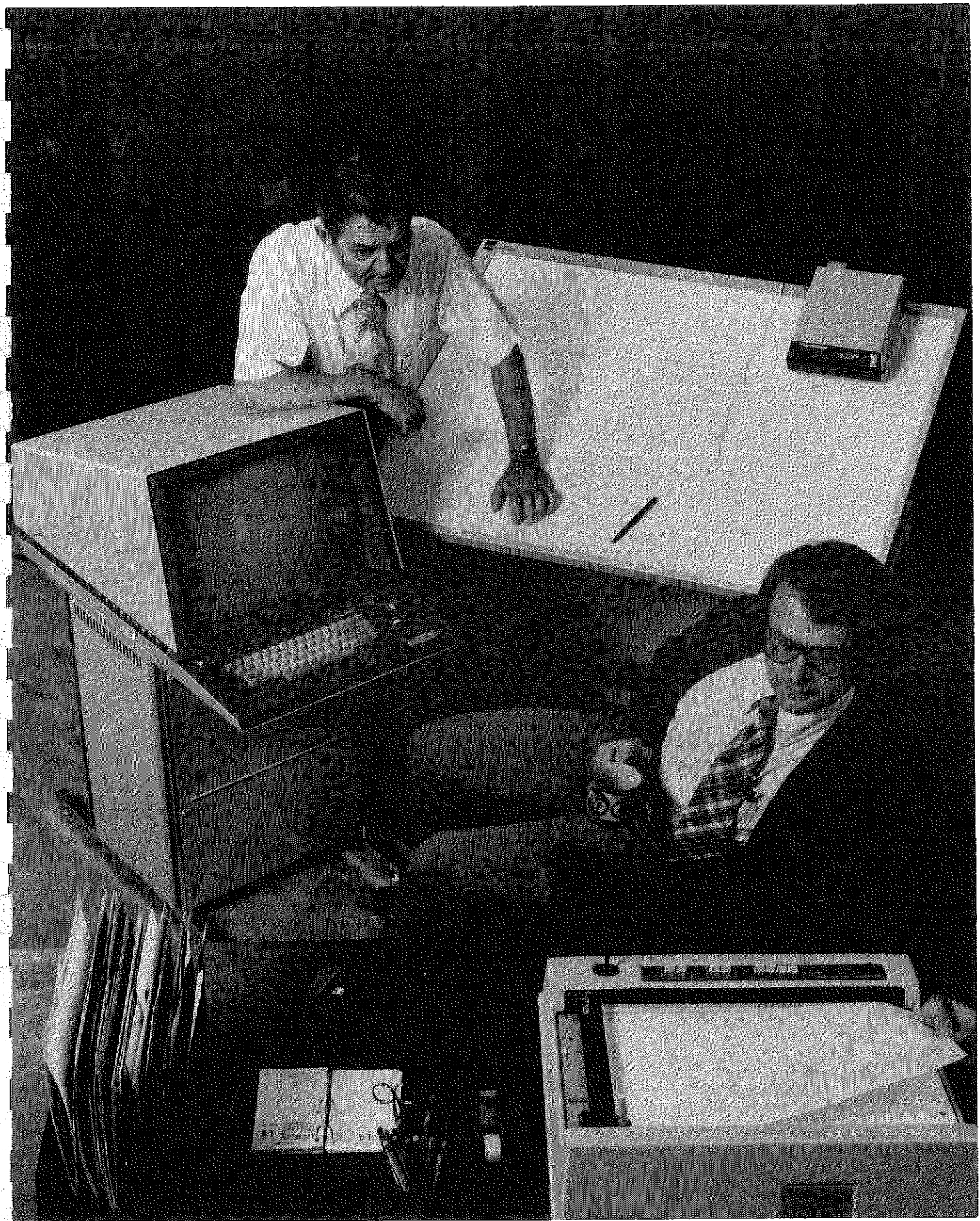
HARDWARE REQUIREMENTS

This section is divided into two parts. The first section deals in general terms with the equipment needed for the interactive network updating process. The second gets into more technical specifics and is designed to provide basic guidelines for anyone desiring to implement the procedure.

General Discussion

There are only two basic "hardware" requirements for implementing a computerized system of network updating. First, the user needs a cathode-ray-tube ("CRT") computer terminal - like the one in Figure 1, similar in appearance to a television screen - which is capable of drawing pictures as well as printing alphanumeric characters. This type of terminal is sometimes referred to as a "full-graphic CRT". Second, there must be access to a computer which both supports a high-level FORTRAN (programming language) compiler and allows a computer program to be linked with routines which actually do the drawing on the screen. These routines are usually purchased from the manufacturer of the CRT at nominal cost.

It is important that the screen of the CRT be large enough to display a natural unit of data - say, a county - without appearing overly cluttered. If it is difficult for the operator to figure out what he is looking at, the purposes of the interactive system - increasing efficiency and accuracy - will not be realized. Screen sizes range from about a ten-inch diagonal rectangle to about nineteen inches on the diagonal. The examples in this report were made on a Tektronix 4014-1, which has a nineteen-inch screen and carries a base price of about \$10,000 to buy or \$700 per month to lease.



Smaller screens carry smaller price tags; screens larger than nineteen inches are generally too expensive to be cost-effective for the procedure described here.

Technical Details

The next paragraphs will be of interest primarily to persons who would actually be doing the implementing of an interactive graphic network update system. They could be bypassed by the more casual reader.

In addition to the consideration of screen size mentioned above, other features should be taken into account before deciding which CRT to buy or lease:

Resolution is important if the program is to calculate the actual length of a link from the screen coordinates of its end points. The Tektronix 4014 series has 4096 x 4096 addressible points. By comparison, the small-screen 4010 has only 1024 x 1024, somewhat increasing the chance of approximation error. The Hughes C-9 has a screen as big as a 4014 but with the resolution of a 4010. The user should decide approximately how many square miles he wants to put on the screen, then compute possible errors for each model of CRT being considered. Pictorially, the situation looks like Figure 2.

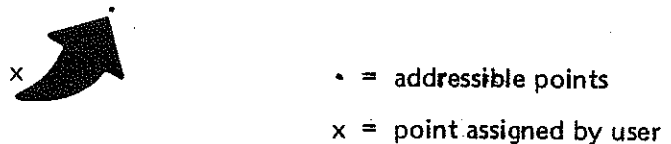


FIGURE 2: Possible Resolution Error

If the user wants to put a node at point "x" and "x" is not an addressible point, "x" will be assigned the coordinates of the nearest addressible point, shown by the arrow. How much resolution error is permissible can only be judged on the basis of each application. In the Statewide network updating system, the coordinate approximation error for most counties can be shown to be on the order of magnitude of about ten feet.

If points are to be referred to the screen by other than (x,y)-coordinates, some method of "pointing" to a particular place on the screen is necessary. This usually takes the form of a crosshair cursor or light pen. It is simply a way of telling the machine "Put a node right here" and having the machine be able to understand. This is called Graphic Input Mode.

Variable alphanumeric character size is a very desirable feature. It can allow one type of labeling to be distinguished from another type. More important, the smaller character sizes give the screen a less cluttered appearance, and labels are less likely to be superimposed.

A hard-copy unit, such as the one shown in Figure 1, is a great asset. It allows the user to take a "photograph" of what is on the screen for future reference. Figures 12 through 28 are hard-copies made on such a unit.

Selective erase - that is, the capability of erasing a part of the screen without redrawing the whole picture - is also desirable, but it becomes less important at higher transmission speeds. For instance, a picture which takes 30 seconds to draw at 300 baud (30 characters per second) on a dial-up line should theoretically take only one second or so if the terminal is hardwired to the computer and driven at 9600 baud.

The Hughes terminals have selective erase, Tektronix does not. But at this writing, the Hughes machines erase by redrawing or reprinting in "erase mode", which means the program has to remember what it has drawn or written. A method of overcoming this limitation is supposed to come out in a few months.

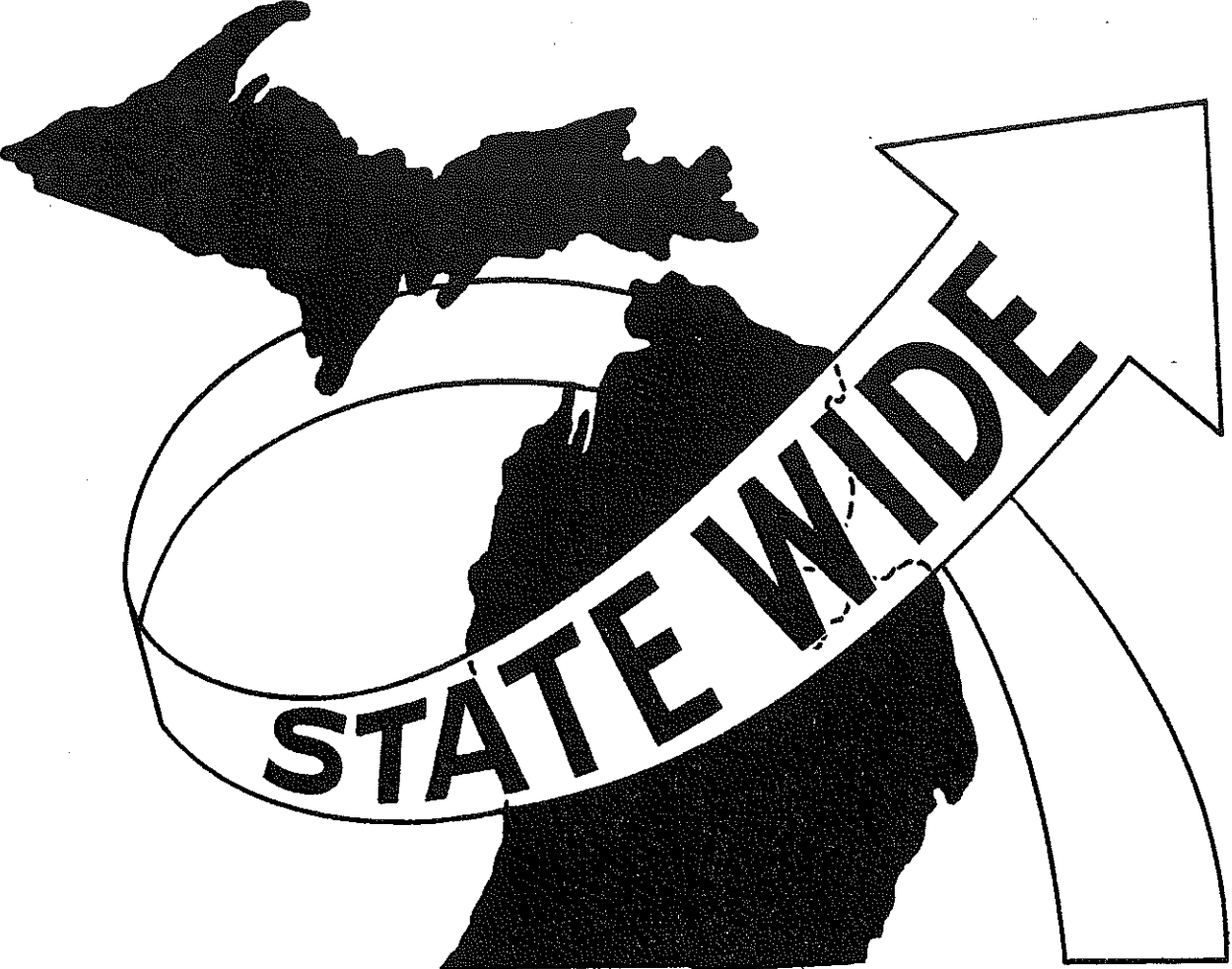
Refresh mode is a very nice, but relatively expensive feature. Basically, refresh mode works like a television screen, so that the position of each point on the screen is updated several times a second. So if one wants to move a line, only the line moves, without having to redraw the entire picture.

A few words are in order about computers. In order to allow several FORTRAN programs to make use of the same plotting software routines, the computer must be high-level enough to allow the linking of a user's compiled program with previously-compiled plot subroutines. This means that the programmer can move a screen cursor with a call to, say, subroutine MOVABS, although no subroutine of that name appears in his source code. The subroutine resides instead in the PLOT-10 subroutine package, which is "linked" or "bound" to the user's program before execution. Examples of such linking capabilities are the LINK-loader on CDC Cybernet's KRONOS time-sharing system or SYSTEM/BINDER on the Burroughs B-6700 or B-7700 systems.

A second consideration is computer speed. Most high-level machines are quite fast, but if a time-sharing system is overloaded, one should think very carefully about investing the time and money required to put up an interactive graphics system on it. Moreover, even a fast line will not help in such a situation: what good does it do to draw at 9600 baud if there is a thirty-second pause between bursts of drawing?

Finally, the reliability of the time-sharing system to be used must be looked at objectively. If the system is prone to frequent periods of down time, this will produce many false starts and restarts in a network update. In that case, it would probably be less frustrating and more productive to stay with manual coding techniques.

SOFTWARE DEVELOPMENT



SOFTWARE DEVELOPMENT

This section describes the software, i.e., computer programs, which make up the transportation network updating system developed by the Statewide Transportation Planning Procedures Section. To appreciate the system requires an understanding of the concepts and tasks utilized for transportation modeling. Those concepts and tasks are therefore discussed here, prior to the actual system development, but only a brief introduction is intended. For a more detailed discussion, see the "Introduction" of Statewide Volume X-A, Statewide Travel Impact Analysis Procedures.

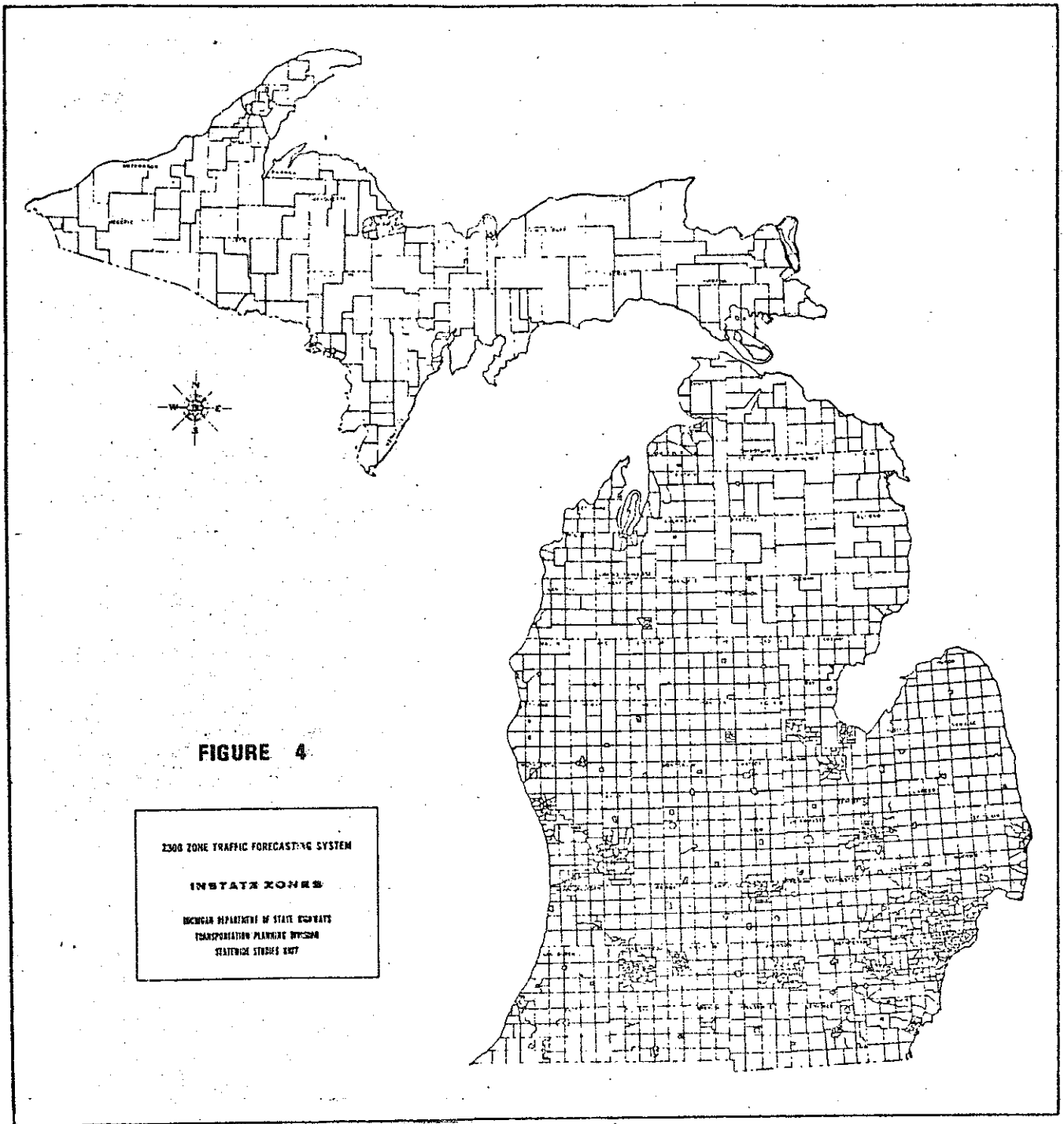
Collection, storage and retrieval of all data employed within the Statewide Transportation Modeling System is tied to a 547 zone system. Of this total, 508 are the "in-state" zones illustrated in Figure 3. The zonal concept is of extreme importance in that it provides a dynamic link between information retrieval and actual modeling procedures. The conversion of raw data from storage within the information files into accurate travel, social, economic, and environmental indicators has been effectively accomplished as a result of gearing the entire system to the zonal format. Figure 4 is a conceptual illustration of a finer 2300 zone system to which all Statewide files are currently being converted.

The transportation network model is the means by which the transportation analyst describes to the computer in its own "language" the transportation system under study. The network is defined in the network model as a set of links and nodes. Nodes are numbered points which are located by (x,y)-coordinates referencing a statewide coordinate grid. A link is defined by



FIGURE 3

**547 ZONE
STATEWIDE TRANSPORTATION
MODELING SYSTEM
INSTATE ZONE MAP
DECEMBER 1973**



its connection of two network nodes. Figure 5-A shows a conceptual drawing of a portion of the highway network within several zones of a zone system. The illustration indicates that there are two basic types of system links - regular links and pseudo-links known as centroid links. A regular link is used to describe a section of the transportation facility (e.g., highway or rail segment) while a centroid, in connecting itself to a node of the base network, allows the feeding of traffic to and from a zone, off of and onto the system.

The transportation analyst must differentiate between types of links according to certain physical and travel characteristics. Each discrete piece of link-specific descriptive data, or link attribute, is stored on magnetic tape in what is known as a "volume field". The primary function of volume fields is to organize the storage of the link data by appropriately numbering the area of tape in which particular information is contained, thus facilitating user access.

An understanding of the volume field concept is critical to one's comprehension of the modeling system for it is consistently employed throughout the process. Figure 5-B illustrates how a highway link's attributes might appear on a segment of magnetic tape if it were visible to the human eye. In creating the network model, data records are taken from punched cards and recorded sequentially on the network tape. First, a link's A and B nodes are recorded to distinguish it from other links within the network. This initial portion of a link's data file contains, in volume fields, other information pertinent to its description - e.g., type (existing or newly created), jurisdiction (who funded the construction and maintains the facility), etc.

FIGURE 5-A: NETWORK DESCRIPTION

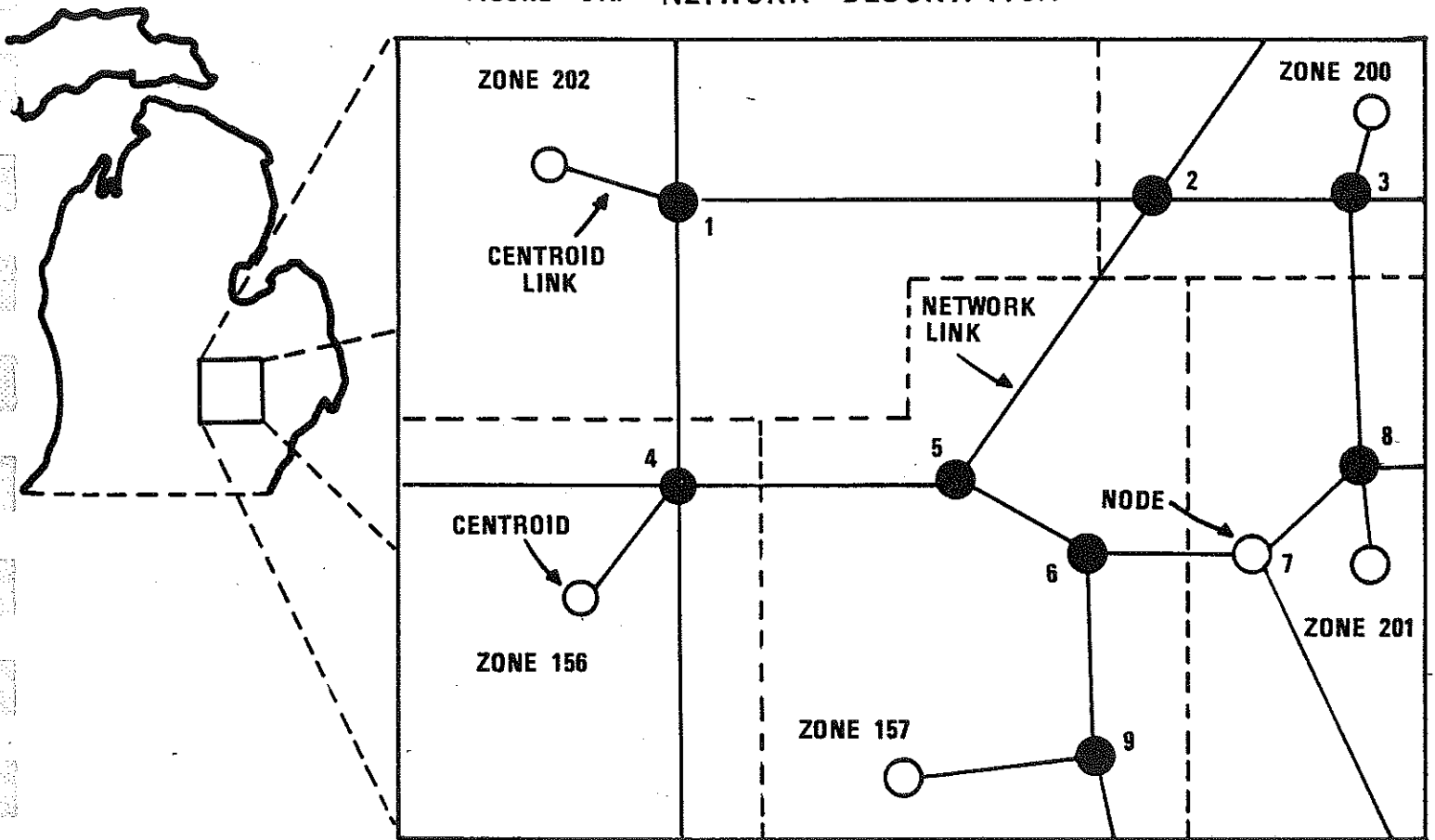
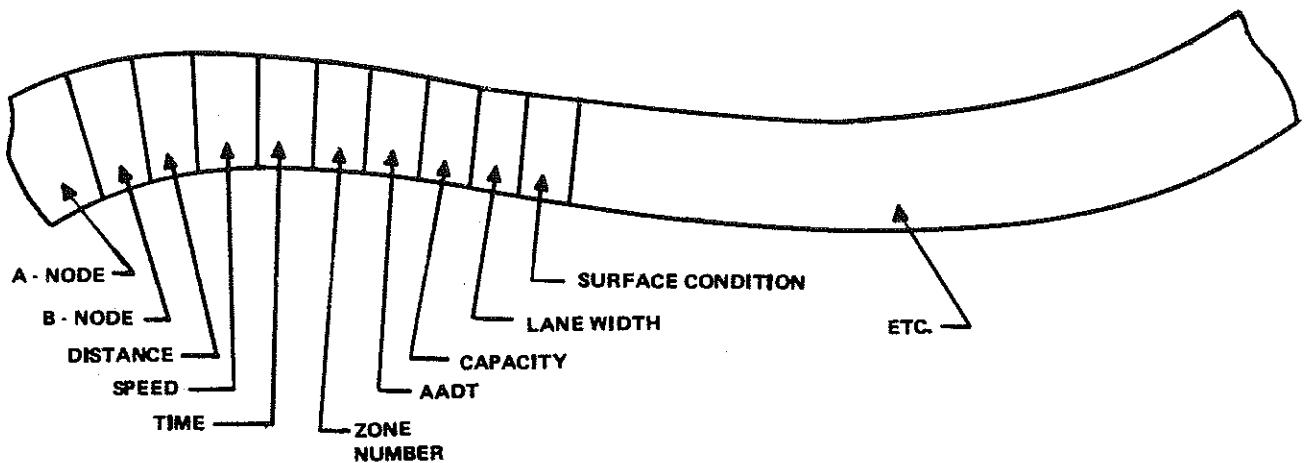


FIGURE 5-B: LINK DESCRIPTION



Once the network tape is created through standard coding procedures and specialized computer programs, it may be modified to simulate alternate transportation proposals. Many such changes are performed when comparisons of travel impacts are desired. The transportation network model provides a primary input not only for the travel forecasting model, but for all models developed within the Statewide System. The steps involved in creating and modifying networks are exacting and time consuming. These are the steps which the interactive network updating system was developed to replace:

Step 1: Cards must be punched to update a base network into the alternate network. The cards are the same format as those used to create the original base network. For the analyst, this means coding, i.e., writing on forms such as Figure 6 from which cards will be punched, all the links and nodes which are to be added, deleted, or changed in the updated alternate network and the link attributes for the new or modified links.

Step 2: After the cards are keypunched, they are input into a series of computer programs which (1) alter the base network to produce an updated alternate network, (2) change or add volume field (link attribute) information, and (3) create a version of the network on tape which can be plotted on paper.

Step 3: After the network plotter tape has been plotted, producing a plot such as Figure 7, the analyst pores over it to ascertain that no errors have been made. Typically, the analyst must check (1) the location of modified nodes, (2) that all the correct links have been added or deleted, and (3) that the volume fields have been correctly updated. If errors are discovered, further updating is begun, going back to Step 1. Often the

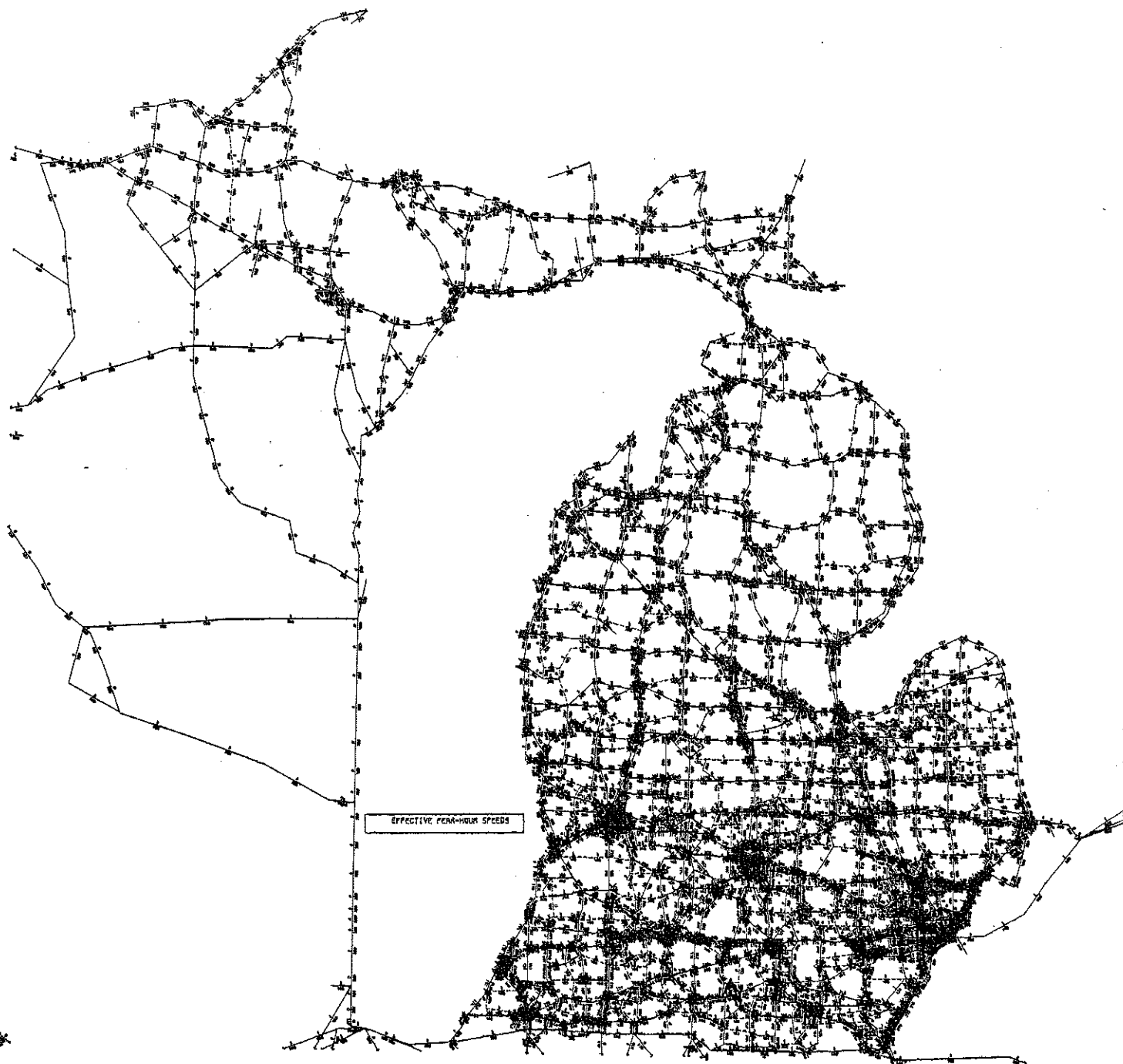


FIGURE 7: Network Plot

entire process is repeated two or three times. Even if gone through only once, it usually takes up to two weeks for coding, computer runs, plotting, and plot checking.

In comparison, the Statewide interactive network updating system is simpler, less laborious, and provides for immediate verification. From the user's perspective, the system is a simple three-part, one-input, one-output system, as shown in Figure 8. The user merely specifies the necessary information to access the base network in the first of three components called; all other file manipulation occurs internally. The user need only pay attention to the location of roads when building the desired network alternate.

The system's first component, TVIN, accesses the base network, which is in a "packed" format for use in the Statewide Transportation Modeling System. TVIN unpacks the network and generates all the files necessary for updating the network and repacking it. TVIN asks the user what counties the alternate will be built in, what link attributes to carry along into the new network, and information necessary to access the base network.

The network updating component, TVEDIT, allows the user to modify the network, one county at a time. It is a user oriented package which will be described in a forthcoming Statewide Report. The following section, "System Application", demonstrates the building of an alternate with TVEDIT.

TVOUT is the component which packs the user's modifications into a network which is ready for input into the Statewide Transportation Modeling System.

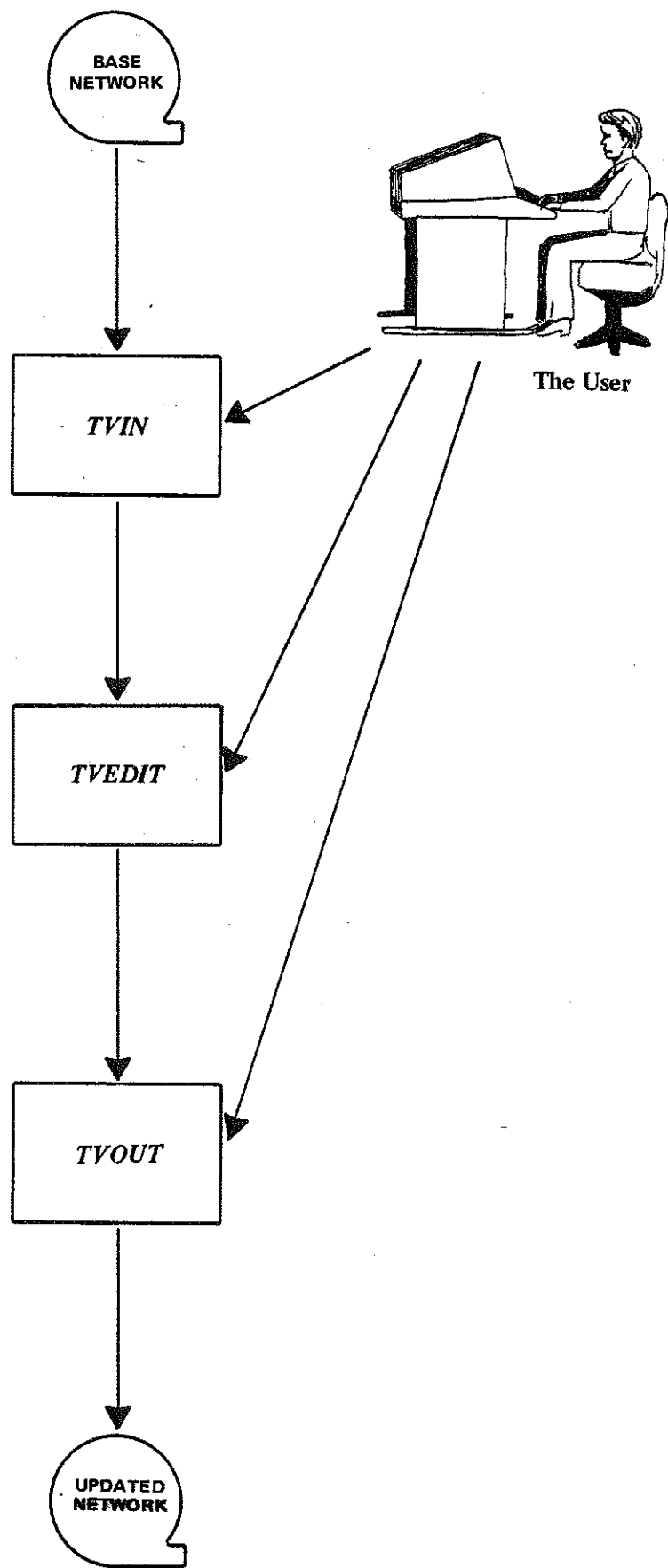


FIGURE 8: Network Updating from the User's Perspective

Internally, the system generates and manipulates many files, as illustrated in Figure 9. Each of those files is described briefly below.

TVIN accesses the user's base network and generates:

- (1) a base alternate information file, which contains basic information about the alternate network being created;
- (2) the links and nodes in the base network, sorted into the user-specified counties, and stored in TVEDIT county network format;
- (3) a file of available node numbers for assignment to new nodes in TVEDIT;
- (4) a file of "other links", i.e., links not in any of the user-specified counties which must be repacked into the edited network by TVOUT; and
- (5) a file of "all nodes" in the base network.

TVIN also internally accesses a file for zone boundaries for the 508 instate zones and produces:

- (6) a file of zone boundaries for each user-specified county.

TVIN sorts the base network, which is simply a list of nodes and associated (x,y)-coordinates and a list of links between nodes and associated transportation link attributes, into counties by keying on a link attribute, control section number.

TVEDIT relies on files created by TVIN to provide a user-oriented and user-directed utility which allows the transportation analyst to creatively update the base network. The TVEDIT routine:

- (1) reads the base network information file and, if the updated alternate is named a different two character code, creates a new updated network information file;
- (2) displays the base county networks and updates them, creating updated county networks;
- (3) uses and updates the available node numbers list; other information written to the available nodes file are nodes which are created on county boundaries and renumbered nodes;

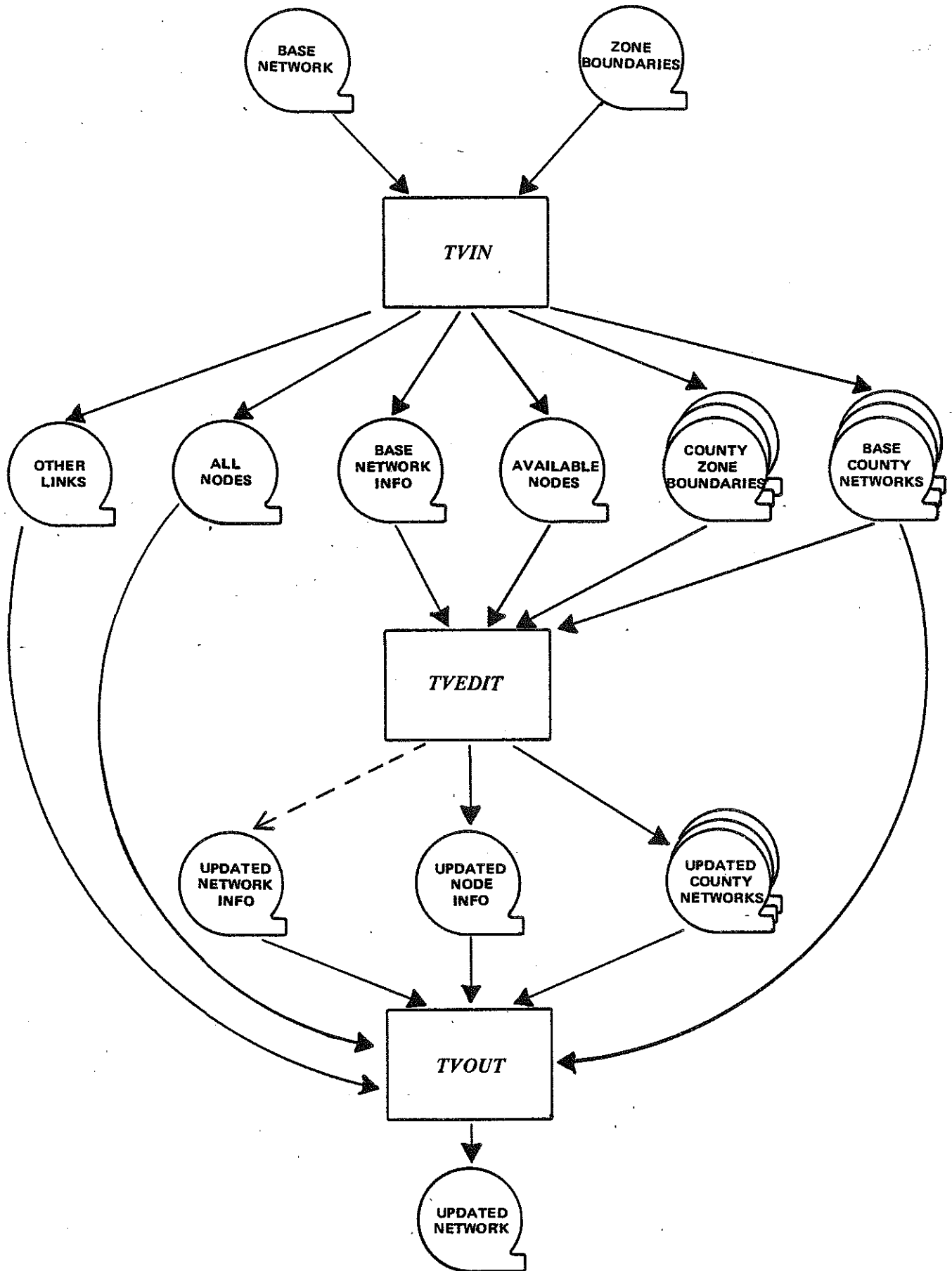


FIGURE 9: Network Updating System File Manipulation

(4) displays the county zone boundaries for user reference.

As illustrated by Figure 10, TVEDIT uses sophisticated file management routines and Tektronix-compatible PLOT-10 software to add, alter, or delete nodes, links and link attributes, network internal titles, and alternate codes.

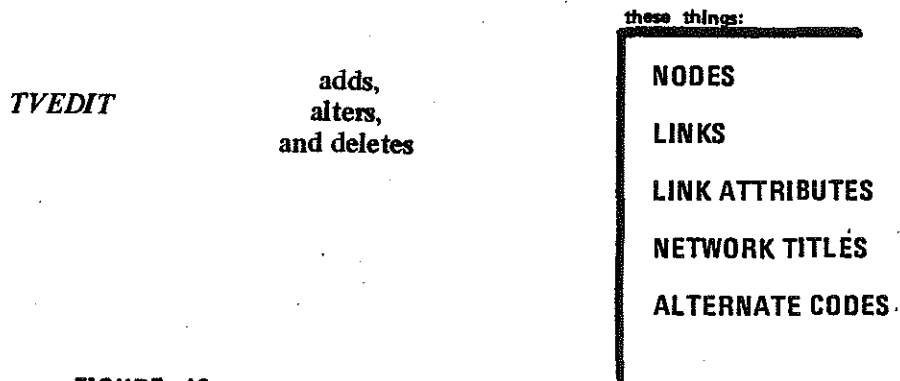


FIGURE 10

TVOUT, in a sense, reverses the processes of TVIN to build the updated county files into a packed network to be tested in the Statewide Modeling System. In constructing the new network, TVOUT relies upon:

- (1) the updated alternate network information file,
- (2) the updated county networks or base county networks which were not updated,
- (3) the file of "other links" created by TVIN,
- (4) the base network file of "all nodes" created by TVIN,
- (5) the list of renumbered nodes.

TVOUT edits all the links and nodes in the above files and sorts them into the order required for packing into network format.

The three components, TVIN, TVEDIT, and TVOUT, may each be run in separate interactive sessions, and TVEDIT may be run in any number of sessions for the same alternate. A final component, TVPURG, purges all files associated with a given alternate network code.

TVIN, TVOUT, and TVPURG are program-directed to get information from the user. TVEDIT, however, requires creative action and specific information possessed by the transportation analyst. As such, TVEDIT requires some familiarizing with its concepts and commands. The following section, "System Application", serves as an introduction to the basic concepts and commands in interactive network updating. A more detailed description of TVEDIT use will be found in a user manual to be published shortly.

SYSTEM APPLICATIONS

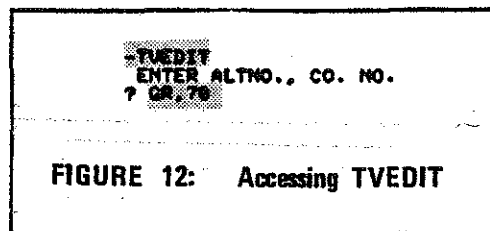


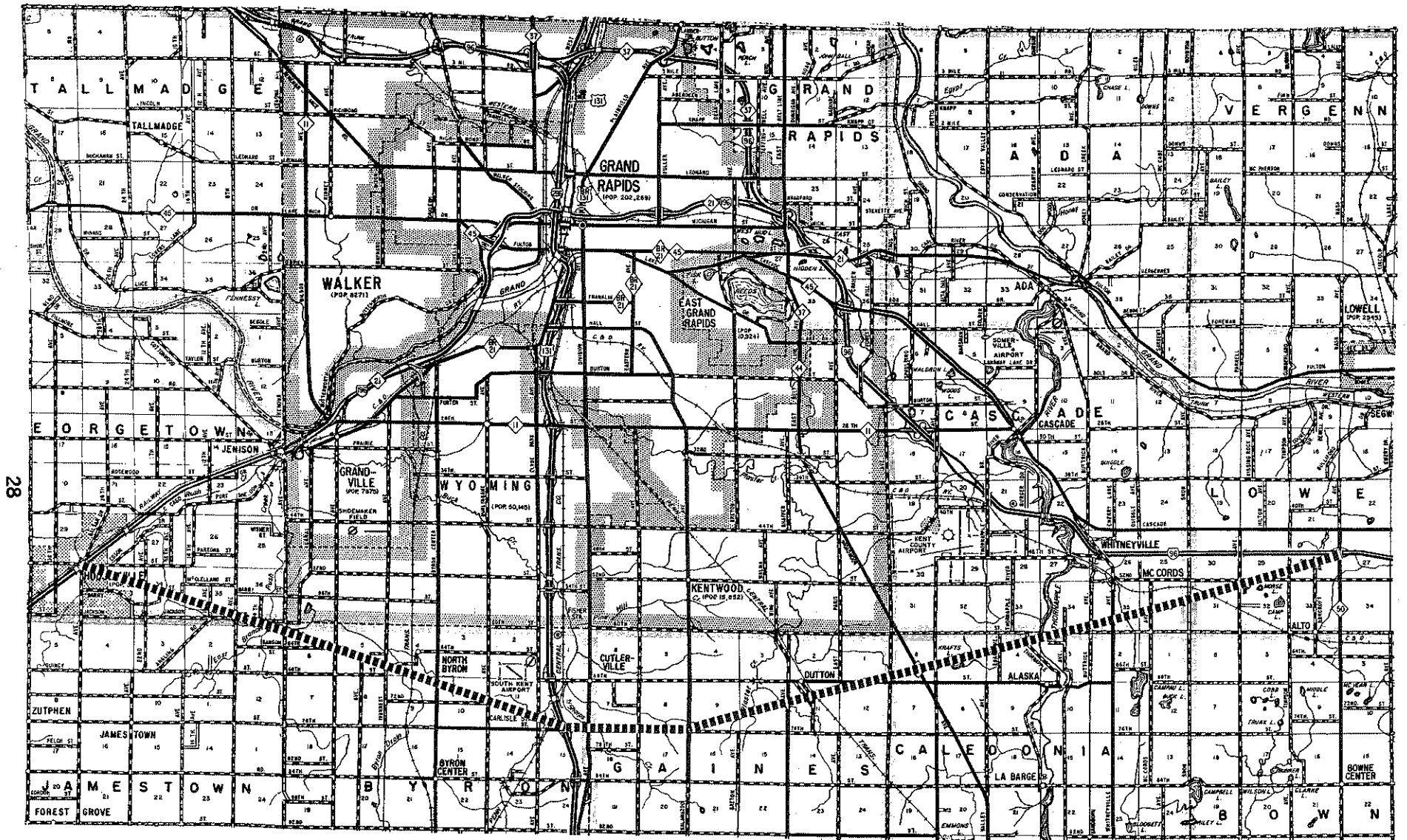
SYSTEM APPLICATIONS

The following section is an actual application of the concepts and commands of the TVEDIT component of the Statewide interactive network updating system. The alternate to be created by TVEDIT is a highway alternate consisting of Federal Aid Primary state trunkline. As shown in Figure 11, the new road would connect I-196 southwest of Grand Rapids to I-96 southwest of the city, forming a southern bypass. The example chosen is a simple, but viable example of network updating.

To create the Grand Rapids bypass with TVEDIT required unpacking a base network with TVIN. For this example, TVIN has already been called, to unpack a 1970 "existing" base network. Figures 12 through 28 will take the reader step by step through the TVEDIT commands to add the new road. The figures are exact copies of the actual CRT displays, except for the shading and arrows which were added later to help the reader follow the text. The figures were produced by a hard-copier like that pictured in Figure 1.

Figure 12, below, shows the one word access to TVEDIT, which responds by asking the alternate code and county number desired. Since alternate GR already exists, TVEDIT accesses all files and produces Figure 13, the links in county 70, Ottawa. Comparing Figure 13 to Figure 13-A, which is the transportation analyst's base map for Ottawa, it is evident that the TVEDIT network accurately depicts the highway network in Ottawa County.





28

FIGURE 11: Grand Rapids Bypass Alternate

New road


ENTER FUNCTIONAL COMMAND

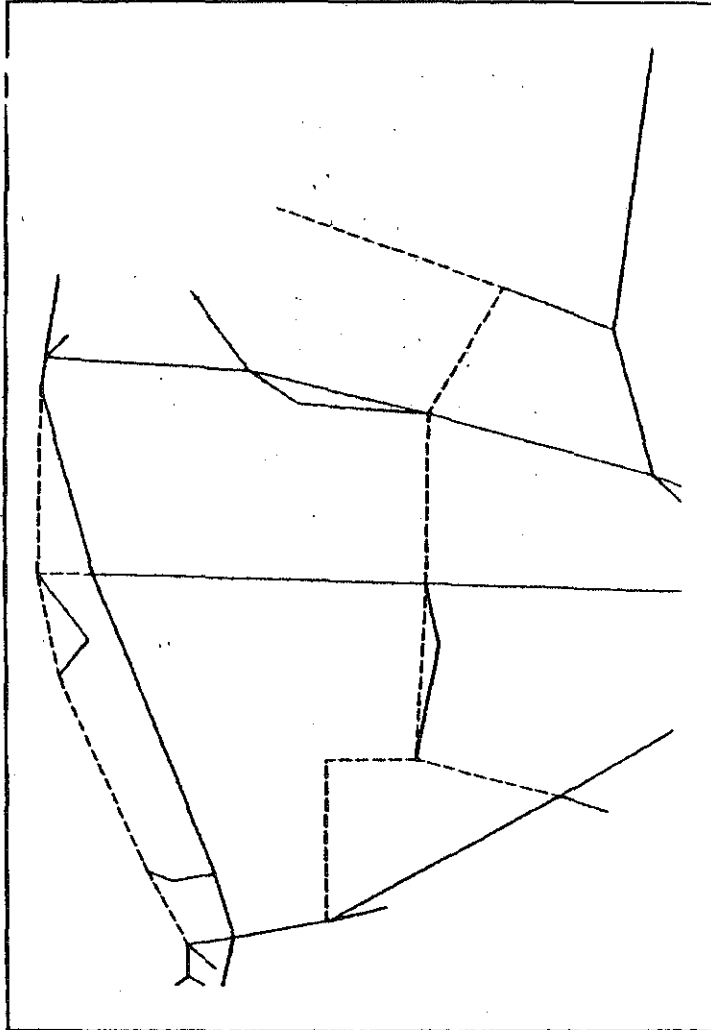


FIGURE 13: Ottawa County Base Network
29

As Figure 13-A indicates, only a small portion of Ottawa County contains the new road, and hence is of concern. Figure 14 illustrates the steps to enlarge the shaded portion of the network. Upon receiving an "ENLG" command, TVEDIT displays the crosshair cursor, which is a horizontal and a vertical line whose intersection defines a point on the screen. Because the cursor is too dim to reproduce with the hard copier, arrows have been added to Figure 14 to indicate that opposite corners of the shaded area were selected for the two cursor positions. TVEDIT clears the screen and produces the enlarged view, complete with node numbers and zone boundaries, shown in Figure 15.

Figure 16 illustrates adding a node on the Kent-Ottawa County boundary. (Nodes are put at county boundaries to allow county summaries of impacts.) The "ADDN" command again calls the cursor and the user positions it (at the arrow) and enters a special code to indicate the node lies on the county boundary. TVEDIT asks what the other county is, the user responds, and TVEDIT draws in the new node.

In Figure 17, the new node is connected to the network, by adding a link: "ADDL,1578,5255". TVEDIT asks what jurisdiction (interstate, state trunkline, county, local) the new link is to be, and dots in the tentative location for user confirmation. In Figure 18, the user confirms the location and enters network model information: zone number, control section, DHV percent, and pattern factor. TVEDIT inserts a solid line (for jurisdiction 3) and adds the link to the updated county network.

Figure 19 illustrates the command to call county 41, Kent. TVEDIT inquires whether the updated county network for Ottawa is to be saved. At the user's Y (for Yes) response, the program saves the updated network and displays the links for Kent County, Figure 20. Again, the TVEDIT network matches the analyst's base map, Figure 20-A, quite well.

ENTER FUNCTIONAL COMMAND
? ENLG
POSITION CURSOR
POSITION CURSOR

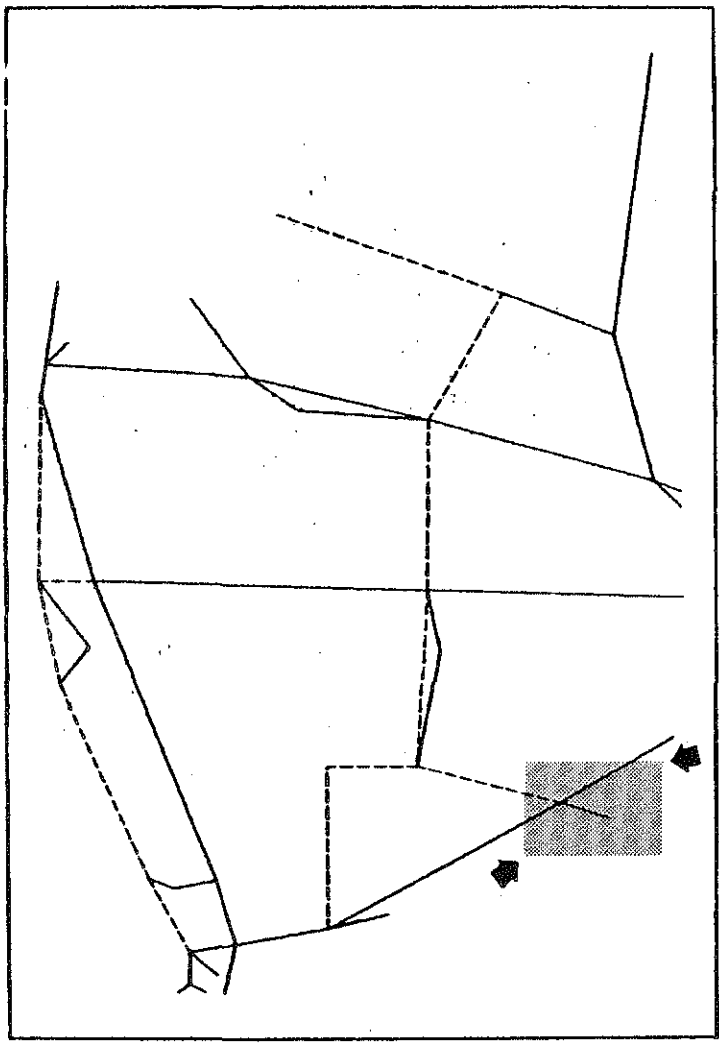


FIGURE 14: Enlarging the View

GRAND RAPIDS BYPASS ALTERNATE BUILT WITH TUEDIT PACKAGE

OTTAWA

ENTER FUNCTIONAL COMMAND

?

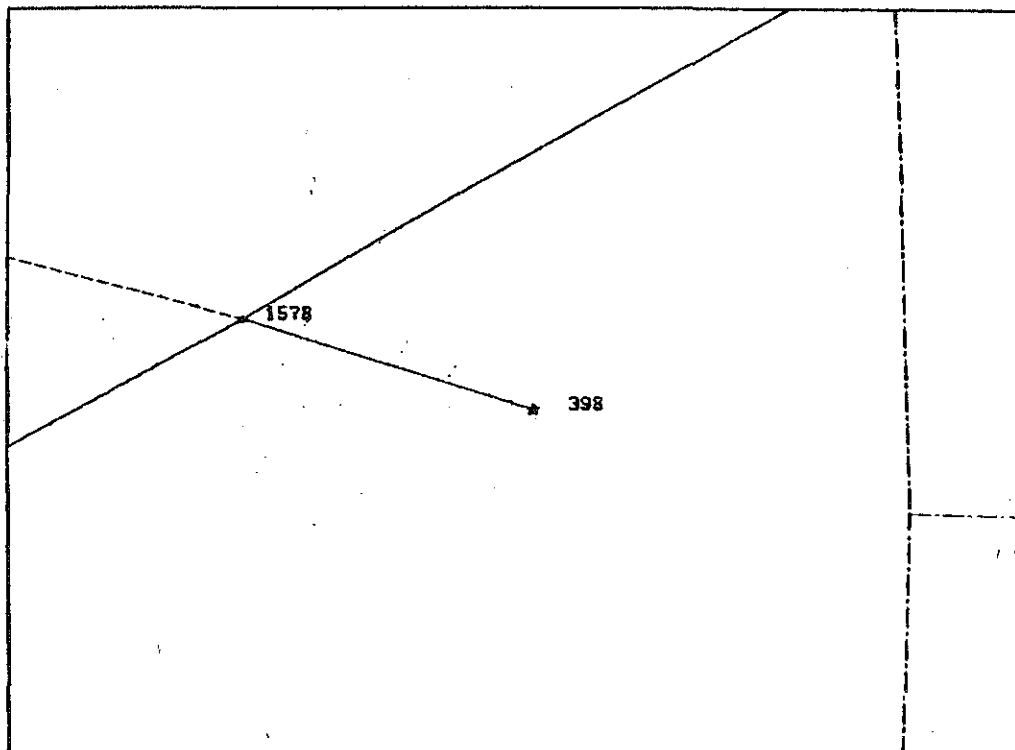


FIGURE 15: Enlarged View

GRAND RAPIDS BYPASS ALTERNATE BUILT WITH TUEDIT PACKAGE

OTTAWA

ENTER FUNCTIONAL COMMAND

? ADDN
POSITION CURSOR

ENTER BOUNDARY COUNTY

? 41
ENTER FUNCTIONAL COMMAND

?

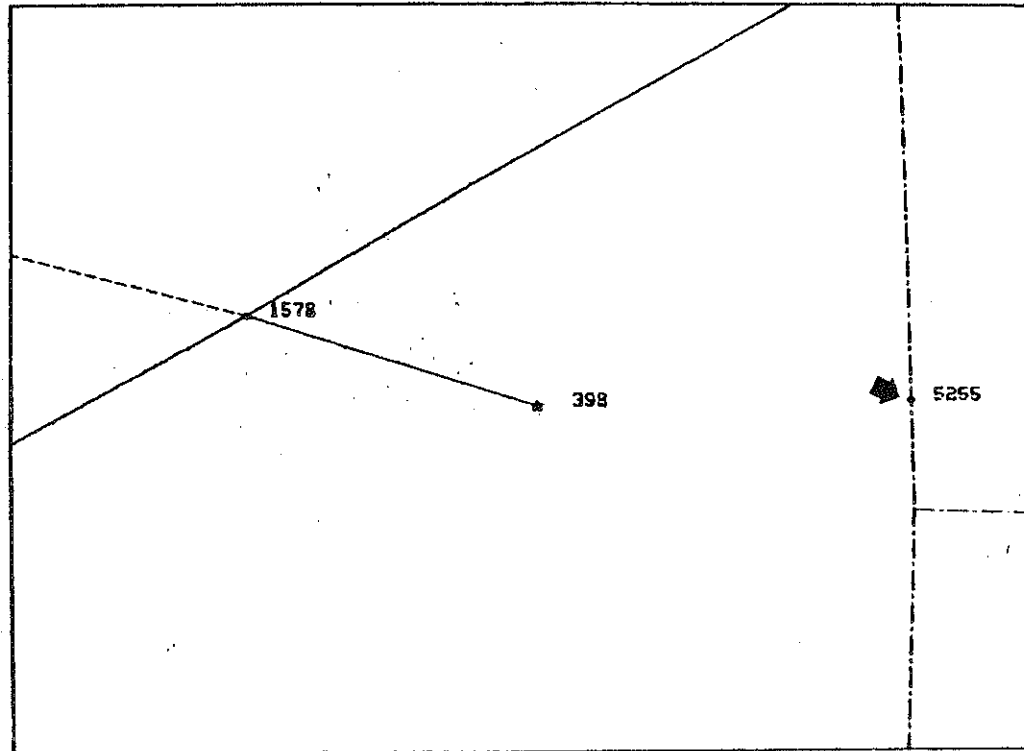


FIGURE 16: Adding a Node

GRAND RAPIDS BYPASS ALTERNATE BUILT WITH TUEDIT PACKAGE

OTTAWA

ENTER FUNCTIONAL COMMAND
? ADDN
POSITION CURSOR
ENTER BOUNDARY COUNTY
? 41
ENTER FUNCTIONAL COMMAND
? ADDL 1578 5255
ENTER JURISDICTION
? 3
CONFIRM ADDITION
?

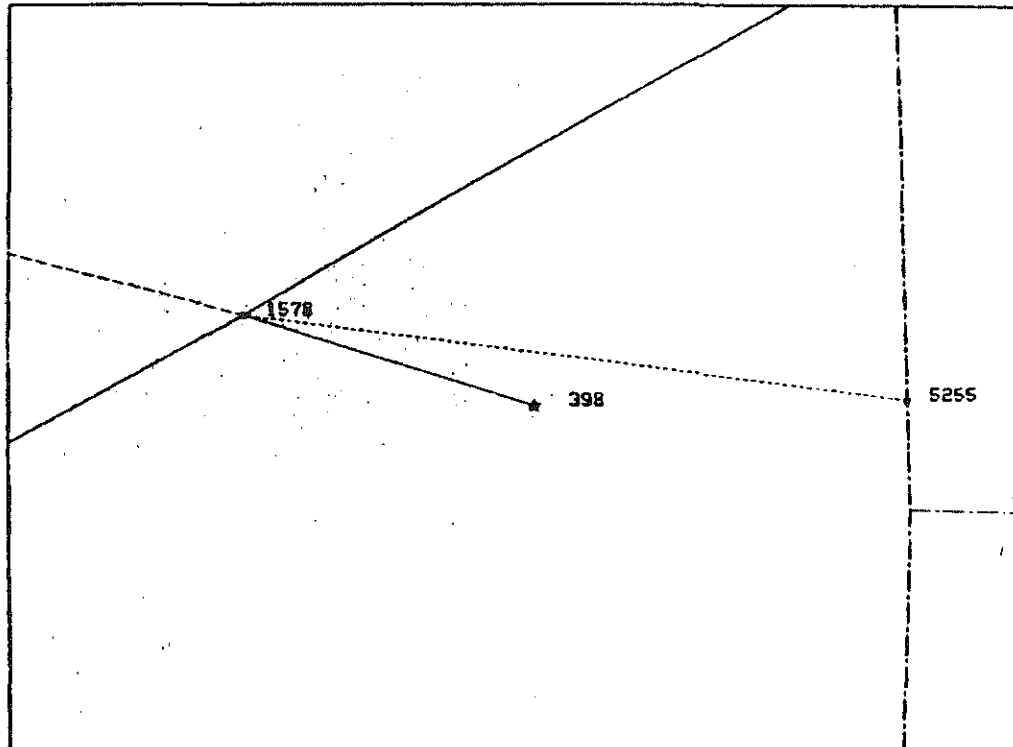


FIGURE 17: Locating a New Link

GRAND RAPIDS BYPASS ALTERNATE BUILT WITH TUEDIT PACKAGE

OTTAWA

ENTER FUNCTIONAL COMMAND

? ADDN
POSITION CURSOR

ENTER BOUNDARY COUNTY

? 41

ENTER FUNCTIONAL COMMAND

? ADDL, 1578, 5255
ENTER JURISDICTION

? 3
CONFIRM ADDITION

? OK

FOR 1578-5255,

ENTER ZONE, C.S., DHUPCT, P.F.

? 398, 76991, 14, 818

ENTER FUNCTIONAL COMMAND

?

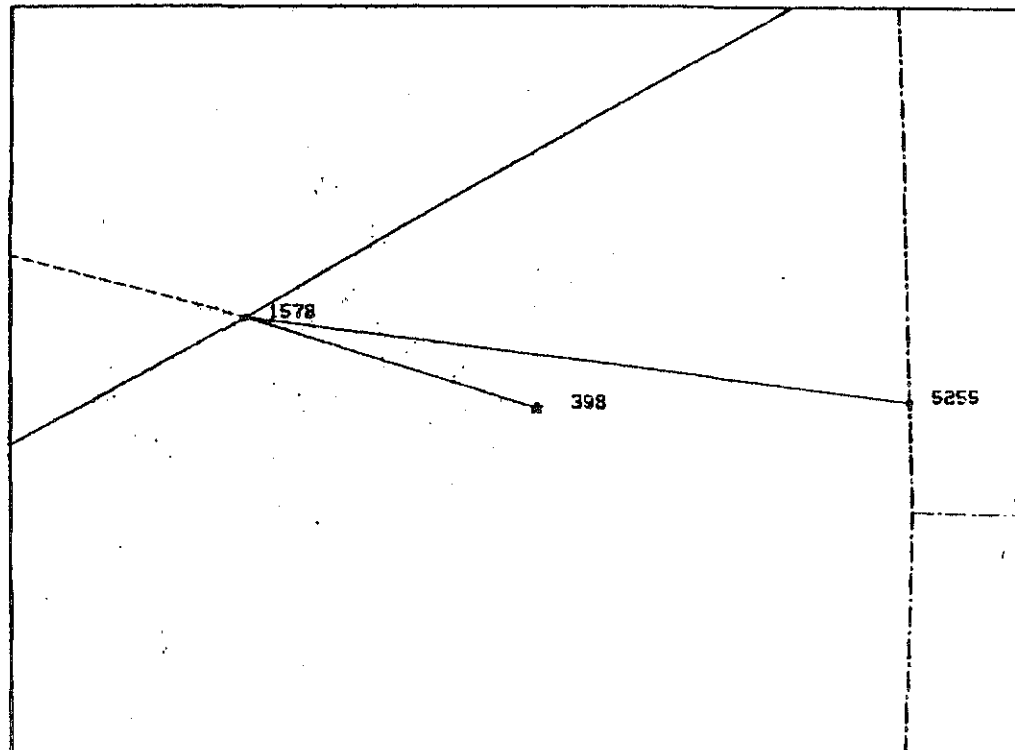


FIGURE 18: Adding the New Link

GRAND RAPIDS BYPASS ALTERNATE BUILT WITH TUEDIT PACKAGE

OTTAWA

ENTER FUNCTIONAL COMMAND

? ADDN
POSITION CURSOR

ENTER BOUNDARY COUNTY

? 41

ENTER FUNCTIONAL COMMAND

? ADDL 1578, 5255
ENTER JURISDICTION

? 3
CONFIRM ADDITION
? OK

FOR 1578-5255.

ENTER ZONE, C.S., DHPCT, P.F.

? 398, 70991, 14, 818

ENTER FUNCTIONAL COMMAND

? HELP 31

IS FILE TO BE SAVED

? Y

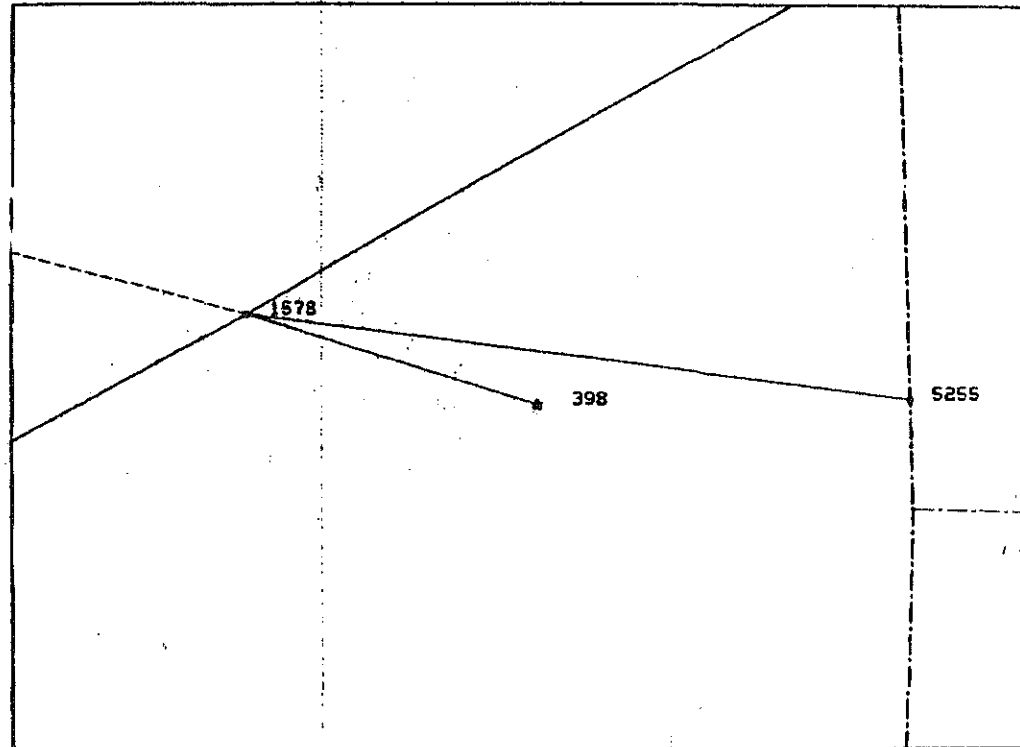
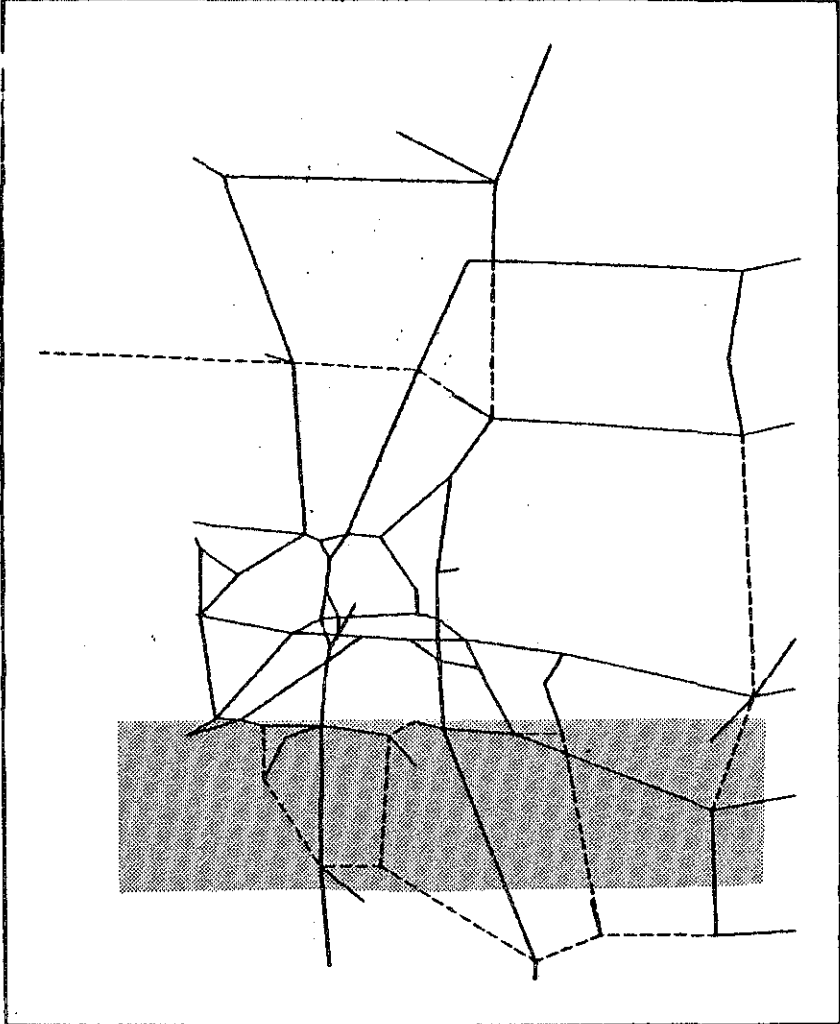
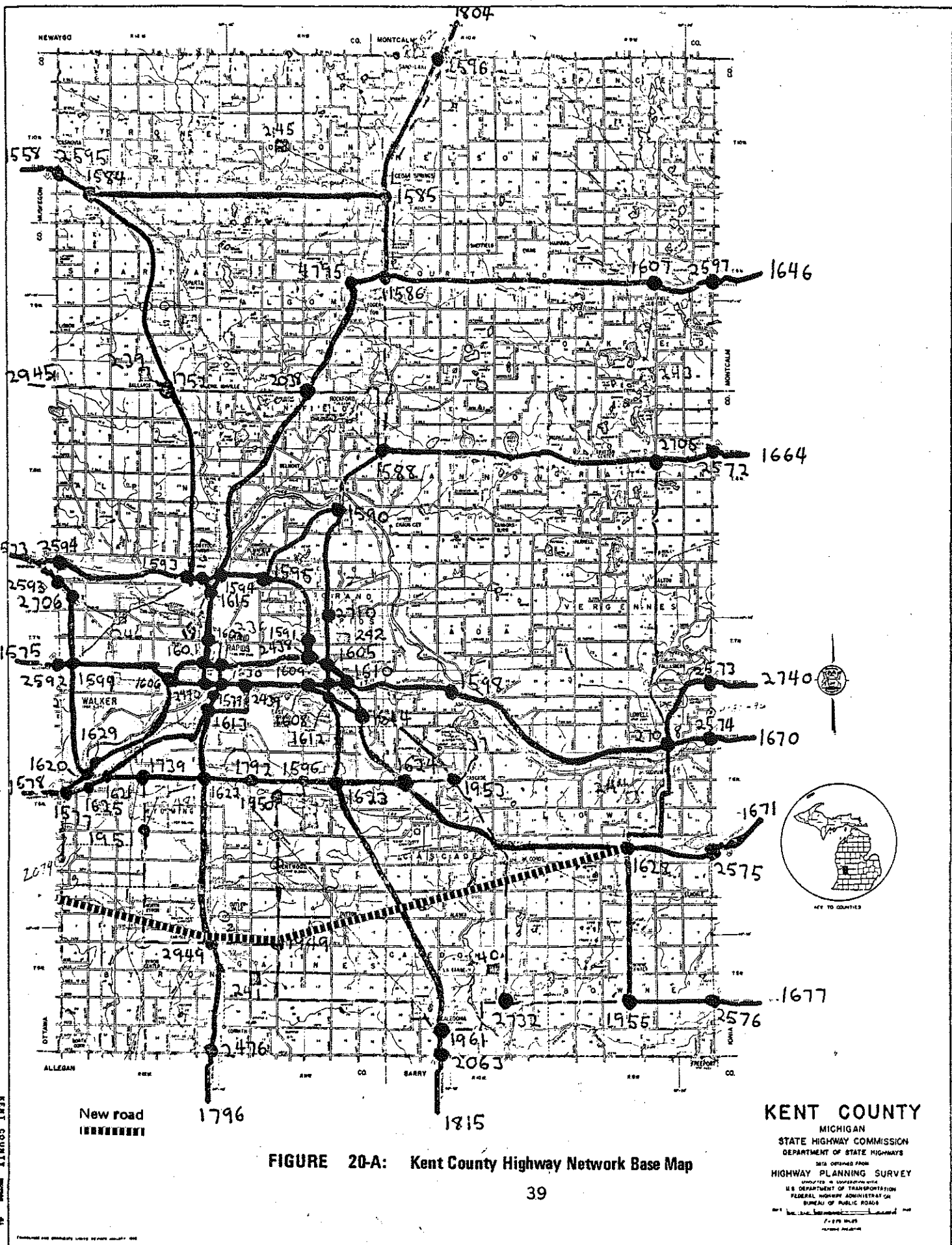


FIGURE 19: Calling a New County

ENTER FUNCTIONAL COMMAND

FIGURE 20: Kant County Base Network





KENT COUNTY
MICHIGAN
STATE HIGHWAY COMMISSION
DEPARTMENT OF STATE HIGHWAYS

INFO OBTAINED FROM
HIGHWAY PLANNING SURVEY
UNDERTAKEN IN COOPERATION WITH
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

Not pictured are steps, similar to Figure 14, to enlarge the shaded portion of Figure 20, producing Figure 21, the area in Kent where the new alternate is to go. Note that node 5255 which was added on the Ottawa-Kent boundary appears on the leftmost boundary (arrow).

Figure 22 illustrates the addition of a link from the county boundary node added in Ottawa County to the network (arrow points to new link). The steps used are the same as in Figures 17 and 18.

In Figure 23, the jurisdiction of an existing link is upgraded from a county road to state trunkline, which simulates building a segment of the new road on an existing right-of-way. In TVEDIT, this particular change is illustrated by the type of line used for the link. After the change, the link, 2949-1949 (arrow) is displayed by a solid line (for jurisdiction 3, state trunkline); before the change, as in Figure 22, it is displayed by a dashed line (for jurisdiction 7, county road). All link attributes are changed internally by the "CJ" command but the user could also change any attributes explicitly in the "CHGP" module.

Figure 24 is a somewhat enlarged view to show all of link 1624-1961; that link is split into two links to allow an interchange with the bypass. Upon receiving a "SPLT" command, TVEDIT displays the cursor for the user to position. TVEDIT then deletes the old long link, asks information about the two new links, adds a new node at the cursor position (arrow), and adds the two new short links.

Figure 25 completes the bypass by adding two links to the new node created by the link split (two dark arrows). Note the county road (dotted line) which is bypassed by the new road because no node links it to the new road at their intersection (hollow arrow).

ENTER FUNCTIONAL COMMAND

?

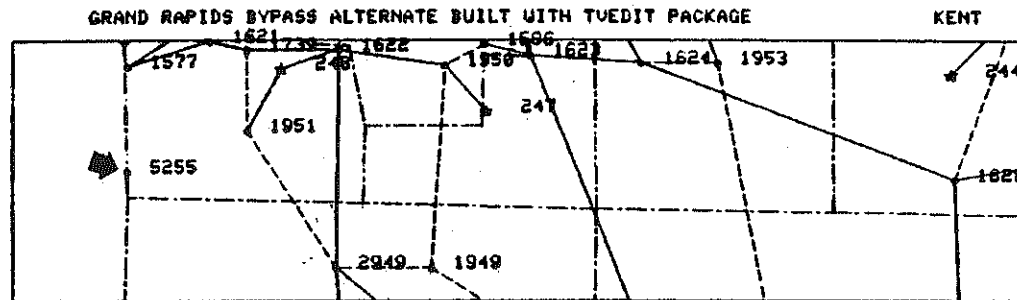


FIGURE 21: Enlarged View

ENTER FUNCTIONAL COMMAND
 ? ADDL 5255 2949
 ENTER JURISDICTION
 ? 3
 CONFIRM ADDITION
 ? OK
 FOR 5255-2949.

ENTER ZONE, C.S., DHPCT, P.F.
 ? 241 41001 14 818
 ENTER FUNCTIONAL COMMAND
 ?

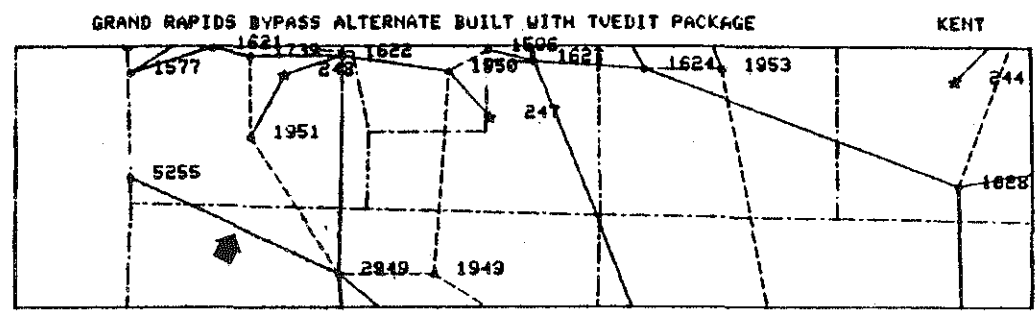


FIGURE 22: Adding Another New Link

ENTER FUNCTIONAL COMMAND

? ADDL 5255, 2949
ENTER JURISDICTION

? 3
CONFIRM ADDITION

? OK
FOR 5255-2949,

ENTER ZONE, C.S., DISTRICT, P.F.

? 241, 41991, 14, 818
ENTER FUNCTIONAL COMMAND

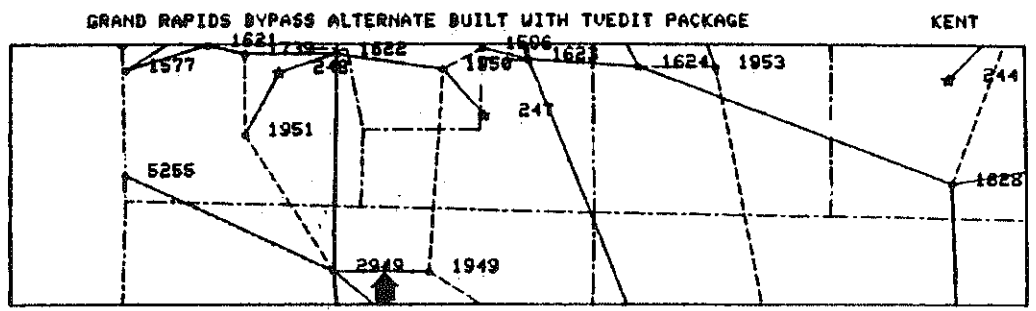
? CHGP, 2949, 1949
ENTER COMMAND, VALUE

? C1, 3
ENTER COMMAND, VALUE

? RE
ENTER FUNCTIONAL COMMAND

?

FIGURE 23: Changing a Link from County Road to State Trunkline



ENTER FUNCTIONAL COMMAND

? 5P11 1623, 1961
POSITION CURSOR

FOR 1623-5256.

ENTER ZONE, C.S., DHPCT, P.F.

? 247
FOR 5256-1961.

ENTER ZONE, C.S., DHPCT, P.F.

? 248
ENTER FUNCTIONAL COMMAND

?

GRAND RAPIDS BYPASS ALTERNATE BUILT WITH TUEDIT PACKAGE

KENT

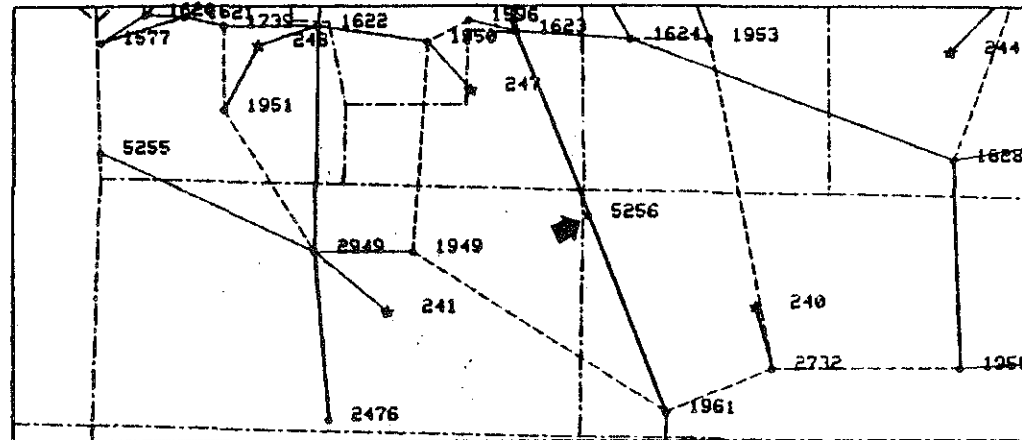
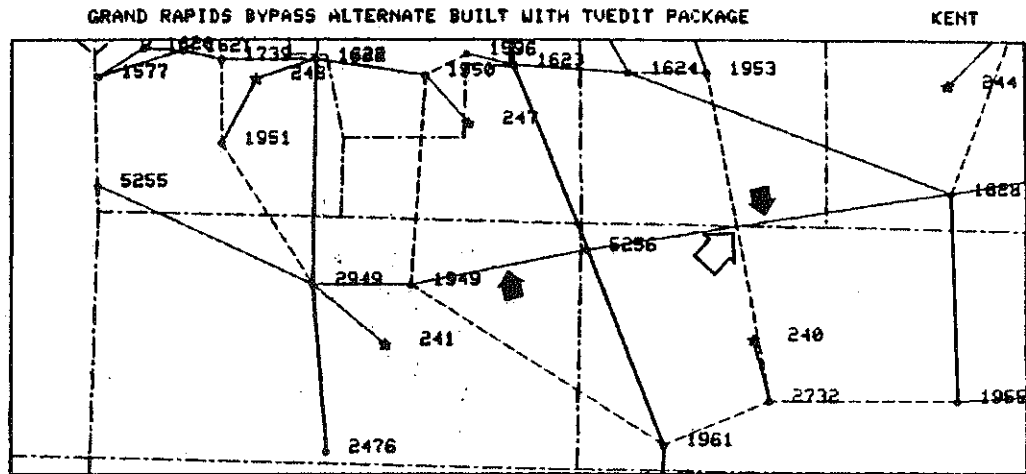


FIGURE 24: Splitting a Link

?
 ENTER FUNCTIONAL COMMAND
 ? SPLT 1623, 1961
 POSITION CURSOR
 FOR 1623-5256,
 ENTER ZONE, C.S., DHUPCT, P.F.
 ? 247/
 FOR 5256-1961,
 ENTER ZONE, C.S., DHUPCT, P.F.
 ? 240/
 ENTER FUNCTIONAL COMMAND
 ? ADDL 1949, 5256
 ENTER JURISDICTION
 ? 3
 CONFIRM ADDITION
 ? OK
 FOR 1949-5256,
 ENTER ZONE, C.S., DHUPCT, P.F.
 ? 241, 1991, 14, 818
 ENTER FUNCTIONAL COMMAND
 ? ADDL 5256, 1628
 ENTER JURISDICTION
 ? 3
 CONFIRM ADDITION
 ? OK
 FOR 5256-1628,
 ENTER ZONE, C.S., DHUPCT, P.F.
 ? 240, 1991, 14, 818
 ENTER FUNCTIONAL COMMAND
 ?

FIGURE 25: Adding Two More New Links



To insure link attributes are correct on the new road, the picture was again enlarged, without node numbers, and link attributes 11, 13, and 14 - control section, pattern factor, DHV percent - displayed along the links in Figure 26. A second view, Figure 27, displays link distance, coded link speed, and accident rates (all having implied decimals, e.g., link distance 250 is 2.50 miles).

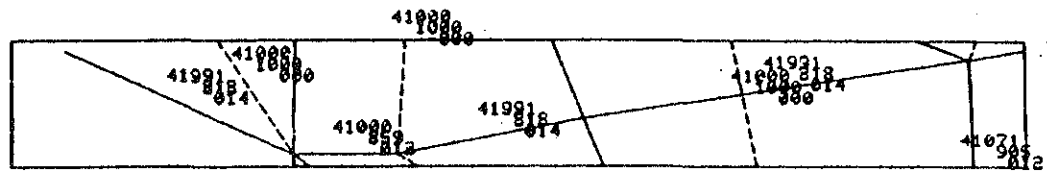
Figure 28, is a view of the updated Kent County network. The user then calls the program end, which inquires whether to save Kent County, does so, and ends.

This illustration was taken from an actual test in which identical alternates were created both by manual-coding methods and by use of the interactive system. With the interactive process, a new road from Grand Rapids to Bay City was entered into the network in under four hours. The manual effort, in comparison, required two days of coding, another day for keypunching, and almost a week more before computer plots of the updated network were available for checking. At that time, one coding error was discovered. But that one error cost three more days of elapsed time, because the new network had to be updated once again before it could be used for impact prediction.

Based on tests such as this one, the interactive network updating system is expected to save approximately thirty-six man-hours per alternate. At \$8.00 per hour, this comes out to a savings of \$288 on one alternate alone. Moreover, elapsed time is reduced from one or two weeks to about one-half day.

ENTER FUNCTIONAL COMMAND
? PARA. 11, 13, 14
ENTER FUNCTIONAL COMMAND

FIGURE 26: Viewing Links' Control Section, Pattern Factor, and OHV Percent

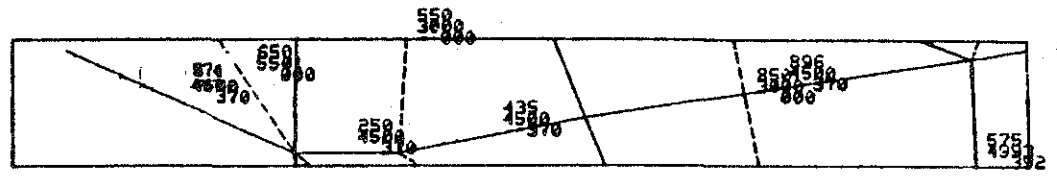


ENTER FUNCTIONAL COMMAND

? PARA 1.2.10

ENTER FUNCTIONAL COMMAND

FIGURE 27: Viewing Links' Distance, Speed, and Accident Rate



ENTER FUNCTIONAL COMMAND

? ENDE
IS FILE TO BE SAVED

? YES
READY.

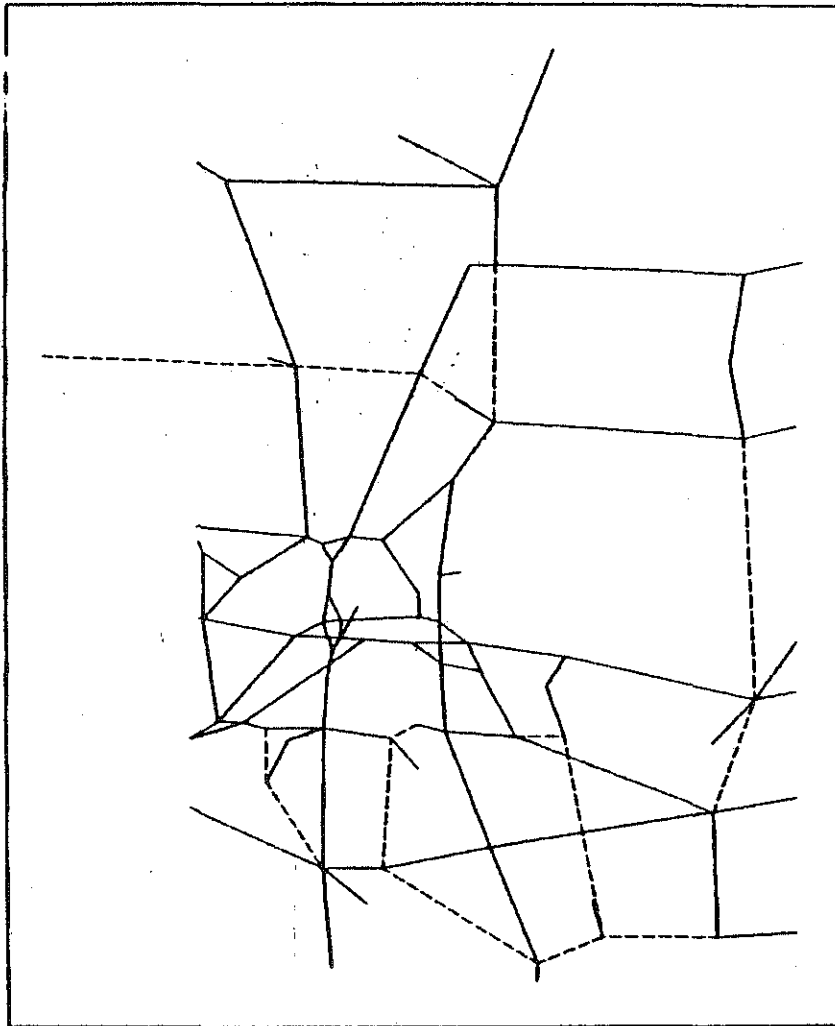
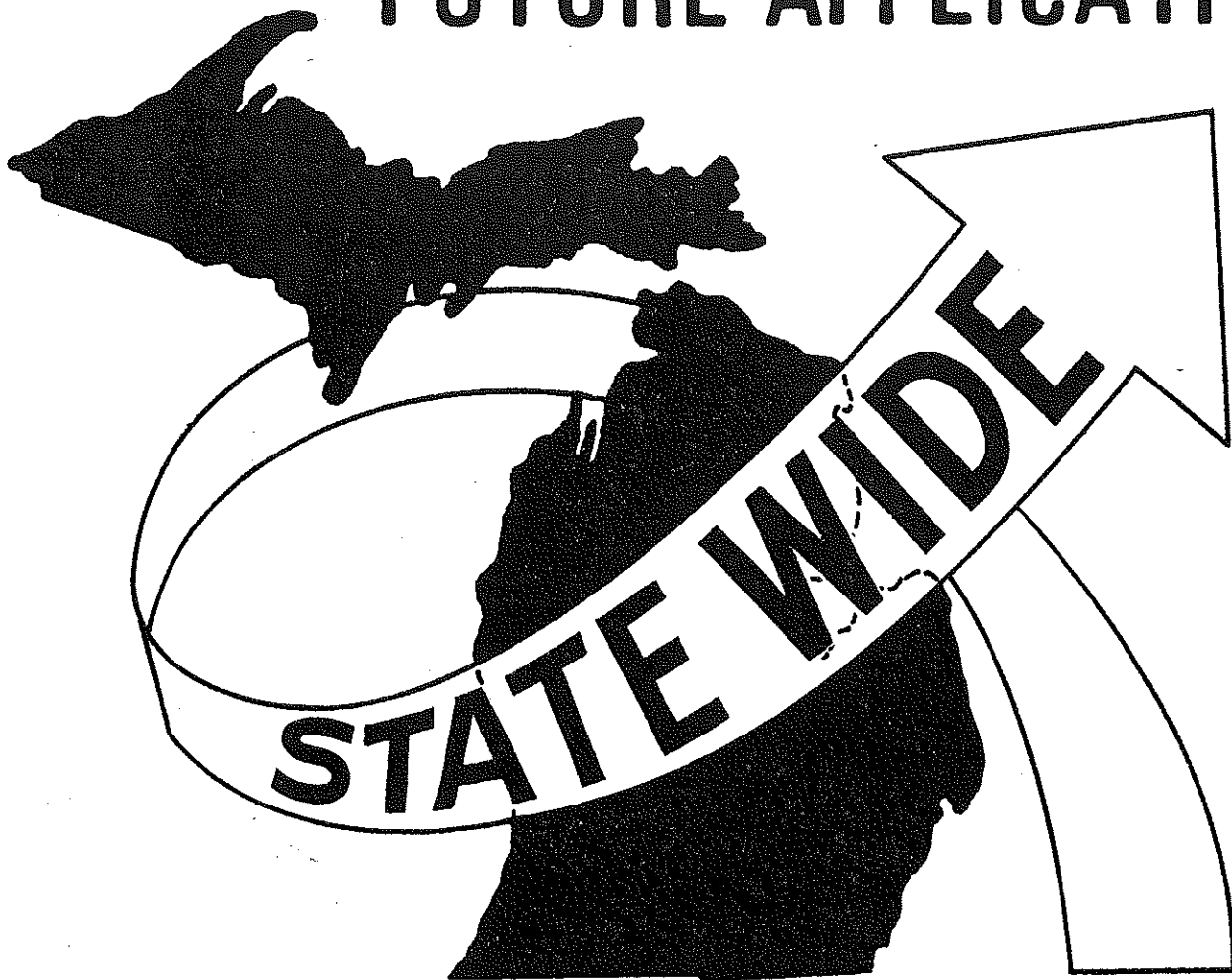


FIGURE 28: Kent County Updated Network

FUTURE APPLICATIONS



FUTURE APPLICATIONS

At least four new applications of the TVEDIT process suggest themselves immediately. They have to do with regional planning, model calibration, multi-modal planning, and truly on-line impact analysis. Let us consider them in order.

Regional Planning. In order to get the overall view of a transportation plan within a region, the TVEDIT program should have the capacity for displaying not only a county, but any combination of counties desired. Based upon what he sees, the user should be able to modify the multi-county plan and have the modifications be made automatically in the respective county files. The level of difficulty here is not too great, and this modification is already being planned.

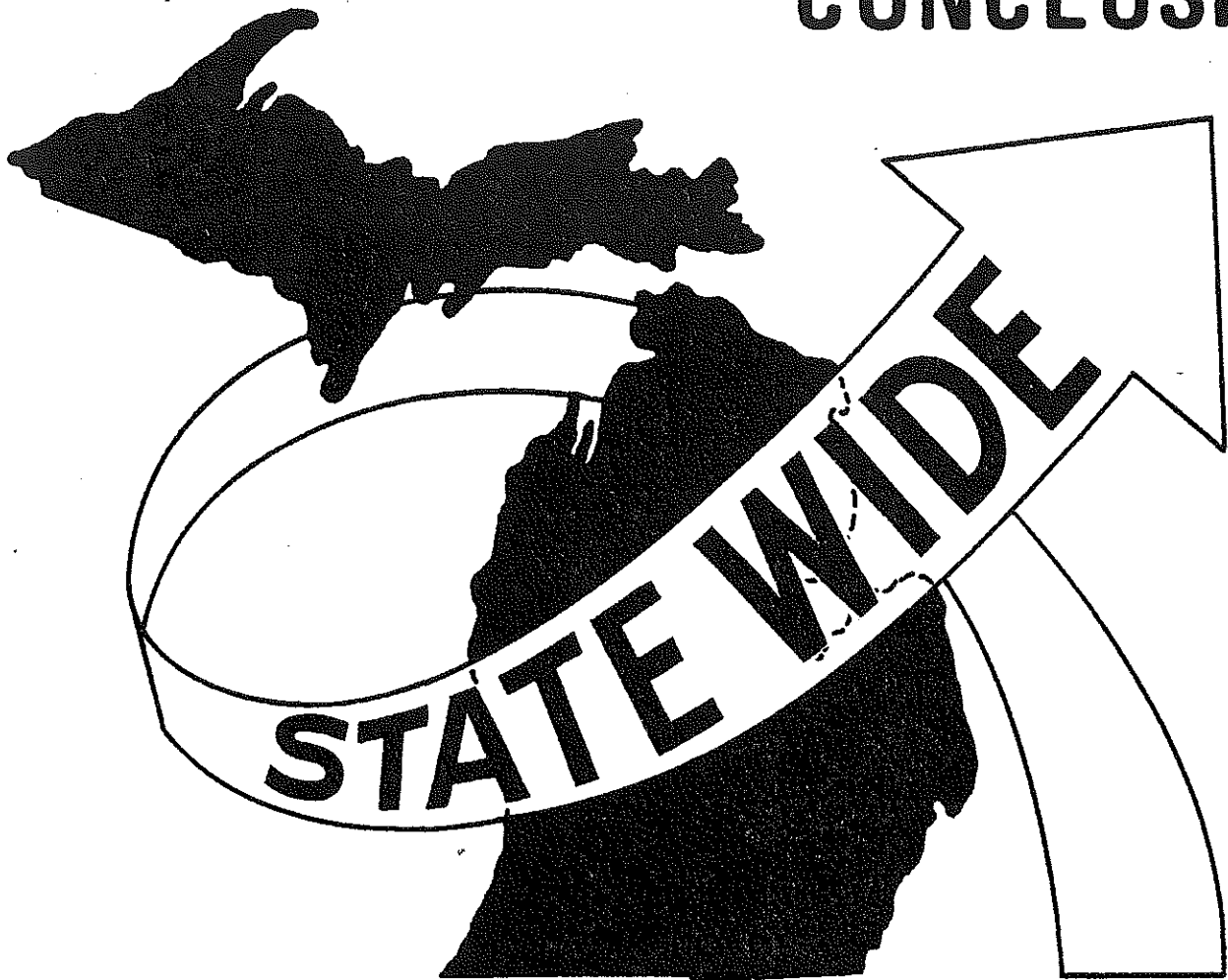
Model Calibration. In recalibrating the Statewide Travel Model, a project already underway, it would be helpful to update a network using TVEDIT and submit it automatically for a calibration run, including trip generation, tree plotting, and plotting of loaded networks. For example, speeds could be adjusted in a region and trees plotted on the screen. If the driving paths look reasonable, an assignment of trips could be made, and the ratio of assigned to observed traffic plotted. The resulting process could reduce the elapsed time in many calibration situations by as much as 70 to 80 percent. This application is also being actively pursued at this time.

Multi-Modal Planning. For any given region, the capacity should exist to display any combination of modes on the screen at the same time. The respective networks could then be modified simultaneously. It is entirely

possible that this option would make multi-modal alternatives much easier to conceptualize.

On-Line Impact Analysis. By combining Segmental Model (see Statewide Travel Modeling Series Volume III) with the same sort of job-stream necessary to model calibration, very quick run times can be achieved for a region. (Segmental Model is a method developed at Statewide for performing impact analysis at a very fine level in the region of greatest interest and analyzing at a coarse level of detail for the rest of the state.) Such enhanced execution times could make possible true on-line impact analysis, with run times in the minutes instead of hours or days. Applications such as this would allow the Department to truly involve the citizen in the transportation planning process.

CONCLUSION



CONCLUSION

In a time of increased emphasis upon public involvement in the transportation planning process, it is important to ensure that the alternate-generation process remains responsive to public feedback. Although the number of alternative plans to be considered increases dramatically, the planning system cannot allow itself to get bogged down to the point that the elapsed time between citizen question and system answer becomes unreasonably long. This would have the ultimate result of killing the public's newly-found enthusiasm.

The process of interactive network updating described in this report goes a long way toward relieving what could otherwise become a crippling burden on the planning procedure. It can eliminate up to eighty percent of the cost and up to ninety-five percent of the elapsed time involved in alternate generation. And because it is less tedious for the operator than manual coding, it tends to eliminate a majority of the "mental-lapse" type of errors which can occur after hours of network coding.

The Statewide interactive network updating system has immediate benefits for the Bureau and the Department. Because it is not a system developed in isolation, but is tied to the existing, fully operational Statewide Transportation Modeling System, the savings in time and manpower will be realized beginning with the next request for modeling a set of alternates. Although modifications would likely be required to adapt the system to other states, interactive network updating system is ready for production in Michigan.

Anyone wishing to offer suggestions or comments on either the interactive updating system or this report or desiring a live demonstration is urged to contact:

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Statewide Transportation Planning Procedures Section
Michigan Department of State Highways and Transportation
P.O. Drawer K
Lansing, Michigan 48904

If a telephone call is preferable, he can be reached at (517) 373-2663 between 7:30 a.m. and 4:30 p.m., e.s.t.