

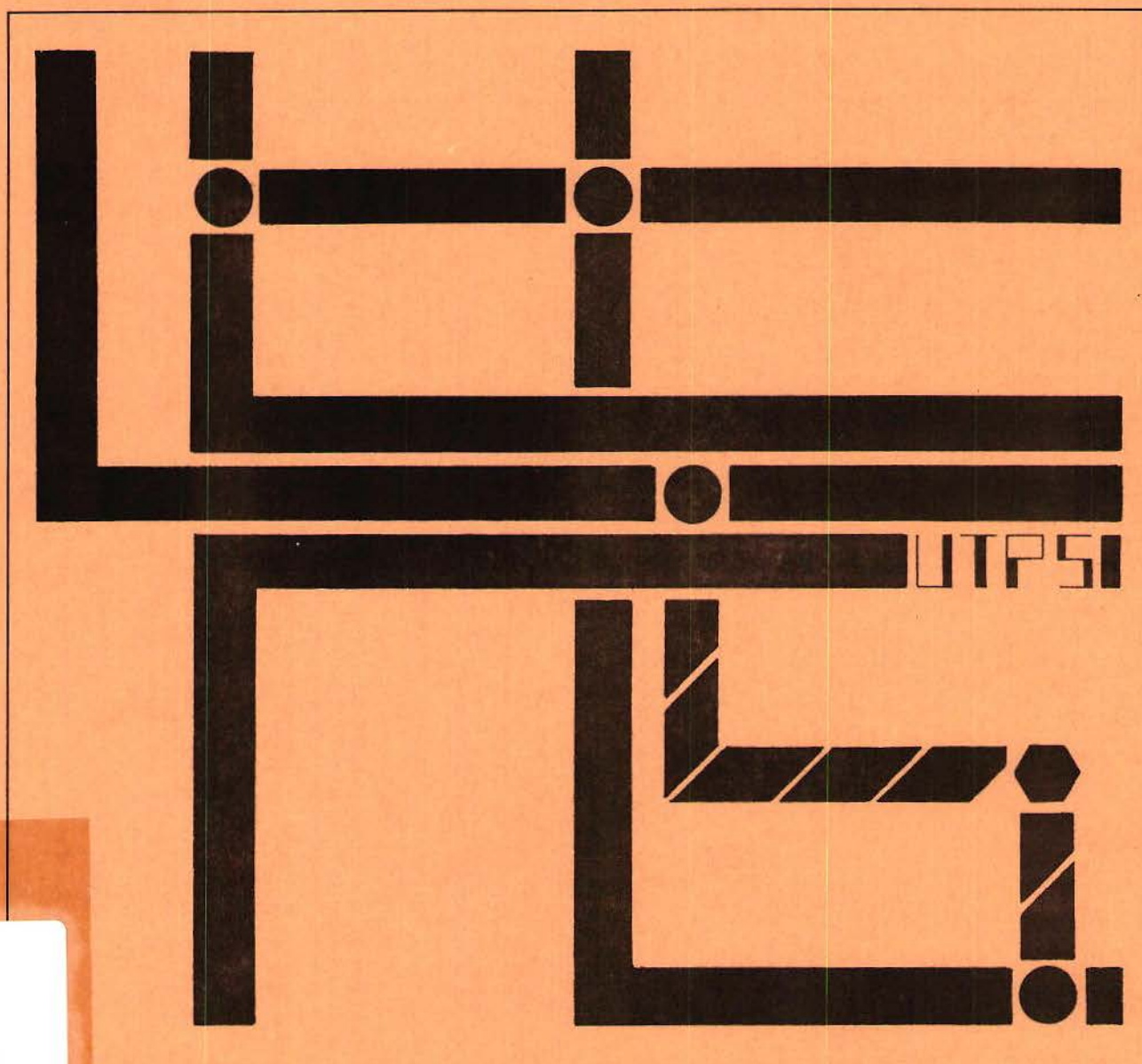


U.S. Department
of Transportation
**Federal Highway
Administration**

Highway Network Analysis

HNET/UROAD Lecture Guide

February 1986



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16. Abstract This document provides an introductory-level explanation of the Urban Transportation Planning System (UTPS) programs HNET and UROAD. The purpose, functions, optional modes of operation, input requirements and output reports of each program are set forth in an easy-to-follow presentation. The document format is based on the visual aids used in lectures from the Introductory UTPS Training Session, which is held several times each year at various sites in the U.S. The visual aids used in the course have been reproduced here and are accompanied by explanatory text which summarizes the major points to be understood with reference to each. This document may be used either as a note-taking guide for course participants or as a self-instructional text to be used in conjunction with other UTPS program documentation.			
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PREFACE

This document provides an introductory-level explanation of the Urban Transportation Planning System (UTPS) programs HNET and UROAD. The purpose, functions, optional modes of operation, input requirements and output reports of each program are set forth in an easy-to-follow presentation. The document format is based on the visual aids used in lectures from the Introductory UTPS Training Session, which is held several times each year at various sites in the U.S. The visual aids used in the course have been reproduced here and are accompanied by explanatory text which summarizes the major points to be understood with reference to each. This document may be used either as a note-taking guide for course participants or as a self-instructional text to be used in conjunction with other UTPS program documentation.

HNET and UROAD are two of the most important programs in the entire UTPS package of computerized tools for the transportation planner or engineer. HNET can create, update and modify a simulated transportation network, while UROAD is a multi-purpose program designed to analyze the performance of such a network. Together they can be used to test optional future networks and produce valuable data for use in the decision-making process. As components of the UTPS package, their file formats are compatible with other UTPS programs to facilitate both data preparation and further data analysis.

The lecture guide was developed under the joint sponsorship of the Urban Mass Transportation Administration and the Federal Highway Administration. For more information about UTPS and the technical activities of UMTA and FHWA, contact:

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Your comments on this or any other UTPS product or service provided by FHWA or UMTA are also invited.



HNET

FIGURE I
HNET FUNCTIONS

BUILD HIGHWAY NETWORKS
UPDATE HIGHWAY NETWORKS
CONVERT OLDHR
SUPPORT NETWORK EVALUATION
PLOT NETWORKS

FIGURE 1 - HNET FUNCTIONS

HNET is the UTPS program for creating, updating, and modifying highway networks. As you know, a highway network is an abstraction of the highway system in a format which the computer can process for transportation planning. HNET supports the latest highway database structure and can easily convert the old historical record (HR) network format (both UTPS and PLANPAC) to the latest network database format.

We will be talking about each of these HNET functions in a lot more detail later on, but first we need to discuss the contents of the highway network as can be coded in HNET.

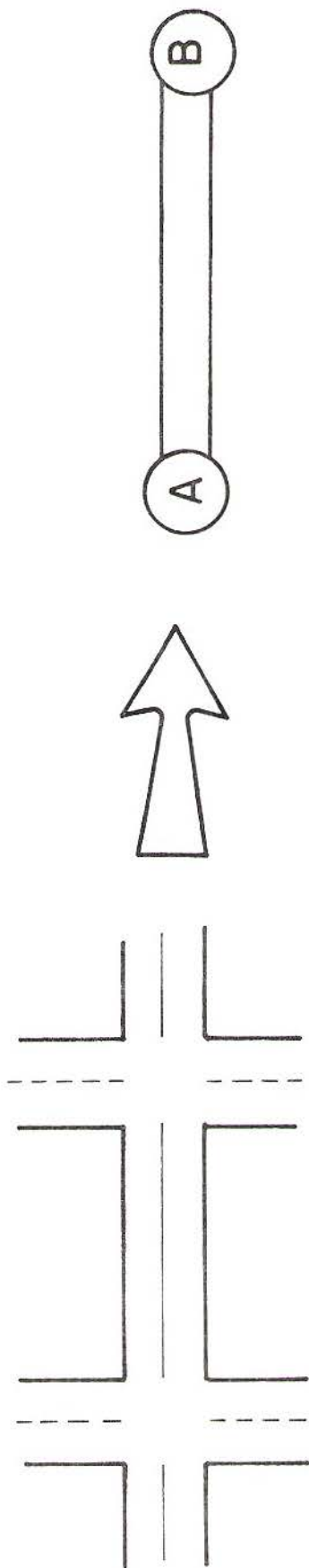
FIGURE 2
HIGHWAY LINK DATA CARDS

		AC		
	1 2	Focus		
	3-7	A	NODES	
	8-12	B		
	13-16	Distance		
	17-18	Toll Class		
	19	Facility Type		
	20	Area Type		
	21-22	UC1		
	23	UC2		
	24-27	Zone		
	28-29	Geo. Loc.		
	30	Use Code		
	31	T/S Flag		
	32-34	Free Flow Time/Speed		
	35-38	Observed Time/Speed		
	39-43	Hourly Capacity		
	44-48	Observed Volume		
	49	No. of Lanes		
	50-51	Link Group		
	52	T/S Flag		
	53-55	Free Flow Time/Speed		
	56-59	Observed Time/Speed		
	60-64	Hourly Capacity		
	65-69	Observed Volume		
	70	No. of Lanes		
	71-72	Link Group		
	73-80	Sequence Number (Optional)		

FIGURE 2 - HIGHWAY LINK DATA FORMAT

This figure represents a computer statement in data card format. Each statement or record contains all information or attributes for one highway link. The first attribute, Action Code (AC), tells the computer whether the link attributes on the card are to be added (A), changed (C) or deleted (D). In the next several figures we will take a closer look at the most important of the other attributes and how they can be used for highway (and transit) system analysis and planning.

FIGURE 3 LINK ATTRIBUTES NODES



COL. 3-7, 8-12

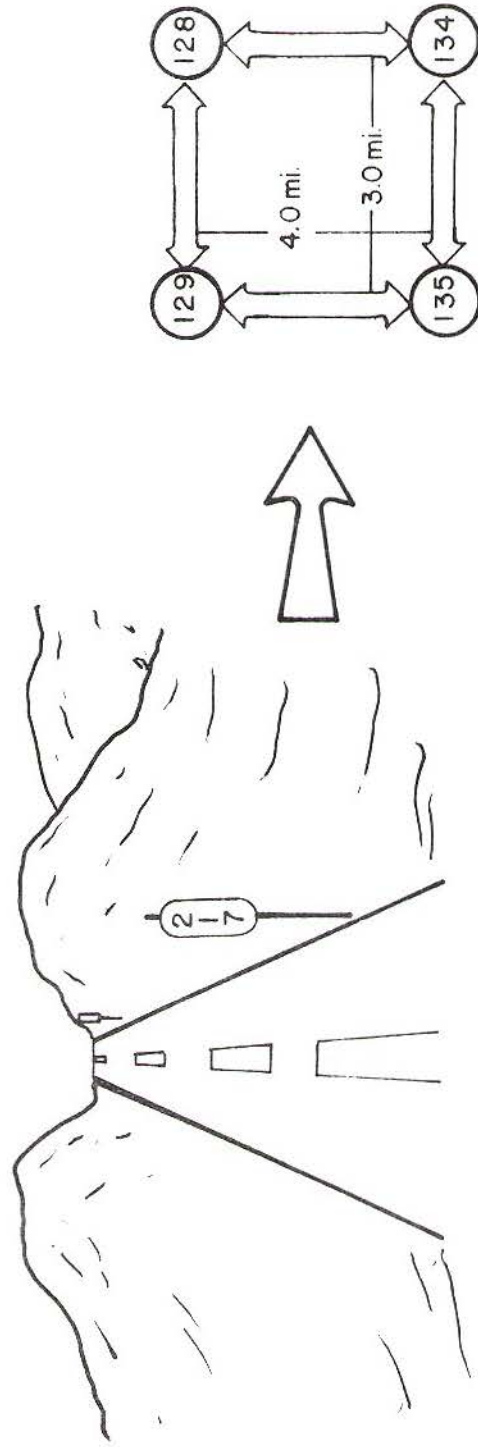
No	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A to B Data										B to A Data																																																														
																											Distance	Trail Class	Facility Type	Area Type	UC1	UC2	Zone	Geo. Loc.	Use Code	T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	Sequence Number (Optional)																																																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Maximum Value: 16,383

FIGURE 3 - LINK ATTRIBUTES (NODES)

A-node and B-node define the link represented by each data record. Nodes typically represent intersections of different roads, or locations where there is a major change in facility characteristics, such as when a road widens from two to four lanes. Note that HNET allows 5-digit node numbers up to a maximum of 16,383.

FIGURE 4
LINK ATTRIBUTES
DISTANCE



COL. 13-16

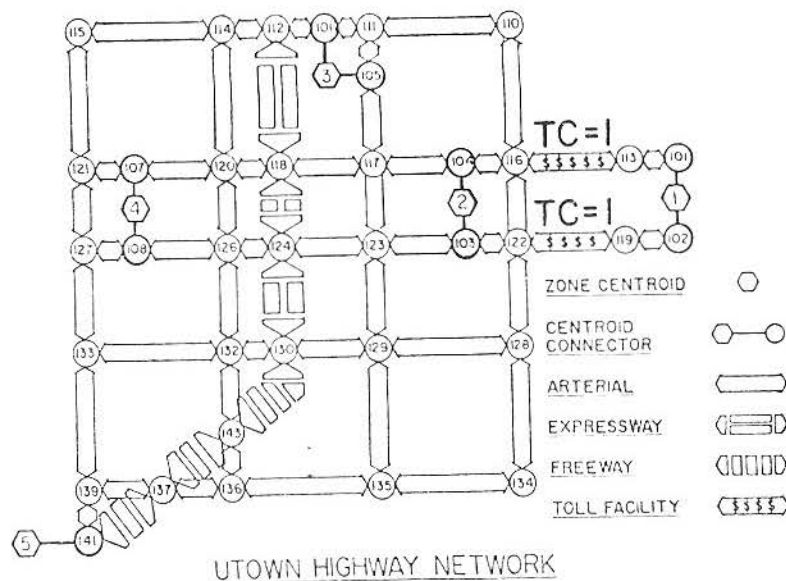
AC	MO	A	B	Distance	Toll Class	Facility Type	Area Type	UC1	UC2	Zone	Geo. Loc.	Use Code	A to B Data										C to A Data										Sequence Number (Optional)	
													Free Flow	Observed Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes		Link Group
1	2	3	7	8-12	13-16	17-18	19	20	21-22	23	24-27	28-29	30	31	32-34	35-38	39-43	44-48	49	50-51	52	53-55	56-59	60-63	64-69	70	71-72	73-80						

FIGURE 4 - LINK ATTRIBUTES (DISTANCE)

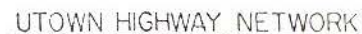
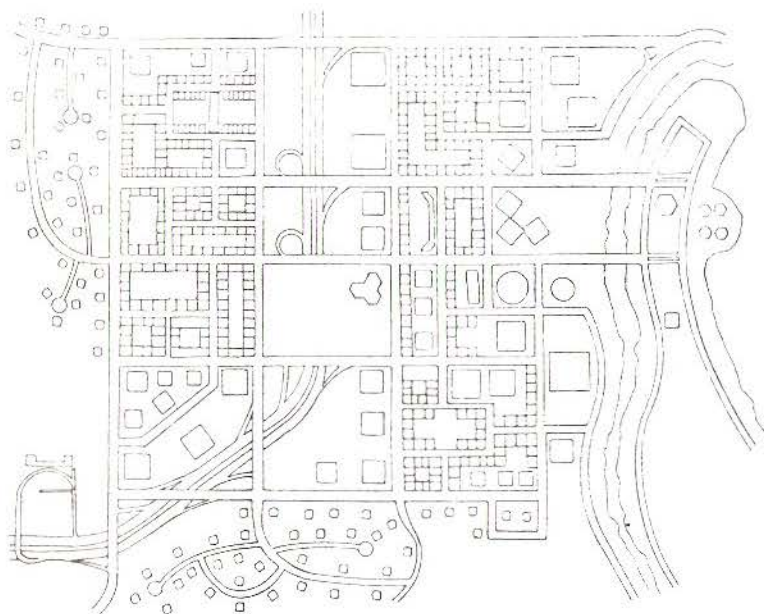
Link distance defines the length of the link in either miles or kilometers. There is no implied decimal point in the distance field, so the user should supply one. Distance is also used in conjunction with either the link speed or time to compute whichever of these attributes is missing (speed or time). "Dummy" links should be coded with a distance of zero (not blank).

FIGURE 5 - LINK ATTRIBUTES (TOLL CLASS)

Toll class is the way in which HNET (and UROAD) recognizes toll facilities in a network. More specifically, toll class should be coded on records for links which represent toll collection facilities; these are typically found at entrances or exits to toll roads, bridges, and tunnels. The toll class attribute takes an integer value between 1 and 20 which, in UROAD, reflects the amount of toll charged on the link and the average time it takes to go through the toll booth. Links without tolls should have no value coded for toll class, and the field should be left blank.



USE: INDEX TO SPEED/CAPACITY TABLE
: TRAVEL/IMPACT SUMMARIZATION



- 1- FREEWAY
- 2- EXPRESSWAY
- 3- TWO-WAY ARTERIAL (WITH PARKING)
- 4- ONE-WAY ARTERIAL (WITHOUT PARKING)
- 6- TWO-WAY ARTERIAL (WITHOUT PARKING)
- ALL OTHER - CENTROID CONNECTOR

A to v Data		B to A Data	
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

FIGURE 6 - LINK ATTRIBUTES (FACILITY TYPE)

The facility type of the link is a key attribute for UTPS network coding. Along with area type and number of lanes, this attribute is used to access a speed/capacity table which contains default values for free flow link speed and capacity. This allows the user to simply classify links according to facility type and area type, letting HNET assign values for speed and capacity. The speed/capacity tables will be discussed when we get to the speed attributes. The user can, however, code speed and capacity for each link or any one link as necessary. We will show this a little later.

The default facility types are keyed to the default speed and capacity values within the speed/capacity table and can be changed with separate update statements. Facility types can take on any integer value between 1 and 6.

Facility type can also be used as a variable to summarize travel on the network or associated impacts. UROAD, for example, produces reports which summarize vehicle miles traveled (VMT) and congested speed by facility type.

FIGURE 7 - LINK ATTRIBUTES (AREA TYPE)

Area type reflects the kind of development around a link and acts as another index (along with facility type and number of lanes) to the speed/ capacity tables. Area type default values reflect five different types of development, from CBD to rural.

As with facility type, area type can be used to summarize travel and impact estimates from the highway analysis process.

FIGURE 8

: IMPACT SUMMARIZATION

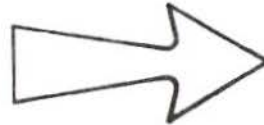
16

FIGURE 8 - LINK ATTRIBUTES (ZONE)

The zone attribute is used to denote the traffic analysis zone in which a link is found. This attribute can be used to summarize highway travel and associated impacts by zone for reporting purposes and for input into other travel models. Note that a two-way link will have the same zone number for both directions unless separate link cards are constructed for each direction (as might be done for links which lie on a zone boundary).

If the zone field is left blank, HNET will attempt to infer the zone number by looking at the zone associated with the A-node of the link on a node data statement (to be discussed a little later). HNET will also infer the zone if the link is a centroid connector (i.e., if either the A-node or B-node is a zone centroid).

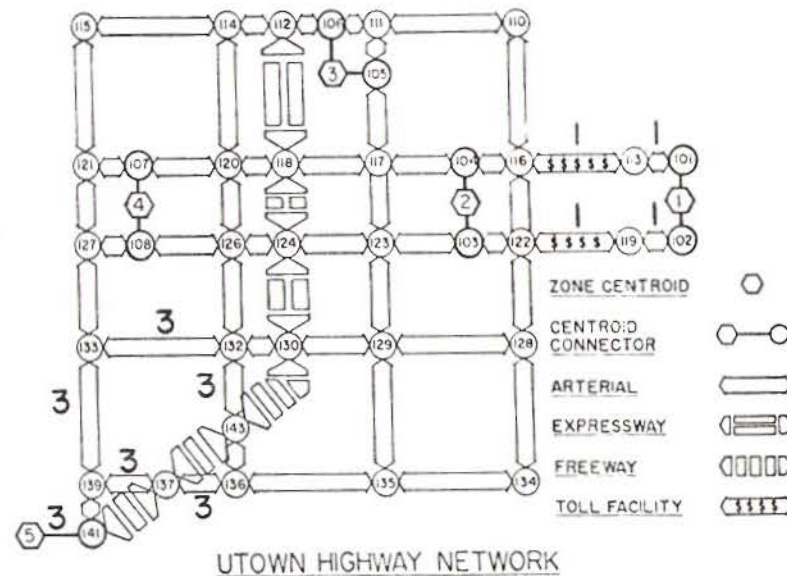
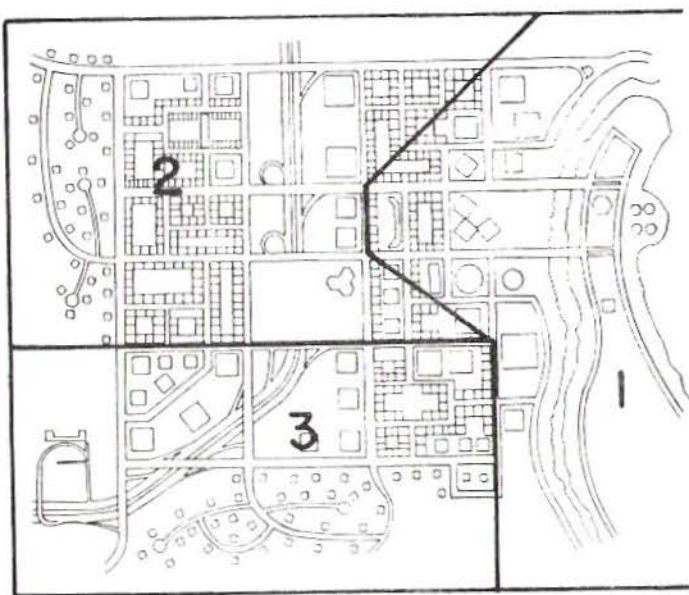
The zone field is used for reporting purposes only. It does not enter into any of the network analysis procedures.

FIGURE 9

LINK ATTRIBUTES

GEOGRAPHIC LOCATION

USE: TRAVEL SUMMARIZATION
IMPACT SUMMARIZATION



COL. 28-29

[illegible]

FIGURE 9 - LINK ATTRIBUTES (GEOGRAPHIC LOCATION)

The geographic location code provides another indication of the link's spatial position in the highway system. UROAD produces reports which aggregate travel characteristics such as VMT, average speed, and volume to capacity (V/C) ratio by the geographic location code. Typical uses of geographic location would include aggregating travel information by political jurisdiction (city, county, municipality, etc.) or by travel corridor. UROAD can accept up to 49 different geographic location codes.

FIGURE 10 - LINK ATTRIBUTES (USE CODE)

Use code designates any special restrictions or prohibitions on use of the facility represented by the link. It can be used by UROAD during traffic assignments to restrict loadings to only those links with specific use codes.

For instance, a truck assignment to the highway network could be performed such that only those facilities which comprise designated truck routes would have truck trips assigned to them. This would be accomplished by designating all links on truck routes with the same use code and instructing UROAD to assign a truck trip table to only those links with that use code.

22

T - TIMES CODED
S - SPEEDS CODED
U - UNIFORM TIME CODED

FREE FLOW TIME/SPEED (COL. 32-34)
OBSERVED TIME/SPEED } (COL. 35-38)
UNIFORM TIME }

COL. 31-38 COL. 52-59

[illegible]

FIGURE 11 - LINK ATTRIBUTES (SPEED/TIME)

UTPS highway network analysis has been structured such that link speed (or travel time) generally comes from a user-constructed speed/capacity table. However, HNET provides the user with the capability to override the link speeds from the table by coding link speed directly in a link statement. All links or any subset of links can have their speed supplied in this way.

23 The speed/time fields on the link statements are comprised of three attributes: a flag which indicates whether speed, travel time or uniform time is coded; a free-flow speed or time; and an observed speed/time or uniform time.

First we will look at the speed/capacity table, the typical way in which HNET supplies link speeds/times, and then we will examine the speed/time attributes which can be supplied on a link-by-link basis.

FIGURE 12

LINK ATTRIBUTES

SPEED/CAPACITY TABLES

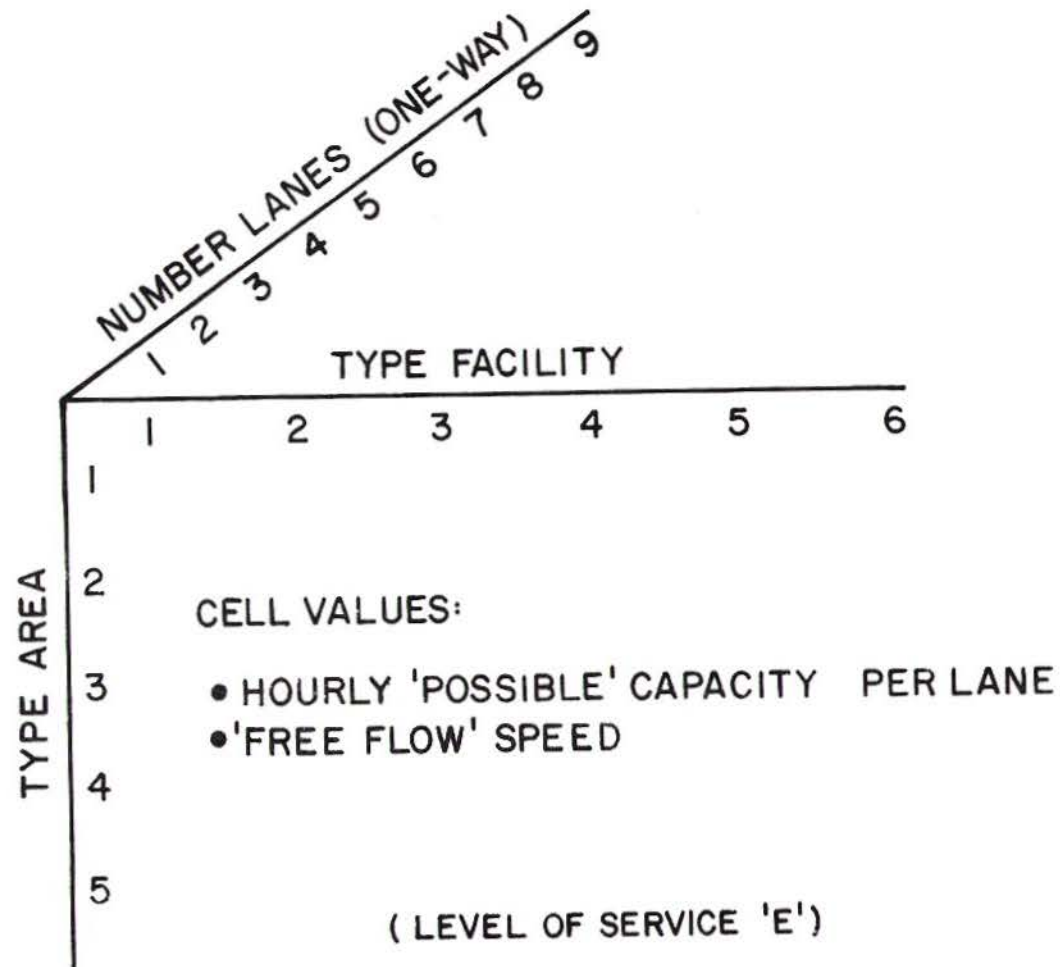


FIGURE 12 - LINK ATTRIBUTES (SPEED/CAPACITY TABLES)

This diagram is a conceptualization of the default speed/capacity table within HNET. The purpose of the table is to allow for easy and consistent coding of link speeds and capacities. The speed (and capacity) assigned to a link from this table is based on the facility type of the link and the area type in which it is located, as well as the number of directional lanes on the facility. The speeds contained in the table are intended to be "free flow" speeds and are used by UROAD in its traffic assignment process.

These speeds can be overridden on a link-by-link basis by coding free-flow speeds in the link statements, as we will show next. Also, the default speed and capacity values in the table can be changed using speed/capacity table update statements.

FIGURE 13

USED BY UROAD FOR TRAFFIC ASSIGNMENT
OVERRIDES SPEED/CAPACITY TABLE VALUES

COL. 32-34 COL. 53-55

PAGE						NODES						
	A	B	C	D	E	F	G	H	I	J	K	L
						Distance						
						Full Class						
						Facility Type						
						Area Type						
						UCI						
						Zone						
						Geo. Loc.						
						Use Code						
						Free Flow						
						Time/Speed						
						Observed						
						Capacity						
						No. of Lanes						
						Link Group						
						Free Flow						
						Time/Speed						
						Observed						
						Capacity						
						No. of Lanes						
						Link group						
						Source						
						(Station)						

FIGURE 13 - LINK ATTRIBUTES (SPEED/TIME)

The free-flow speed or time attribute (Columns 32-34) allows the overriding of speed/capacity table values. Free-flow speed/time is the value used by UROAD in traffic assignment. Free-flow is defined as the speed or travel time attained by a vehicle when no other traffic is on a facility. Average delays due to permanent traffic control devices should be included. Where speeds typically are above the posted speed limit, the higher average speed should be chosen.

Recall that this free-flow speed is used in a traffic assignment process which only approximates real world conditions. An exact determination of link speed is typically not warranted.

Decimals may be coded in the speed/time field. If they are not coded, the entries must be right justified.

FIGURE 14

OBSERVED SPEED/TIME

UNIFORM TIME

**USES: TO KEEP CONSTANT LINK TIME DURING RESTRAINED TRAFFIC ASSIGNMENT;
UROAD WILL NOT ADJUST UNIFORM TIME REGARDLESS OF VOLUME
ON LINK (e.g. CENTROID CONNECTORS)**

COL. 35-38

COL. 56-59

[illegible]

FIGURE 14 - LINK ATTRIBUTES (SPEED/TIME)

Columns 35-38 contain either an observed speed/time for the link or the uniform time on the link, based on whether an "S/T" or a "U" is coded for the flag in Column 31.

Observed speed or time is the speed actually observed or estimated to occur on the facility represented by the link. Observed speed/time is compared with assignment speeds from UROAD to calibrate a network. In addition, the UTPS transit network program INET optionally uses observed highway speeds to estimate transit speeds.

Uniform time is used when the analyst wants to keep the time on a link constant through an iterative capacity-restrained assignment process in UROAD. This constant time is primarily used on centroid connector links where a single link represents a multitude of lower level facilities not coded in the network; the uniform time would represent the average time required to access the network from that zone.

Decimals may be coded in this field. If they are not, HNET assumes whole numbers.

30

OVERRIDES SPEED/CAPACITY TABLE VALUES
 USED BY UROAD IN TRAFFIC ASSIGNMENT FOR UPDATING LINK TIMES
 UNDER RESTRAINED ASSIGNMENT
 USED BY UROAD IN REPORTING V/C RATIOS

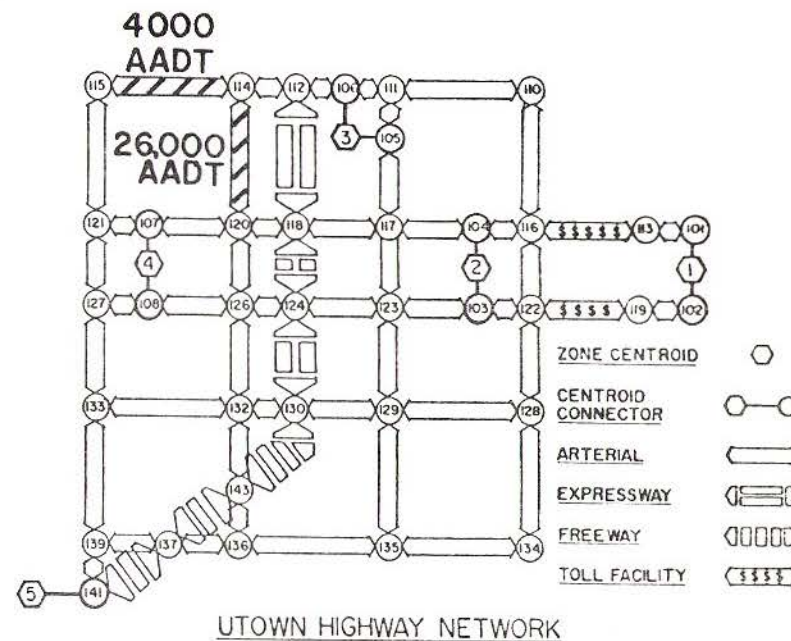
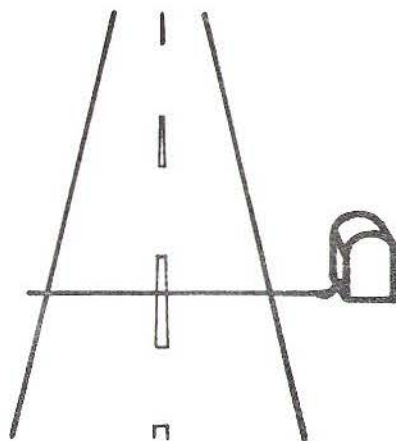
[illegible]

FIGURE 15 - LINK ATTRIBUTES (CAPACITY)

Capacity represents the per lane capacity of the link (facility) as expressed in vehicles per hour. This value overrides the particular capacity value that would be assigned to the link from the speed/capacity table. It is used by UROAD in updating link times during capacity-restrained assignments. If the default link time updating procedure in UROAD (the so-called "BPR curve") is used, then the capacity value should be that obtained at Level of Service "E" on the facility. UROAD also reports volume/capacity ratios for links based on their capacity value.

FIGURE 16 LINK ATTRIBUTES OBSERVED VOLUME

USE: NETWORK CALIBRATION
: SYSTEM EVALUATION



COL. 44-48 COL. 65-69

Link	Nodes		Distance	Toll Class	Facility Type	Area Type	UC1	UC2	Zone	Geo. Loc.	A to B Data					B to A Data					Sequence Number (Optional)	
	A	B									Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	
68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	
90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	
134	135	136	137	138	139	140	141															

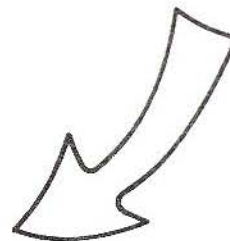


FIGURE 16 - LINK ATTRIBUTES (OBSERVED VOLUME)

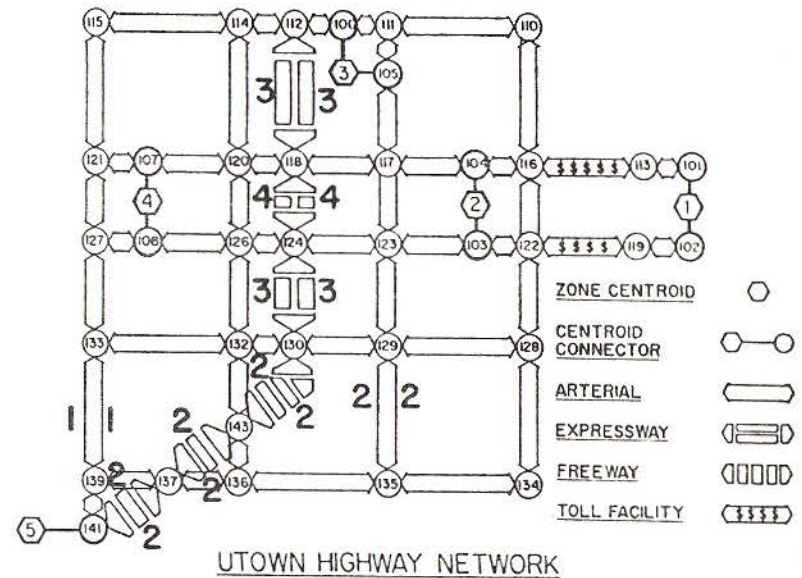
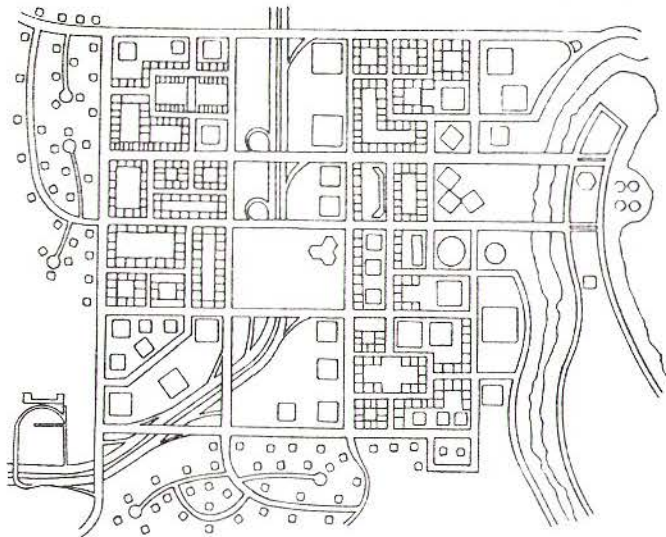
Observed link volume or traffic count is used by UROAD to produce reports which aid in calibrating a network or performing traffic assignment. The time interval of the counts should correspond to that of the modeling process so that the comparisons are valid (e.g., peak period, 24-hour, etc.).

FIGURE 17

LINK ATTRIBUTES

NUMBER OF LANES

USE: ALONG WITH CAPACITY PER LANE
DETERMINES TOTAL LINK CAPACITY
: TRAVEL SUMMARIZATION



COL. 49

COL. 70

AL Focus	NODES		Distance	Toll Class	Facility Type	Area Type	UC1	UC2	Zone	Geo. Loc.	Use Code	A to B Data								B to A Data								Sequence Number (Optional)
	A	B										T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group			
1	2	3-7	8-12	13-16	17-18	19	20	21-22	23	24-27	28-29	30	31	32-34	35-38	39-43	44-48	49	50-51	52	53-55	56-59	60-64	65-69	70	71-72	73-80	

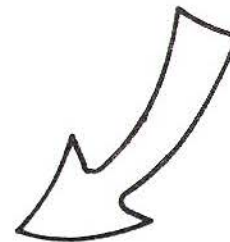


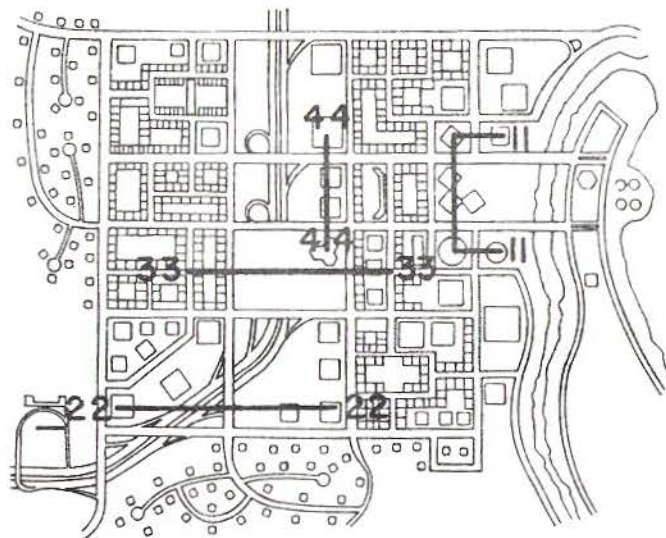
FIGURE 17 - LINK ATTRIBUTES (NUMBER OF LANES)

Number of lanes is used as an index into the speed/capacity table along with facility type and area type. The number of lanes multiplied by the per lane capacity generates the total capacity of the link.

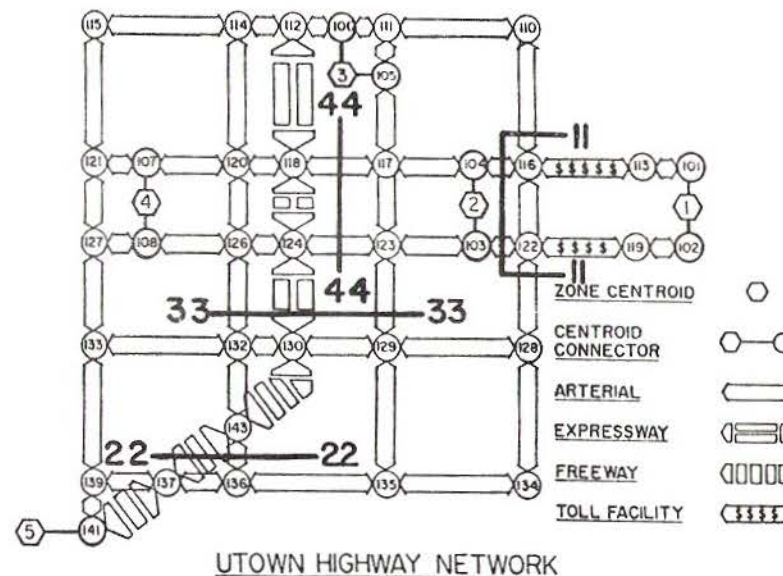
FIGURE 18

LINK ATTRIBUTES LINK GROUP

USE: NETWORK CALIBRATION
: IMPACT SUMMARIZATION



CUTLINES



UTOWN HIGHWAY NETWORK

COL. 50-51

COL. 71-72

AL	Focus		MODES	Distance	Toll Class	Facility Type	Area Type	UC1	UC2	Zone	Geo. Loc.	Use Code	A to B Data							B to A Data							Sequence Number (Optional)	
	A	B											T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group	T/S Flag	Free Flow Time/Speed	Observed Time/Speed	Hourly Capacity	Observed Volume	No. of Lanes	Link Group		
1	2	3-7	8-12	13-16	17-18	19	20	21-22	23	24-27	28-29	30	31	32-34	35-38	39-43	44-48	49	50-51	52	53-55	56-59	60-64	65-69	70	71-72	73-80	



FIGURE 18 - LINK ATTRIBUTES (LINK GROUP)

Link group provides another way to summarize travel and impact values of the highway system and provides another level of aggregation for use in model calibration. Typically, all links which cross the same cutline, screenline, or cordon line should be assigned to the same link group since UROAD summarizes volumes, speeds, volume/capacity and volume/count ratios by link group. There can be up to 99 different link groups in one network.

FIGURE 19
NODE DATA CARD

AC	NODE	X COORDINATE	Y COORDINATE	ZONE		GEO. LOC.	AREA TYPE		SEQUENCE NUMBER
1	2-6	8-15	17-24	26-29		41-42	44		73-80

FIGURE 19 - NODE DATA STATEMENT

Node data statements supply attributes for network nodes. Their primary function is to provide x-y coordinates for nodes to permit network plotting. However, they can also provide geographic information on the node (and therefore links) which facilitates network aggregation and impact aggregation within other UTPS programs. Also, as we discussed earlier, the zone number and geographic location code can be entered on node statements and HNET will join them to the link information.

FIGURE 20
HIGHWAY NETWORK DATABASE

N-FILE (ENTITY FILE)

- **NODE DATA**
- **BASIC LINK DATA**
- **DIRECT ACCESS**

Z- FILE (ATTRIBUTE FILES)

- **NODE Z- FILE**
 - X-Y COORDINATES**
 - OTHER NODE ATTRIBUTES**
- **LINK Z-FILE**
 - BASIC LINK ATTRIBUTES**
 - TRAFFIC ASSIGNMENT ATTRIBUTES**
 - INTERFACE WITH OTHER UTPS PROGRAMS**
 - UROAD**
 - UMATRIX**
 - INET**
 - NAG**

FIGURE 20 - HIGHWAY NETWORK DATABASE

HNET reads the node and link data statements previously described and produces up to three different computer files which make up the highway network database. HNET creates the N-File, which contains all basic node and link information, and two Z-Files, one for nodal information and one to store link data.

The N-File is designed to allow for easy (and cheap) updating of network attributes. It can be read and written only by HNET, and contains node data and link attributes from the data statements.

The Z-Files, both node and link, are constructed differently from the N-File. They are the files which pass the network information to other UTPS programs such as UROAD and UMATRIX, and can have information added to them by programs other than HNET.

The link Z-File contains all the information from the link data statements, as well as appropriate values from the speed/capacity tables. It is also designed to hold link attributes determined by UROAD traffic assignments, such as congested speed, assigned volume, and V/C ratio.

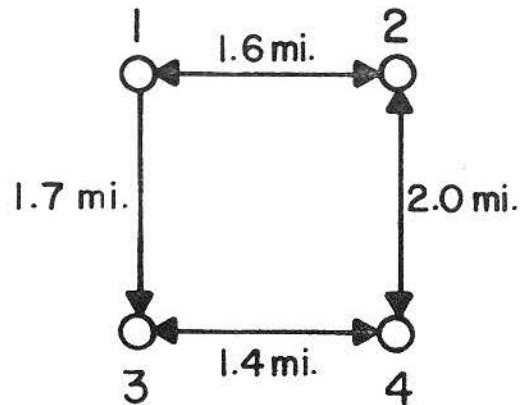
The Z-Files are more expensive to create and update than N-Files, so they are typically created with HNET only after the N-File has been created, updated and checked out.

Let's take a closer look at the basic structure of the link Z-File so you can understand how it works and learn some of the terms in the program write-ups.

FIGURE 21
Z-FILE

LIST OF ATTIBUTE VALUES → LAV

EXAMPLE



D
(DISTANCE) =
LAV

1.6
1.7
1.6
2.0
MV
1.4
2.0
1.4

(LINK)

1-2
1-3
2-1
2-4
3-1
3-4
4-2
4-3

MV = MISSING VALUE

FIGURE 21 - Z-FILE (LIST OF ATTRIBUTE VALUES - LAV)

A Z-File (or in this specific example, a link Z-File) contains lists of attribute values, or LAVs. These LAVs are the way in which the link Z-File stores link attribute information.

In this example, we have a 4-node network with 7 links (3 two-way links and 1 one-way link). Posted on the links is one of their attributes -- distance. The link Z-File for this network would contain a LAV for the attribute Distance, depicted on the right. It is an ordered list of the distance values for each link in the network. The first value in the distance LAV is 1.6, which is the distance, in miles, of Link 1-2. The list of distance values continues down to Link 4-3. Note the value for distance in the position which corresponds to Link 3-1 is missing. This is because Link 3-1 does not exist (Link 1-3 is one-way). The LAV still contains a placeholder missing value code (MV) so that the file can keep track of all other LAV values.

This data structure allows for easy retrieval and updating of information by all UTPS programs that read and write this file. The Z-File consists of many LAVs, one for each attribute. Other UTPS programs, such as UMATRIX, can manipulate the values in LAVs and referencing is easily accomplished by their program or user-assigned LAV names.

FIGURE 22

HNET OPERATIONS

- BUILD N-FILE
- UPDATE N-FILE
- CREATE ALTERNATE NETWORK FROM N-FILE
- EXTRACT SUBAREA NETWORK FROM N-FILE
- BUILD Z-FILES
- CONVERT OLDHR
- COMPARE ASSIGNMENT RESULTS
- PLOT NETWORKS

FIGURE 22 - HNET OPERATIONS

Now that the network attributes have been discussed, let's talk about how HNET builds the network files, the reports it prepares, and how the user communicates with the program to exercise the various functions.

HNET is designed as a flexible program in that what it does is a function of not only the keywords coded, but also the types of files and reports which are requested or supplied. HNET performs at least eight different operations (as listed in the figure). In the next several figures we will look more closely at each operation and, at the same time, explain HNET keywords and reports.

FIGURE 23
HNET FUNCTIONS
BUILD N-FILE

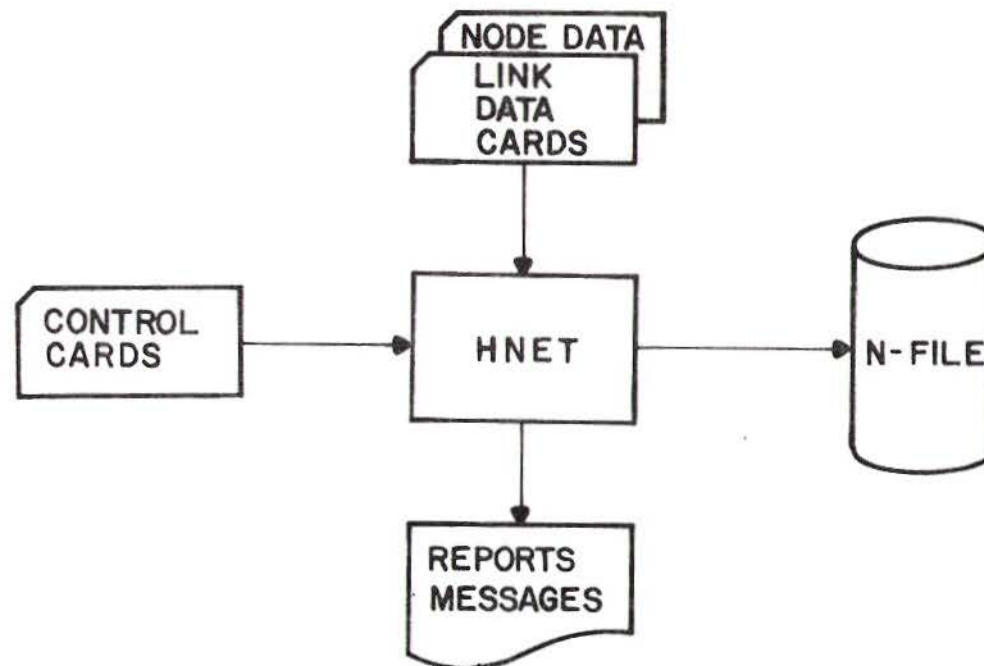


FIGURE 23 - HNET FUNCTIONS (BUILD N-FILE)

Building the basic network N-File is typically the first use of HNET. Link and node data statements, as discussed previously, are input along with the &PARAM, &OPTION and &SELECT control statements. Outputs are the network N-File and selected reports and messages. The next figure shows a typical instruction statement for building an N-File with HNET.

FIGURE 24
HNET FUNCTIONS
BUILD N-FILE

```
// HNET EXEC HNET,CORE=256K,  
// NI='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPNI='(NEW,KEEP)'  
// HNET.NODES DD *  
    (NODE CARDS GO HERE)  
// HNET.LINKS DD *  
    (LINK CARDS GO HERE)  
// HNET.SYSIN DD *  
    HNET RUN TO BUILD N-FILE  
    &PARAM ZONES=5,NODES=143 &END  
    &SELECT FT=1,6,5,MVOK='FFS','FFT',  
    REPORT=1,2,4,5,7,8,10,14,15 &END
```

FIGURE 24 - HNET FUNCTIONS (BUILD N-FILE)

This is a typical instruction statement for HNET to build an N-File. We won't go into a discussion of JCL set-up other than to note the specification of the N-File as output and the link and node statements as input. The &PARAM keywords set the maximum zone and node number values which will be written on the N-File. The reports listed in the &SELECT statement are those which display information on N-File status and contents. (A brief discussion of each report follows.)

The "FT=1,6,5" specifies the valid range and default value for facility types (FT) input on the link statements. This feature allows range checking and default value coding for each potential link attribute. In this particular example, we are telling HNET that all coded facility type values on the input link cards should be between 1 and 6, and any link with a value not in that range will be flagged with a warning in Report 1. In addition, all facility type values not coded (e.g., blank) will be given a default value of 5.

The "MVOK-'FFS'" tells HNET that all link attributes must have values coded on the input link statements except for free-flow speed (FFS) and free-flow time (FFT). The abbreviations used (e.g., FFS, FFT) are the UTPS-specified LAV names for those link attributes. Any link statements with a blank in any field except those specified by the "MVOK" keyword will be flagged with a warning in Report 1. This allows the user to customize HNET's error checking to his or her own coding conventions.

FIGURE 25 - HNET REPORT 1

Report 1 is a playback of input link statements with each statement shown as one line on the report. Error flags, if any, are printed directly under any problem entry. The report will be produced for all link statements containing errors, even if it was not selected.

Warnings or errors can be of three types:

- | | |
|--------------|--|
| D (Default): | A default value (as coded for this attribute on the &SELECT statement) replaces the missing value indicated in the statement field position above the "D". |
| W (Warning): | The value in the input and playback above the "W" contains an invalid character or exceeds the range specified on the &SELECT statement for that link attribute. |
| E (Error): | An error in the A-Node or B-Node makes the link impossible to identify, or an error in the action code makes the requested link action impossible to determine. The link statement has been ignored by HNET. |

Use the upper or lower column position guide to find the column number of each error flag, then consult the link statement format to determine which field was flagged.

In the example, note that the "E"s indicate that all link statements had the A-node values coded in the wrong columns as they were not right justified in column 7. The "W"s indicate that for link statement 109-111, a value was mispunched in the distance field and the area type of 6 exceeds the default range of 1-5.

The error summary following the card playback gives counts of total errors and warnings for each link attribute field (read across, left to right).

FIGURE 26

HNET REPORT 2

HNET RUN TO BUILD NETWORK FILES

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HNET REPORT 2

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INPUT NODE DATA CARD IMAGES

+++++ ++++++ ++++++ +--- +--- +---++

1---5---10---15---20---25---30---35---40---45---50---55---60---65---70-

1	121.00	104.00
2	89.00	104.00
3	65.00	144.00
4	29.00	104.00
5	5.00	10.00
101	121.00	114.00
102	121.00	94.00
103	89.00	94.00
104	89.00	114.00
105	75.00	144.00
106	65.00	154.00
107	29.00	114.00
108	29.00	94.00
110	105.00	154.00
111	75.00	154.00
112	55.00	154.00
113	114.00	114.00
114	45.00	154.00
115	15.00	154.00
116	105.00	114.00
117	75.00	114.00
118	55.00	114.00
119	114.00	94.00
120	45.00	114.00
121	15.00	114.00
122	105.00	94.00
123	75.00	94.00
124	55.00	94.00
126	45.00	94.00
127	15.00	94.00
128	105.00	54.00
129	75.00	54.00
130	55.00	54.00
132	45.00	54.00
133	15.00	54.00
134	105.00	14.00
135	75.00	14.00
136	45.00	14.00
137	25.00	14.00
139	15.00	14.00
141	15.00	10.00
143	45.00	31.00

1---5---10---15---20---25---30---35---40---45---50---55---60---65---70-

NT020 120 (INFORMATION): N-FILE UPDATING BEGINNING

NT020 120 (INFORMATION): N-FILE UPDATING COMPLETED

FIGURE 26 - HNET REPORT 2

Report 2 is a playback of node data statements with message flags interspersed. Report 2 will also be printed for node statements with errors even if it has not been requested. The error flag meanings are the same as those of Report 1. An error summary message is also printed for node data statement images.

FIGURE 27 HNET REPORT 4

HNET RUN TO UPDATE NFILE

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N - F I L E U P D A T E E R R O R M E S S A G E S

A	ANODE	BNODE	SEQUENCE	S	DIAGNOSIC MESSAGE
A	47	83	00000220	E	LINK ALREADY EXISTS, ADD REJECTED
D	70	312	00000230	W	LINK DOES NOT EXIST, DELETE REJECTED
D	71	73	00000240	W	LINK DOES NOT EXIST, DELETE REJECTED
D	73	71	00000240	W	LINK DOES NOT EXIST, DELETE REJECTED
A	83	47	00000220	E	LINK ALREADY EXISTS, ADD REJECTED
C	103	110	00000250	E	LINK DOES NOT EXIST, CHANGE REJECTED
C	110	103	00000250	E	LINK DOES NOT EXIST, CHANGE REJECTED
D	312	70	00000230	W	LINK DOES NOT EXIST, DELETE REJECTED

HNT020 120 (INFORMATION): N-FILE UPDATING COMPLETED

FIGURE 27 - HNET REPORT 4

Report 4 is a record of errors encountered when building or updating an N-File. It indicates errors encountered by HNET in attempting to perform the requested action on the N-File. The column with the heading "A" is the action code which describes the desired link card action: to add, change, or delete the link as specified. The "SEQUENCE" number refers to the statement in error by the user-assigned number in Columns 73-80 of the link statement. If no sequence number has been coded, HNET will assign numbers to the input link data statements starting with 1 and using an increment of 1. "S" is the error severity code of either a warning (W) or error (E).

FIGURE 28

HNET REPORT 5

HNET RUN TO BUILD NETWORK FILES

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HNET

REPORT 5

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N - F I L E U P D A T E			A C T I O N R E P O R T		
ANODE	BNODE	ACTION TAKEN	ANODE	BNODE	ACTION TAKEN
1		COORDINATES ADDED	1	101	LINK ADDED
1	102	LINK ADDED	2		COORDINATES ADDED
2	103	LINK ADDED	2	104	LINK ADDED
3		COORDINATES ADDED	3	105	LINK ADDED
3	106	LINK ADDED	4		COORDINATES ADDED
4	107	LINK ADDED	4	108	LINK ADDED
5		COORDINATES ADDED	5	141	LINK ADDED
101		COORDINATES ADDED	101	1	LINK ADDED
101	113	LINK ADDED	102		COORDINATES ADDED
102	1	LINK ADDED	102	119	LINK ADDED
103		COORDINATES ADDED	103	2	LINK ADDED
103	122	LINK ADDED	103	123	LINK ADDED
104		COORDINATES ADDED	104	2	LINK ADDED
104	116	LINK ADDED	104	117	LINK ADDED
105		COORDINATES ADDED	105	3	LINK ADDED
105	111	LINK ADDED	105	117	LINK ADDED
106		COORDINATES ADDED	106	3	LINK ADDED
106	111	LINK ADDED	106	112	LINK ADDED
107		COORDINATES ADDED	107	4	LINK ADDED
107	120	LINK ADDED	107	121	LINK ADDED
108		COORDINATES ADDED	108	4	LINK ADDED
108	126	LINK ADDED	108	127	LINK ADDED
110		COORDINATES ADDED	110	111	LINK ADDED
110	116	LINK ADDED	111		COORDINATES ADDED
111	105	LINK ADDED	111	106	LINK ADDED
111	110	LINK ADDED	112		COORDINATES ADDED
112	106	LINK ADDED	112	114	LINK ADDED
112	118	LINK ADDED	113		COORDINATES ADDED
113	101	LINK ADDED	113	116	LINK ADDED
114		COORDINATES ADDED	114	112	LINK ADDED
114	115	LINK ADDED	114	120	LINK ADDED
115		COORDINATES ADDED	115	114	LINK ADDED
115	121	LINK ADDED	116		COORDINATES ADDED
116	104	LINK ADDED	116	110	LINK ADDED
116	113	LINK ADDED	117		COORDINATES ADDED
117	104	LINK ADDED	117	105	LINK ADDED
117	118	LINK ADDED	117	123	LINK ADDED
118		COORDINATES ADDED	118	112	LINK ADDED
118	117	LINK ADDED	118	120	LINK ADDED
118	124	LINK ADDED	119		COORDINATES ADDED
119	102	LINK ADDED	119	122	LINK ADDED
120		COORDINATES ADDED	120	107	LINK ADDED
120	114	LINK ADDED	120	118	LINK ADDED
120	126	LINK ADDED	121		COORDINATES ADDED
121	107	LINK ADDED	121	115	LINK ADDED
121	127	LINK ADDED	122		COORDINATES ADDED
122	103	LINK ADDED	122	116	LINK ADDED

FIGURE 28 - HNET REPORT 5

Report 5 lists the N-File update actions taken for each node and link input to HNET. It provides a record of activity for the HNET run.

FIGURE 29

HNET REPORT 7

HNET RUN TO BUILD NETWORK FILES

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HNFT REPORT 7

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N - FILE LINK CONTENTS

A	B	D	DIST	TC	FFS	SPD	TIME	CAP	COUNT	N	ZONE	LG	U	C	CC	F	A	GL
NODE	NODE									L						T	T	
1	101	R	0.50				3.00*			9	1					5	1	1
1	102	R	0.50				3.00*			9	1					5	1	1
2	103	R	0.30				1.80*			9	2					5	2	1
2	104	R	0.30				1.80*			9	2					5	2	1
3	105	R	0.50				2.00*			9	3					5	4	2
3	106	R	0.50				2.00*			9	3					5	4	2
4	107	R	0.30				1.20*			9	4					5	4	1
4	108	R	0.30				1.20*			9	4					5	4	1
5	141	R	0.50				2.00*			9	5					5	4	3
101	1	R	0.50				3.00*			9	1					5	1	1
101	113	R	0.50							4	1					6	1	1
102	1	R	0.50				3.00*			9	1					5	1	1
102	119	R	0.50							4	1					6	1	1
103	2	R	0.30				1.80*			9	2					5	2	1
103	122	R	0.60							4	2	11				6	2	1
103	123	R	1.15							4	2					3	2	1
104	2	R	0.30				1.80*			9	2					5	2	1
104	116	R	0.60							4	3	11				6	2	1
104	117	R	1.15							4	3					3	2	1
105	3	R	0.50				2.00*			9	3					5	4	2
105	111	R	0.55							2	3					3	3	2
105	117	R	1.10							2	3					3	4	2
106	3	R	0.50				2.00*			9	3					5	4	2
106	111	R	0.50							1	3					3	4	2
106	112	R	0.60							1	3					3	4	1
107	4	R	0.30				1.20*			9	4					5	4	1
107	120	R	1.10							2	4					3	4	2
107	121	R	0.65							1	4					3	5	2
108	4	R	0.30				1.20*			9	4					5	4	1
108	126	R	1.10							2	4					3	4	2
108	127	R	0.65							1	4					3	5	2
110	111	R	1.75							1	3					3	4	2
110	116	R	1.65							2	3	11				3	2	1
111	105	R	0.55							2	3					3	3	2
111	106	R	0.50							1	3					3	4	2
111	110	R	1.75							1	3					3	4	2
112	106	R	0.60							1	3					3	4	1
112	114	R	0.65							1	4					3	4	2
112	118	R	1.65							3	3					2	3	2
113	101	R	0.50							4	1					6	1	1
113	116	R	0.00	1						3	1					6	2	1
114	112	R	0.65							1	4					3	4	2
114	115	R	1.75							1	4					3	5	2
114	120	R	1.65							2	4					3	4	2
115	114	R	1.75							1	4					3	5	2
115	121	R	1.65							1	4					3	5	2

FIGURE 29 - HNET REPORT 7

Report 7 is a listing of all link data attributes contained in the output N-File. Values of link free flow speed and/or capacity which the user defaults to the speed/capacity tables will not be displayed in this report as they are posted to the link Z-file but not the intermediate N-File.

Column headings for Report 7 have the following meaning:

D =	Direction Code (I=Inbound, O=Outbound, B=Twoway) An 'Inbound' link is a place-holding, nonexistent link whose (B,A) counterpart exists as a oneway, 'Outbound' link.
DIST =	Distance in miles or kilometers
TC =	Toll Code
FFS =	Free Flow Speed in miles/hour or kilometers/hour
CAP =	Capacity in (vehicles/lane) hour
NL =	Number of Lanes
LG =	Link Group
LU =	User Defined Link Attribute
UC =	Use Code
CC =	User Defined Link Attribute
FT =	Facility Type
AT =	Area Type
GL =	Geographic Location

'*' after the observed time field indicates a uniform time (UT) which will not be changed by a UROAD traffic assignment.

FIGURE 30 HNET REPORT 8

HNET RUN TO BUILD NETWORK FILES

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N - F I L E N O D E C O N T E N T S

NODE	ZONE	DIST	SUPER	GL	AT	LI	LO	NODE	ZONE	DIST	SUPER	GL	AT	LI	LO
1							2	2							2
3							2	2							2
5							1	1			101				2
102							2	2			103				3
104							3	3			105				3
106							3	3			107				3
108							3	3			110				2
111							3	3			112				3
113							2	2			114				3
115							2	2			116				4
117							3	4			118				4
119							2	2			120				4
121							3	3			122				3
123							4	3			124				4
126							4	4			127				3
128							3	3			129				4
130							4	4			132				4
133							3	3			134				2
135							3	3			136				3
137							4	4			139				3
141							3	3			143				4

HNT020 192 (INFORMATION): NODE Z-FILE UPDATING BEGINNING

HNT020 192 (INFORMATION): NODE Z-FILE UPDATING COMPLETED

FIGURE 30 - HNET REPORT 8

Report 8 is a concise listing of node data contained in the N-File. Node x-y coordinates are reported separately in Report 10. Column headings have the following meanings:

ZONE	=	Zone in which the node is located
DIST	=	District in which the node is located
SUPER	=	Super-District in which the node is located
GL	=	Geographic Location in which the node is located
AT	=	Area Type in which the node is located
LI	=	Count of Links Inbound to the node
LO	=	Count of Links Outbound from the node

FIGURE 31

HNET REPORT 10

HNET RUN TO BUILD NETWORK FILES

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HNET REPORT 10

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NODE COORDINATES

NODE	X	Y	X	Y	X	Y
1	121.00	104.00	89.00	104.00	65.00	144.00
4	29.00	104.00	5.00	10.00	-	-
100	-	-	121.00	114.00	121.00	94.00
103	89.00	94.00	89.00	114.00	75.00	144.00
106	55.00	154.00	29.00	114.00	29.00	94.00
109	-	-	105.00	154.00	75.00	154.00
112	55.00	154.00	114.00	114.00	45.00	154.00
115	15.00	154.00	105.00	114.00	75.00	114.00
118	55.00	114.00	114.00	94.00	45.00	114.00
121	15.00	114.00	105.00	94.00	75.00	94.00
124	55.00	94.00	-	-	45.00	94.00
127	15.00	94.00	105.00	54.00	75.00	54.00
130	55.00	54.00	-	-	45.00	54.00
133	15.00	54.00	105.00	14.00	75.00	14.00
136	45.00	14.00	25.00	14.00	-	-
139	15.00	14.00	-	-	15.00	10.00
142	-	-	45.00	51.00	-	-

MIN X=	5.00	MAX X=	121.00	MIN Y=	10.00	MAX Y=	154.00
AT NODE	5	AT NODE	102	AT NODE	141	AT NODE	115

FIGURE 31 - HNET REPORT 10

Report 10 is a listing of network coordinates. The report is read across and down with three sets of coordinates displayed on each line. Node numbers for the second and third sets of coordinates on each line must be interpolated. If a node has coordinates, they are displayed. If a node is in the network, but has no coordinates, blanks are displayed in the coordinate area. If a node is not in the network (no links and no node data statement supplied), two dashes (- -) are displayed in the coordinate area. Lines with all dashes for the coordinates are automatically suppressed.

FIGURE 32 HNET REPORT 14

HNET RUN TO BUILD NETWORK FILES

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N - FILE STATUS REPORT

-----PARAMETERS-----				USED	--LINK COUNT--		---HIGH---	
NODES	ZONES	DISTS	SUPERS	NODES	ONEWAY	TOWAY	NODE	ZONE
143	5	2500	2500	42	2	61	143	5

SPACE(WORDS): DIRECTORY= 1425 DATA USED= 2500 DATA UNUSED= 10325
 THERE IS ENOUGH SPACE IN THE DIRECTORY TO STORE 194 MORE NODES
 THERE IS APPROXIMATELY ENOUGH DATA SPACE TO STORE 574 MORE LINKS

U P D A T I N G H I S T O R Y

---EVENT---			
DATE	TIME	Z	COMMENT
23SEP81	9.01.46	Y	BUILT FROM LINKS= URD81.DATA
23SEP81	9.01.46	Y	CREATED Z-FILE DSN= SYS81266.T090134.RA000.UMT A2335.LZFILE
23SEP81	9.01.46	Y	CREATED Z-FILE DSN= SYS81266.T090134.RA000.UMT A2335.NZFILE

FIGURE 32 - HNET REPORT 14

Report 14 is the N-File status report. It includes a brief record of the current N-File parameters, file space usage, and update history. A code of "Y" under the "Z" column indicates that a link or node Z-File was created or updated by the HNET run indicated by the "DATE" and "TIME".

FIGURE 33 HNET REPORT 15

HNET RUN TO BUILD NETWORK FILES

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UNUSED NODE NUMBERS					
NOSES=	0	-100	109	125	131 138 140 142

FIGURE 33 - HNET REPORT 15

Report 15 is a terse list of the unused node numbers in the N-File. The report does not include nodes in the network which are unconnected. Unconnected nodes are readily identified in Report 8 from the node (zero links inbound to the node and zero links outbound from the node).

FIGURE 34

HNET OPERATIONS UPDATE N-FILE

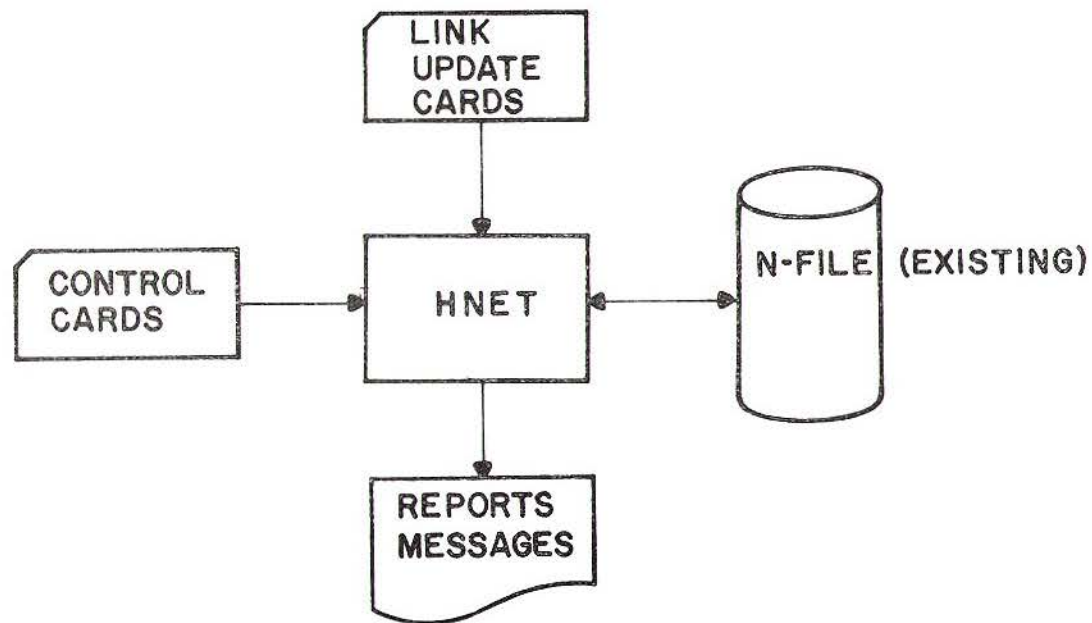


FIGURE 34 - HNET OPERATIONS (UPDATE N-FILE)

Once an N-File has been built it can be updated or changed as the network description changes or as errors are found and need correction. The process for updating is very similar to building an N-File except that the N-File referenced by HNET already exists and the input link and node statements reflect changes to an existing network contained in that N-File.

FIGURE 35
HNET OPERATIONS
UPDATE N-FILE

```
//HNET EXEC HNET,CORE=256K,  
// NI='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPNI='(OLD,KEEP)'  
//HNET.LINKS DD *  
      (LINK CARD UPDATES GO HERE)  
//HNET.SYSIN DD *  
      HNET RUN TO UPDATE N-FILE  
      &SELECT REPORT=1,-5,14 &END
```

FIGURE 35 - HNET OPERATIONS (UPDATE N-FILE)

The sample JCL set-up for HNET to update an N-File is almost identical to the JCL for building an N-File. The primary difference is that the N-File is an existing one, not a new one being created in the HNET run. All reports requested (1-5 and 14) have been discussed from the previous HNET run.

FIGURE 36

HNET FUNCTIONS CREATE ALTERNATE NETWORK

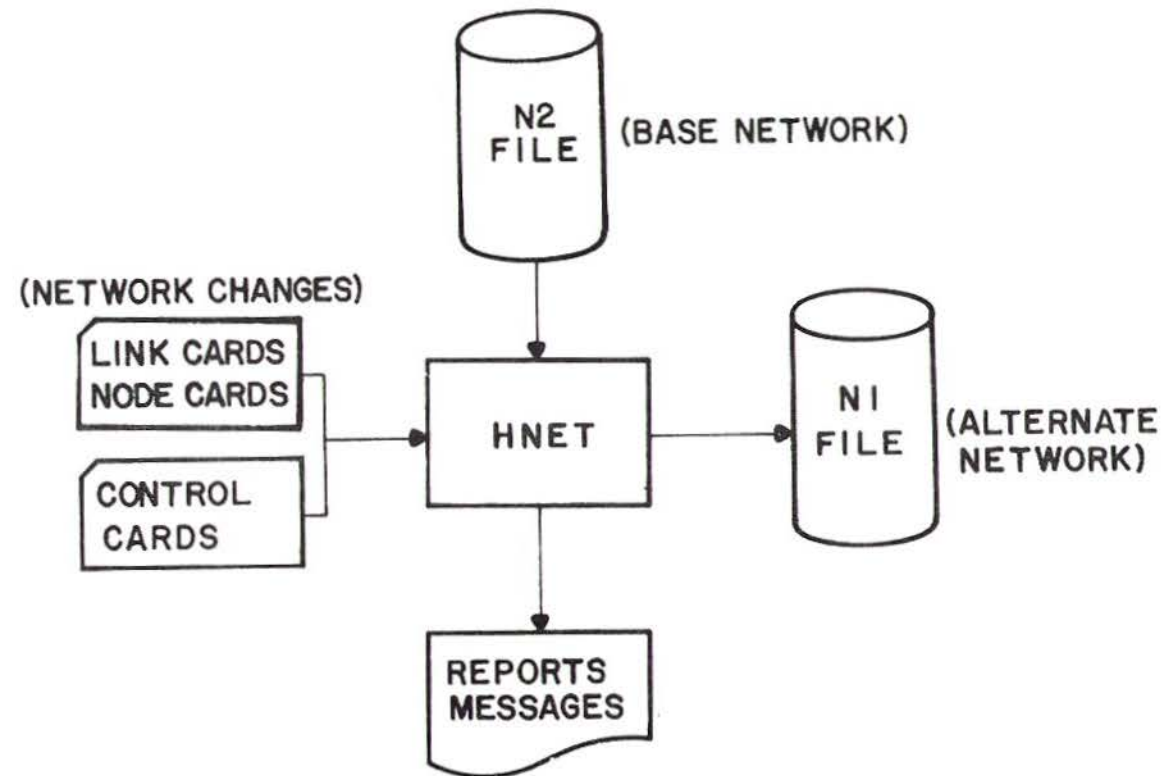


FIGURE 36 - HNET FUNCTIONS (CREATE ALTERNATE NETWORK)

HNET can also be used to create alternative networks. Highway system alternatives can be created easily using this HNET operation. HNET creates a new N-File representing a network alternative based on network changes input via node and link statements and a base network on an input N-File. Thus HNET makes use of the large portion of the base network which is constant in an alternate network and allows easy updating of the small portion which does change.

FIGURE 37
HNET FUNCTIONS
CREATE ALTERNATE NETWORK

```
//HNET EXEC HNET,CORE=256K,  
// NI='DSN=UMTA.UTOWN.ALTI,VOL=SER=UMTAI',DISPNI='(NEW,KEEP)',  
// N2='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPN2='(OLD,KEEP)'  
//HNET.NODES DD *  
    (NODE CHANGE CARDS GO HERE)  
//HNET.LINKS DD *  
    (LINK CHANGE CARDS GO HERE)  
//HNET.SYSIN DD *  
    HNET RUN TO CREAT ALT UTOWN NET  
    &PARAM NODES=147 &END  
    &SELECT REPORT=4,5,6,14 &END
```


FIGURE 37 - HNET FUNCTIONS (CREATE ALTERNATE NETWORK)

The JCL set-up to control this operation requires both an N1 and N2 File. By HNET convention, the N2 File is the existing network and the N1 File is the new alternate. The node and link statements input for this run are those which modify the base network description to create the alternate.

FIGURE 38 HNET REPORT 6

BUILD A FILE FROM OLD Z50 HR

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HNET REPORT 6

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N - FILE UPDATE LISTING

A		P		-----OBSERVED-----						N		L U		F A					
A	NODE	NODE	D	DIST	IC	FFS	SPD	TIME	CAP	COUNT	L	ZONE	LG	U	C	CC	T	T	GL

	1	X,Y=		3.30,			5.00	Z=	DIST=			SUPER=		GL=			AT=		
A	1	71 R	0.00								9		40				5 1	4	
A	1	194 R	0.00								9		40				5 1	4	
A	1	195 R	0.00								9		40				5 1	4	
	2	X,Y=		3.61,			5.22	Z=	DIST=			SUPER=		GL=			AT=		
A	2	171 R	0.00								9		40				5 1	4	
A	2	196 R	0.00								9		40				5 1	4	
A	2	197 R	0.00								9		40				5 1	4	
A	2	198 R	0.00								9		40				5 1	4	
	3	X,Y=		2.90,			5.10	Z=	DIST=			SUPER=		GL=			AT=		
A	3	191 R	0.13					0.78*			9		40				5 1	4	
A	3	199 R	0.10					0.60*			9		40				5 1	4	
A	3	200 R	0.13					0.78*			9		40				5 1	4	
	4	X,Y=		2.90,			4.80	Z=	DIST=			SUPER=		GL=			AT=		
A	4	192 R	0.12					0.72*			9		40				5 1	4	
A	4	202 R	0.12					0.72*			9		40				5 1	4	
	5	X,Y=		4.20,			5.00	Z=	DIST=			SUPER=		GL=			AT=		
A	5	176 R	0.17					1.02*			9		40				5 2	8	
A	5	177 R	0.19					1.14*			9		40				5 2	8	
A	5	203 R	0.13					0.78*			9		40				5 2	8	
	6	X,Y=		4.15,			6.00	Z=	DIST=			SUPER=		GL=			AT=		
A	6	98 R	0.23					0.69*			9		40				5 3	12	
A	6	180 R	0.38					1.14*			9		40				5 3	12	
	7	X,Y=		3.45,			5.80	Z=	DIST=			SUPER=		GL=			AT=		
A	7	92 R	0.00								9		40				5 2	8	
A	7	204 R	0.00								9		40				5 2	8	
A	7	205 R	0.00								9		40				5 2	8	
	8	X,Y=		3.12,			5.60	Z=	DIST=			SUPER=		GL=			AT=		
A	8	168 R	0.20					1.20*			9		40				5 2	8	
A	8	183 R	0.00								9		40				5 2	8	
A	8	207 R	0.00								9		40				5 2	8	
	9	X,Y=		4.20,			5.45	Z=	DIST=			SUPER=		GL=			AT=		
A	9	179 R	0.00								9		40				5 2	8	
A	9	208 R	0.00								9		40				5 2	8	
	10	X,Y=		3.40,			6.20	Z=	DIST=			SUPER=		GL=			AT=		
A	10	86 R	0.33					1.32*			9		40				5 3	12	
A	10	96 R	0.15					0.60*			9		40				5 3	12	
A	10	97 R	0.34					1.36*			9		40				5 3	12	
A	10	186 R	0.10					0.40*			9		40				5 3	12	
	11	X,Y=		2.50,			5.20	Z=	DIST=			SUPER=		GL=			AT=		
A	11	161 R	0.00								9		40				5 3	12	
A	11	163 R	0.00								9		40				5 2	8	
A	11	209 R	0.00								9		40				5 2	8	
	12	X,Y=		2.45,			4.80	Z=	DIST=			SUPER=		GL=			AT=		
A	12	193 R	0.00								9		40				5 2	8	
A	12	210 R	0.00								9		40				5 2	8	
	13	X,Y=		2.50,			4.50	Z=	DIST=			SUPER=		GL=			AT=		
A	13	117 R	0.00								9		40				5 2	8	
A	13	118 R	0.00								9		40				5 2	8	

FIGURE 38 - HNET REPORT 6

Report 6 is a listing of all nodes and links added, changed, or deleted in this run. The link data provided is the same as that provided in Report 7, but is limited to N-File Updates.

Column headings for Report 6 have the following meaning:

D =	Direction Code (I=Inbound, O=Outbound, B=Two-way) An 'Inbound' link is a place-holding, nonexistent link whose (B,A) counterpart exists as a oneway, 'Outbound' link.
DIST =	Distance in miles or kilometers
TC =	Toll Code
FFS =	Free Flow Speed in miles/hour or kilometers/hour
CAP =	Capacity in (vehicles/lane) hour
NL =	Number of Lanes
LG =	Link Group
LU =	User Defined Link Attribute
UC =	Use Code
CC =	User Defined Link Attribute
FT =	Facility Type
AT =	Area Type
GL =	Geographic Location

'*' after the observed time field indicates a uniform time (UT) which will not be changed by a UROAD traffic assignment.

FIGURE 39

HNET OPERATIONS EXTRACT SUBAREA NETWORK

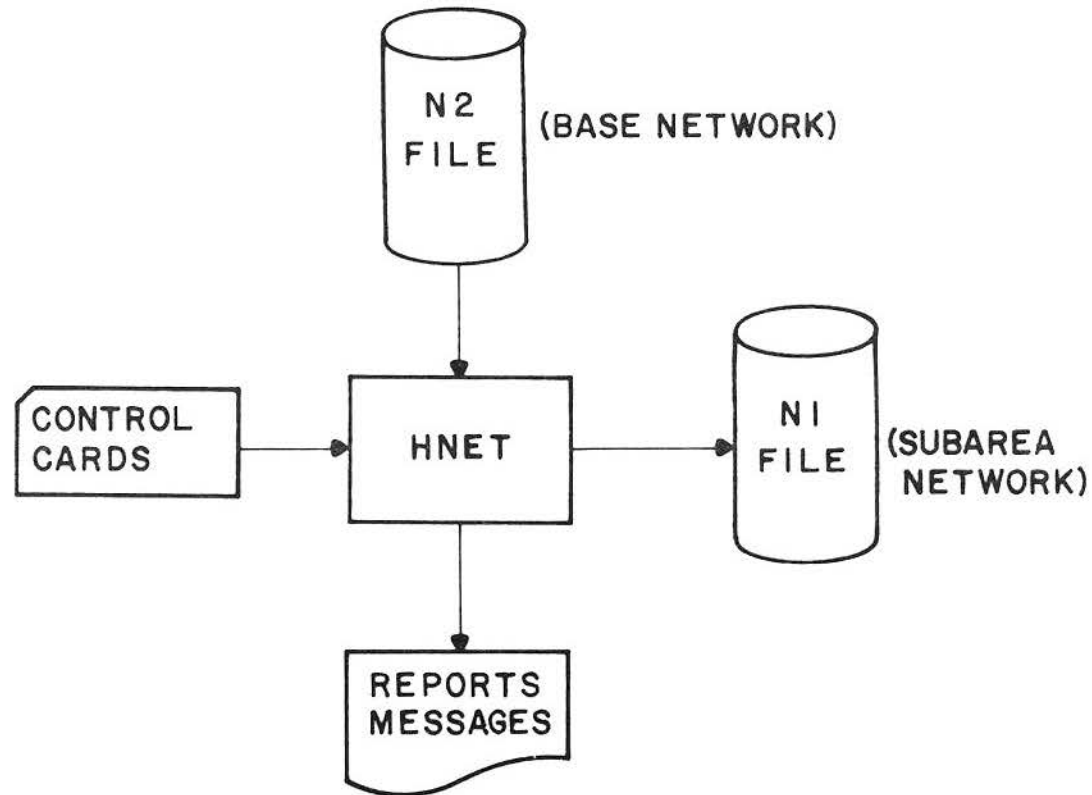


FIGURE 39 - HNET OPERATIONS (EXTRACT SUBAREA NETWORK)

Extraction of a subarea network also requires an input base network N-File and an output N-File which contains the subarea network description. The subarea network is defined by a set of node numbers (and associated links) delineated with the "N" keyword in the &SELECT statement. All attributes associated with these links are copied to the new, subarea N-File.

FIGURE 40
HNET OPERATIONS
EXTRACT SUBAREA NETWORK

```
// HNET EXEC HNET,CORE=256K,  
// NI='DSN=UMTA.UTOWN.SUBAREA,VOL=SER=UMTAI',DISPNI='(NEW,KEEP)',  
// N2='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPN2='(OLD,KEEP)'  
// HNET.SYSIN DD *
```

HNET RUN TO CREATE SUBAEA NETWORK

```
&PARAM NODES=143,ZONES=5 &END  
&SELECT N=3,5,105,106,111,112,114,117,118,120,123,124,126,129,  
130,132,135,-137,139,141,143 &END
```

FIGURE 40 - HNET OPERATIONS (EXTRACT SUBAREA NETWORK)

The JCL set-up contains two N-Files -- the input base network (N2) and the subarea network (N1). The "N" keyword in the &SELECT statement "carves out" a subarea network, which in this example is comprised of the UTOWN freeway corridor. All links whose A-node and B-node are specified in the "N" keyword range create the subarea network.

FIGURE 41

HNET OPERATIONS BUILD Z-FILES

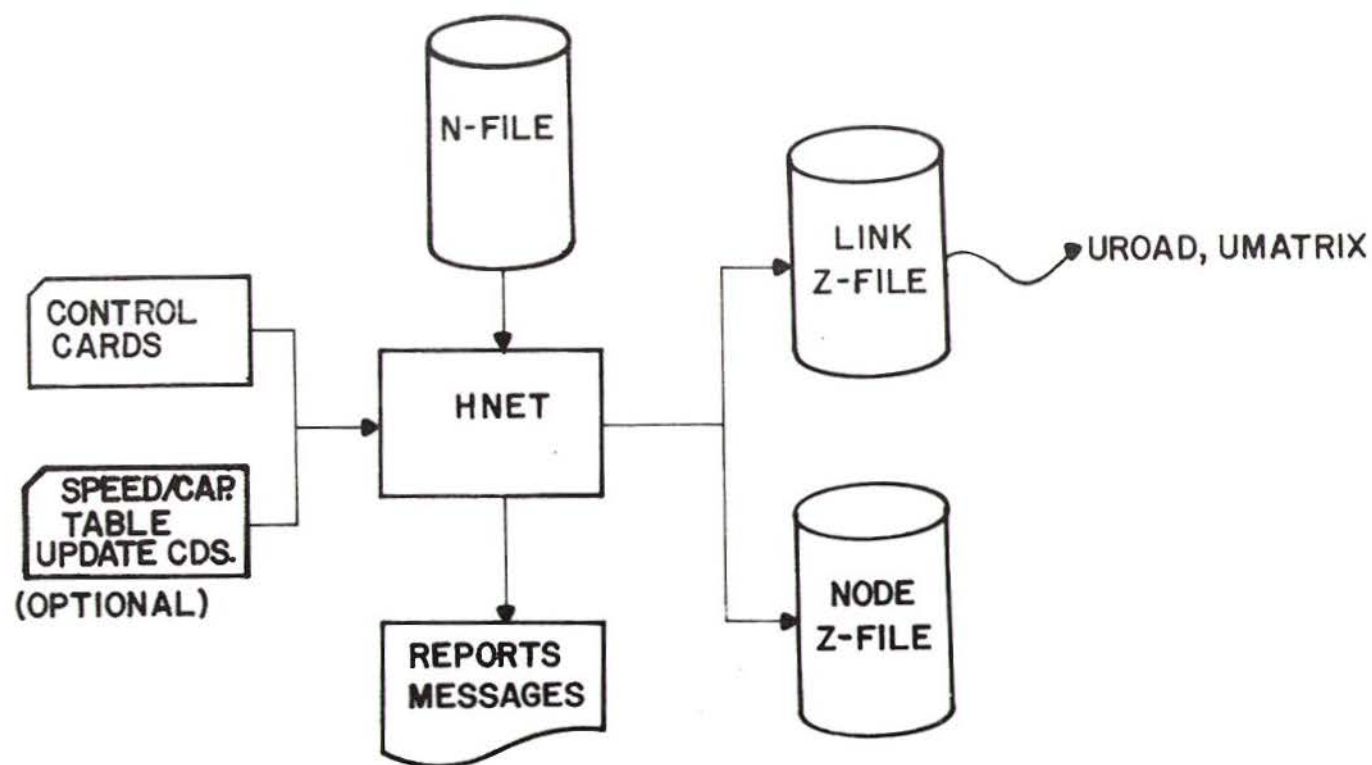


FIGURE 41 - HNET OPERATIONS (BUILD Z-FILES)

Building Z-Files from an N-File is the key operation of HNET as the Z-Files allow the highway network to be analyzed with other UTPS programs such as UROAD and UMATRIX. HNET posts all network information contained in the N-File to the Z-File in the usual, default mode. The user can select the attributes to be posted using the "LZLAWS" and "NZLAWS" keywords on the &SELECT statement.

Link speeds and capacities, if determined from the speed/capacity table, are posted to the link Z-File in this operation as well as any speeds and capacities which were coded in the link statements. The speed/capacity table default values can be modified using speed/capacity update statements which allow the user to change any or all values in the table.

FIGURE 42
HNET OPERATIONS
BUILD Z-FILES

```
// HNET EXEC HNET,CORE=256K,  
// NI='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPNI='(OLD,KEEP)',  
// ZI='DSN=UTOWN.LZFILE,VOL=SER=UMTAI',DISPZI='(NEW,KEEP)',  
// Z2='DSN=UTOWN.NZFILE,VOL=SER=UMTA2',DISPZ2='(NEW,KEEP)'  
// HNET.SYSIN DD *  
      HNET RUN TO CREATE LINK AND NODE Z-FILES  
      &SELECT REPORT=16,18,19 &END  
      &DATA  
      (S/C TABLE UPDATE CARDS GO HERE)
```


FIGURE 42 - HNET OPERATIONS (BUILD Z-FILES)

The JCL set-up to build link and node Z-Files is shown. Note that the N1 File which contains the UTOWN network description is read in and two Z-Files are produced: a link Z-File (Z1) and a node Z-File (Z2). The computer file space requirements for the Z-Files must be supplied in the JCL and can be computed from formulas in the HNET program write-up. It has been omitted here for simplification. Upon initial creation, space must be provided for the new LAVs that will be created by UROAD or UMATRIX and added to the Z-Files.

Any speed/capacity update statements (called cards in the figure) follow the &DATA statement at the end of the control statements.

FIGURE 43

HNET REPORT 16

HNET RUN TO BUILD NETWORK FILES

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C O N T E N T S O F Z - F I L E Z 1

LINKS= 126 CREATION: DATE=23SEP81 TIME= 9.01.46 PROG=HNET
 CPEATED FROM DSN=SYS81266,T090134,RA000,UMTA2335,NFILE

SPACE TOTAL UNUSED EMBEDDED
 (WORDS): DATA= 15000 USED= 3550 AVAILABLE= 11450 FREE SPACE= 0

ATTRIBUTE ENTRIES: LAVS PRESENT= 21 MAX LAVS POSSIBLE=136

-----CREATION-----						
LAV NAME	UNITS	TYPE	DATE	TIME	PROGRAM	DESCRIPTION
A	143	I*2	23SEP81	9.01	HNET	LINK ANODES
AT		I*1	23SEP81	9.01	HNET	AREA TYPE
B	143	I*2	23SEP81	9.01	HNET	LINK BNODES
C	VEH/LN/H	I*2	23SEP81	9.01	HNET	CAPACITY
CC		I*1	23SEP81	9.01	HNET	CONSTRUCTION CODE
D	MI	R*4	23SEP81	9.01	HNET	DISTANCE
DC		I*1	23SEP81	9.01	HNET	DIRECTION CODE
FFS	MI/H	R*4	23SEP81	9.01	HNET	FREE FLOW SPEED
FFT	MIN	R*4	23SEP81	9.01	HNET	FREE FLOW TIME
FT		I*1	23SEP81	9.01	HNET	FACILITY TYPE
GL		I*1	23SEP81	9.01	HNET	GEOGRAPHIC LOCATION
LG		I*1	23SEP81	9.01	HNET	LINK GROUP
LU		I*1	23SEP81	9.01	HNET	LAND USE CODE
NL		I*1	23SEP81	9.01	HNET	NUMBER OF LANES
OS	MI/H	R*4	23SEP81	9.01	HNET	OBSERVED SPEED
OT	MIN	R*4	23SEP81	9.01	HNET	OBSERVED TIME
OV	VEH	I*4	23SEP81	9.01	HNET	OBSERVED VOLUME OR COUNT
TC		I*1	23SEP81	9.01	HNET	TOLL CLASS
UC		I*1	23SEP81	9.01	HNET	USE CODE
UT	MIN	R*4	23SEP81	9.01	HNET	UNIFORM TIME
Z	5	I*2	23SEP81	9.01	HNET	ZONE NUMBER

FIGURE 43 - HNET REPORT 16

Report 16 displays the contents and status of the link Z-File created by HNET. It lists all LAVs in the link Z-File by their HNET-assigned LAV names, the applicable units of measurement, the creation date and time of the most current LAVs and a longer description of the LAV contents.

FIGURE 44

HNET REPORT 18

HNET RUN TO BUILD NETWORK FILES

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HNET REPORT 18

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LINK SPEED AND CAPACITY TABLES

AREA TYPE 1

LANES		-----FACILITY TYPE-----					
		1	2	3	4	5	6
1	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
2	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
3	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
4	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
5	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
6	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
7	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
8	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0
9	CAPACITY	1750	800	600	700	10000	600
	SPEED	48.0	37.0	22.0	22.0	10.0	22.0

AREA TYPE 2

LANES		-----FACILITY TYPE-----					
		1	2	3	4	5	6
1	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
2	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
3	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
4	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
5	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
6	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
7	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
8	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0
9	CAPACITY	1750	1000	550	550	10000	800
	SPEED	48.0	44.0	25.0	29.0	15.0	25.0

UNITS: CAPACITY IN (VEH/LN)/H AT LEVEL OF SERVICE E
SPEED IN MI/H

FIGURE 44 - HNET REPORT 18

Report 18 displays the contents of the speed/capacity tables used to assign speed and capacity values to links in the network based on their facility type, area type, and number of lanes (as we discussed earlier). Report 18 displays all table values by number of lanes (NL) and facility type for each area type. The report reflects any changes made to the default values with speed/capacity table update statements, which the user can optionally input in any HNET run that builds a link Z-File.

Capacity values represent link capacity in vehicles per lane per hour and speed represents link free flow speed in miles per hour (or kph).

FIGURE 45

HNET REPORT 19

HNET RUN TO BUILD NETWORK FILES

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C O N T E N T S O F Z - F I L E Z 2

NODES= 143 CREATION: DATE=23SEP81 TIME= 9.01.46 PROG=HNET
 CREATED FROM DSN=SYS81266.T090134.RA000.UMTA2335.NFILE

SPACE TOTAL UNUSED EMBEDDED
 (WORDS): DATA= 15000 USED= 1950 AVAILABLE= 13050 FREE SPACE= 0

ATTRIBUTE ENTRIES: LAVS PRESENT= 9 MAX LAVS POSSIBLE=137

-----CREATION-----						
LAV NAME	UNITS	TYPE	DATE	TIME	PROGRAM	DESCRIPTION
AT		I*1	23SEP81	9.01	HNET	AREA TYPE
DIST	2500	I*2	23SEP81	9.01	HNET	DISTRICTS
GL		I*1	23SEP81	9.01	HNET	GEOGRAPHIC LOCATION
LI		I*1	23SEP81	9.01	HNET	LINKS IN
LO		I*1	23SEP81	9.01	HNET	LINKS OUT
SUPER	2500	I*2	23SEP81	9.01	HNET	SUPER DISTRICTS
X	1.00	R*4	23SEP81	9.01	HNET	X COORDINATES
Y	1.00	R*4	23SEP81	9.01	HNET	Y COORDINATES
Z	5	I*2	23SEP81	9.01	HNET	ZONES

* - UNITS FIELD OF THE X AND Y LAVS CONTAINS THE &PARAM DSCALE VALUE

FIGURE 45 - HNET REPORT 19

Report 19 displays the status and contents of the node Z-File in the same manner that Report 16 displays the link Z-File.

FIGURE 46

HNET OPERATIONS

CONVERT UTPS OLDHR

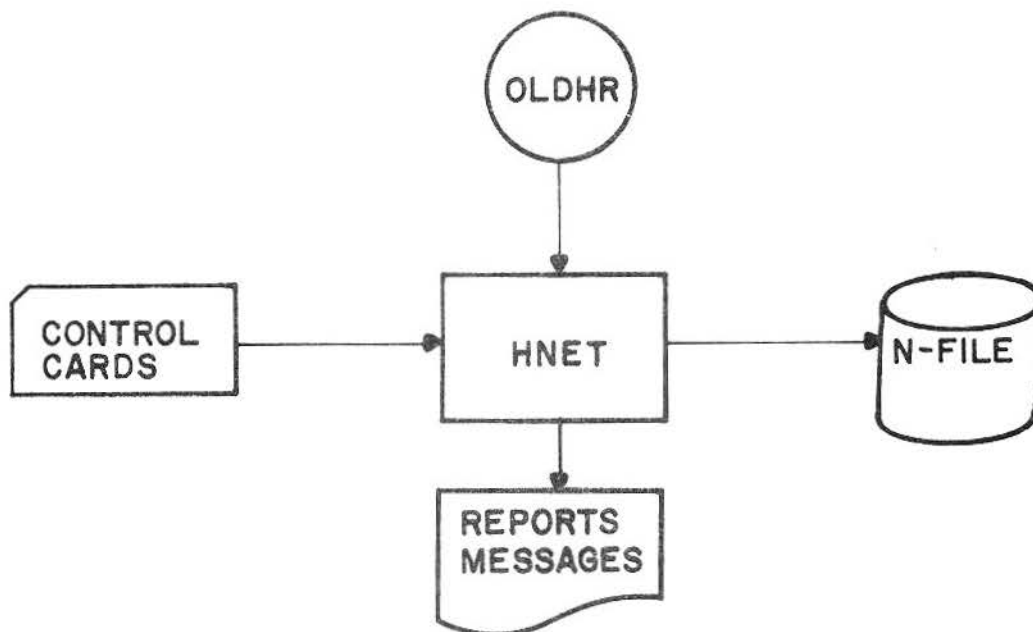


FIGURE 46 - HNET OPERATIONS (CONVERT UTPS OLDHR)

For those users who already have a computerized highway network file in either a PLANPAC or UTPS historical record file (OLDHR), HNET can convert the OLDHR File to the N-File format and then generate Z-Files. Conversion of a UTPS format OLDHR is more automatic and straightforward, as the network description already should conform to most of HNET's network coding conventions (particularly with respect to facility type, area type, and number of lanes). Conversion of a PLANPAC OLDHR can require more pre-processing to move attributes around and add others required in UTPS, such as area type and facility type.*

The control of HNET for this conversion function requires an OLDHR File as input and an "OLDHR=T" coded in the &OPTION statement.

HNET can both convert "basic" network data from a UTPS or PLANPAC OLDHR File to an N-File and copy "load" data from a UTPS OLDHR to a link Z-File, as we will show in another figure. "Basic" data items are defined as those link attributes contained in the OLDHR as built by old program HR (or BUILDHR), while "load" data items are the link attributes added to the OLDHR File by an earlier UROAD traffic assignment.

* The simplest method devised so far for this is to write a Fortran program to rearrange PLANPAC data fields. For further information, contact Fred Ducca of the FHWA at the address listed in the preface.

FIGURE 47
HNET OPERATIONS
CONVERT UTPS OLDHR

```
// HNET EXEC HNET,CORE=256K,  
// OLDHR='DSN=UMTA.UTOWN.HR,VOL=SER=UMTA2',  
// NI='DSN=UMTA.UTOWN.NET,VOL=SER=UMTA1',DISPNI='(NEW,KEEP)'  
// HNET.SYSIN DD *
```

HNET RUN TO BUILD N-FILE FROM OLDHR

```
&PARAM NODES=143,ZONES=5 &END
```

```
&OPTION OLDHR=T &END
```

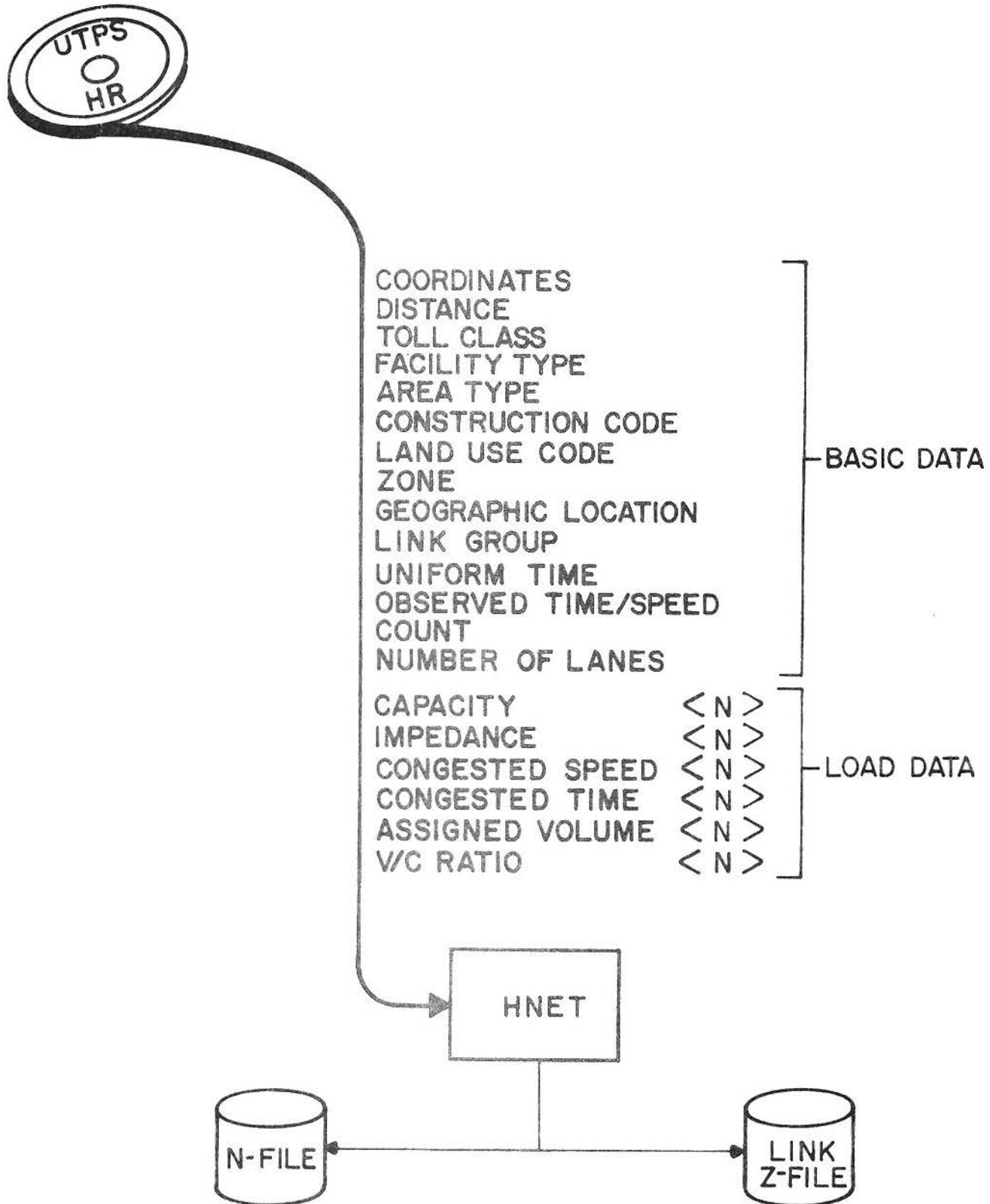
```
&SELECT REPORT=1,-5,6,-8,14 &END
```


FIGURE 47 - HNET OPERATIONS (CONVERT UTPS OLDHR)

This is a JCL set-up to convert a UTPS OLDHR File to an N-File. Note that the OLDHR File is read in and that the option OLDHR=T is coded. This run will copy the basic data from the OLDHR File and create an N-File with appropriate node and link information. Any attribute changes could then be accomplished in subsequent HNET runs using the N-File as input and output.

FIGURE 48

HNET OPERATIONS CONVERT OLDHR



UTPS OLDHR ATTRIBUTES
THAT CAN BE CONVERTED

FIGURE 48 - HNET OPERATIONS (CONVERT UTPS OLDHR)

The data that can be copied by HNET from a UTPS OLDHR consists of both "basic" data and "load" data. Basic data are the link attributes that come from the "old style" link statements and coordinate statements as input to program HR. The load data are the link attributes appended to an OLDHR by the old version (1980 or earlier) of UROAD after a traffic assignment. They include assigned volume, V/C ratio, and congested speed. Since there may be multiple sets of load data appended to an OLDHR from multiple UROAD assignments, HNET can retrieve these multiple sets by referencing each attribute with a numerical superscript. For example, the assigned link volumes from the first set of load data would be referenced by its assigned LAV name V1, the second set (if any) by V2, etc. Each load data attribute can be referenced in this manner.

The load data can only be written to a link Z-File and cannot be stored in an N-File. Hence, when converting a UTPS OLDHR, HNET would be run to create both an N-File and link Z-File from the OLDHR. This could also be done in a sequential manner with the N-File being created and "cleaned-up" first, and then a link Z-File created in a sequential HNET run.

FIGURE 49

HNET OPERATIONS CONVERT OLDHR

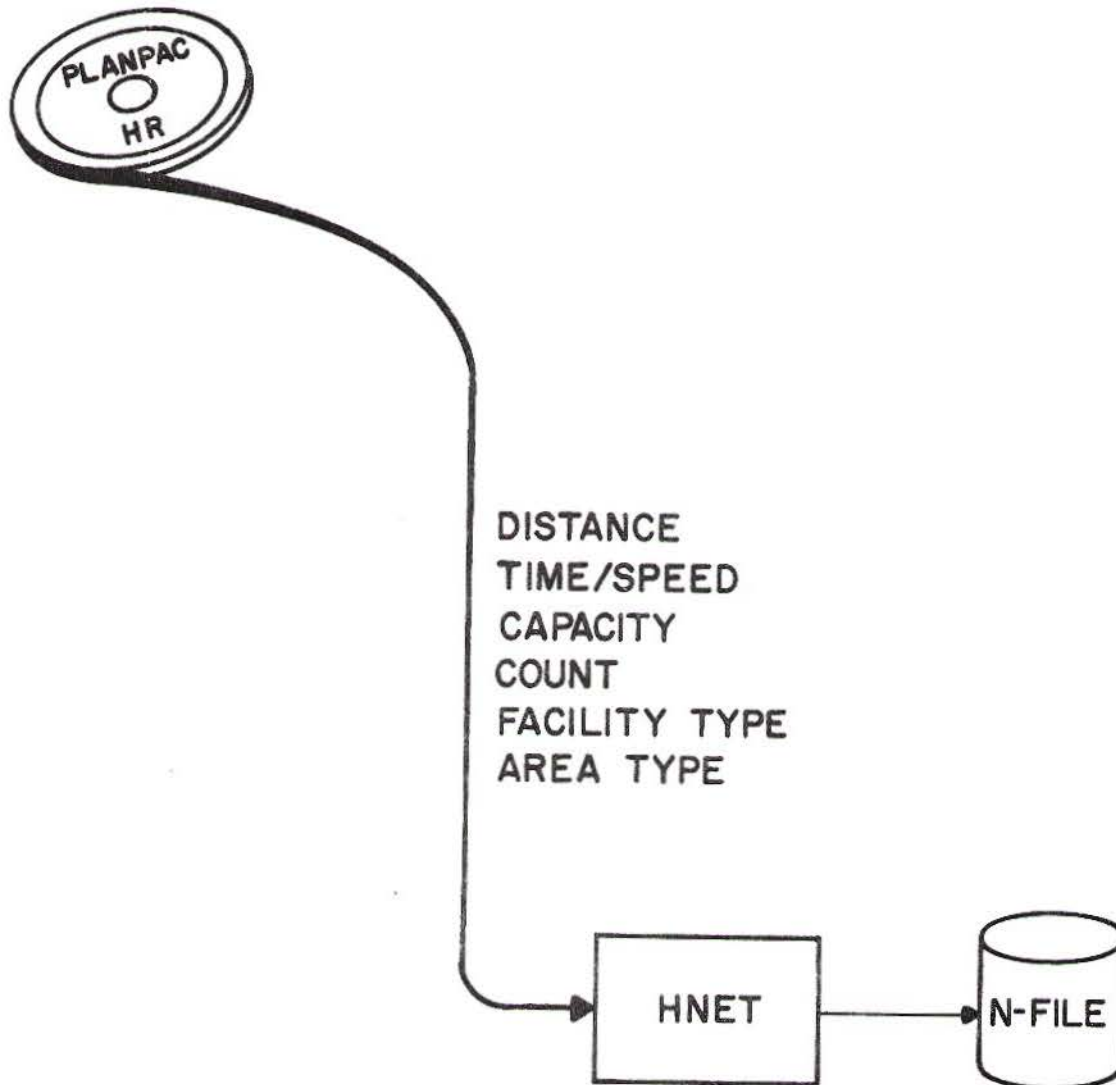


FIGURE 49 - HNET OPERATIONS (CONVERT PLANPAC OLDHR)

The amount of information that HNET can copy from a PLANPAC OLDHR is considerably less than from a UTPS OLDHR. This is primarily due to the differences in network coding conventions between PLANPAC and UTPS. At most, HNET can copy link distance, speed/time, capacity, count, facility type and area type. Typically the facility type and area type codes from PLANPAC do not correspond with the UTPS conventions and would need subsequent modification.

An alternative approach, not illustrated here, is to manipulate the original PLANPAC link statements by rearranging attribute fields so that HNET can more easily find the link attributes. Subsequent network updating with HNET is required in either case to produce a complete network description for further UTPS analysis.

FIGURE 50

HNET FUNCTIONS BUILD Z-FILE FROM OLDHR COPY LOAD DATA

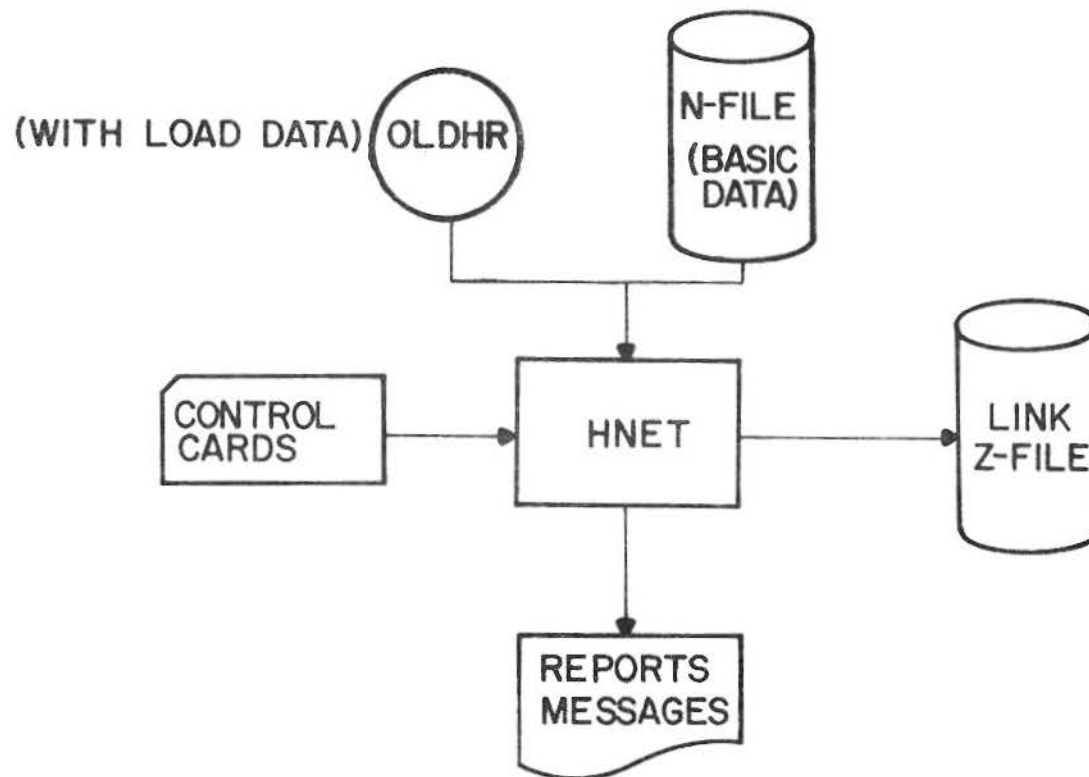


FIGURE 50 - HNET FUNCTIONS (BUILD Z-FILE FROM OLDHR)

The creation of a link Z-File from a UTPS OLDHR requires both an OLDHR and an N-File. This example also assumes the copying of load data appended to the OLDHR by an earlier UROAD traffic assignment. The load data from the OLDHR as well as the basic data from the N-File are used to create the new link Z-File.

Link data attributes to be copied are specified in the &SELECT statement, including both basic data and load data.

FIGURE 51
HNET FUNCTIONS
COPY UTPS OLDHR LOAD DATA
BUILD Z-FILE

```
//HNET EXEC HNET,CORE=256K,  
// OLDHR='DSN=UMTA.UTOWN.HR,VOL=SER=UMTAI',  
// NI='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPNI='(OLD,KEEP)',  
// ZI='DSN=UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',DISPZI='(NEW,KEEP)'  
//HNET.SYSIN DD *  
      HNET RUN TO BUILD Z-FILE FROM OLDHR  
&SELECT LZLAVS='DC','D','TC','FT','AT','Z',  
      'OS','OT','OV','NL','GL','LG','A','B','VI','CSI',  
      'CTI','CI','VCI',REPORT=16 &END
```

FIGURE 51 - HNET FUNCTIONS (COPY UTPS OLDHR LOAD DATA - BUILD Z-FILE)

The JCL set-up to copy load data from a UTPS OLDHR and generate a link Z-File includes an input N-File (N1) which would have been previously created by HNET from the OLDHR and would contain "basic" data. In addition, the OLDHR file is read in to provide the "load" data. The output consists of a link Z-File (Z1) which will contain both basic and load data from the OLDHR.

The &SELECT keyword LZLAVS specifies which data items are to be copied from the N-File and OLDHR to the link Z-File. The link attributes to be copied are determined by their assigned LAV names which are specified in the HNET program write-up. "V1", "CS1", etc., refer to the first set of load data from the OLDHR and reference the assigned volume (V1), congested speed (CS1), congested time (CT1), capacity (C1) and Volume/Capacity Ratio (VC1).

FIGURE 52

HNET OPERATIONS

COPY N-FILE

CONVERT TO METRIC

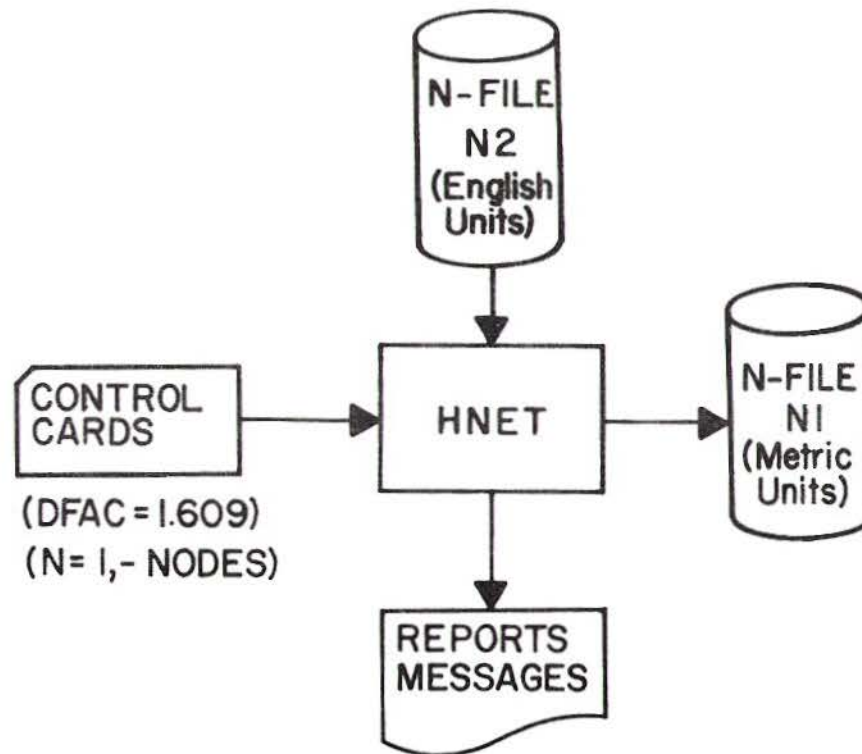


FIGURE 52 - HNET OPERATIONS (COPY N-FILE - CONVERT TO METRIC)

HNET can also be used to convert a network from English units to metric units. This conversion requires an input N-File in English units and an output N-File to contain the metric network. An "unbuild" function must be invoked for this conversion to be accomplished where intermediate link and node statements are produced by HNET. HNET is instructed to do this by coding a node selection in the control statements as is done when building a subarea network. In this instance however, the node selection keyword selects all node numbers in the input network so that the entire network is selected and converted to metric units. Both distance (miles to kilometers) and speed (miles/hour to kilometers/hour) are converted if DFAC is set equal to 1.609 (the conversion factor between English and metric) in the &PARAM statement.

FIGURE 53
HNET OPERATIONS
COPY N-FILE
CONVERT TO METRIC

```
// HNET EXEC HNET,CORE=256K,  
// N2='DSN=UMTA.UTOWN.NFILE,VOL=SER=UMTAI',DISPN2='(OLD,KEEP)',  
// N1='DSN=UMTA.UTOWN.METRIC.NFILE,VOL=SER=UMTAI',DISPN1='(NEW,KEEP)'  
// HNET.SYSIN DD *
```

HNET RUN TO CONVERT TO METRIC NETWORK

&PARAM DFAC=1.609344 &END

&SELECT N=1,-143,REPORT=4,5,7,RNODES=101,-143 &END

NOTE: IF ULINK AND UNODES FILES CODED IN JCL,
HNET WILL SAVE LINK AND NODE CARD IMAGES

FIGURE 53 - HNET OPERATIONS (COPY N-FILE - CONVERT TO METRIC)

The JCL set-up required to convert a highway network to metric units includes an input N-File (N2) and an output N-File (N1) and/or ULINK and UNODES Files which will contain link and node statements. The &PARAM keyword DFAC is set to the conversion value from English to metric units and the &SELECT keyword "N" is coded with all nodes (1-143 in UTOWN) to cause HNET to perform a network "unbuild" operation. The unbuild is required for the DFAC conversion to work.

FIGURE 54

HNET OPERATIONS COMPARE ASSIGNMENTS

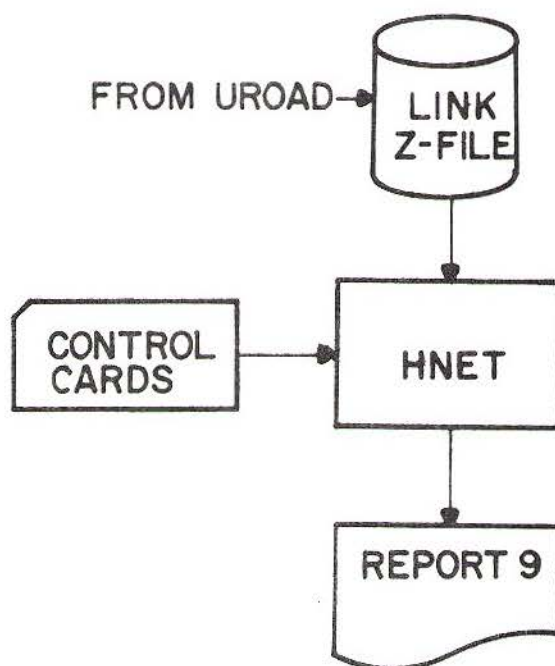


FIGURE 54 - HNET OPERATIONS (COMPARE ASSIGNMENTS)

HNET also facilitates the comparison of alternative traffic assignment results or the comparison of assignment results with the observed base conditions of the network. This is accomplished by reading in a link Z-File which contains at least one set of traffic assignment information written by UROAD. If more than one assignment has been performed with UROAD on the network, they can be compared by reading the resultant LAVs of both assignments from the input link Z-File. Report 9 is used to display the comparison on a link-by-link basis.

This comparison can be made only when the same network is used in both assignments.

FIGURE 55
HNET OPERATIONS
COMPARE ASSIGNMENTS

```
//HNET EXEC HNET,CORE=256K,  
// ZI='DSN=UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',DISPZI='(OLD,KEEP)'  
//HNET.SYSIN DD *  
      HNET RUN TO COMPARE TWO UROAD ASSIGNMENTS  
&SELECT LOADS=1,2,REPORT=9 &END
```


FIGURE 55 - HNET OPERATIONS (COMPARE ASSIGNMENT)

The "LOADS" keyword on the &SELECT statement tells HNET which assignment LAVs from the link Z-File are to be displayed in Report 9. Each UROAD traffic assignment run writes five LAVs for each link in the network (impedance, assigned volume, congested speed, congested time, V/C ratio). Report 9 allows for comparison of these values for two different assignments or between an assignment and the base network conditions (observed volumes and speeds). The next figure shows a sample output from Report 9.

FIGURE 56

HNET REPORT 9

HNET RUN TO COMPARE TWO UROAD ASSIGNMENTS

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HNET REPORT 9

PAGE 5

LINK DATA WITH LOADS

A NODE	B U NODE C	FREEFLOW TIME SP	---	ASSIGNED (LOAD 1)---	---	ASSIGNED (LOAD 2)---				
			IMP	VOL	TIME SP	V/C	IMP	VOL	TIME SP	V/C
116	104	1.44 25	0.01	751	1.44 25	0.23	0.01	841	1.44 25	0.26
116	110	3.96 25	0.04	0	3.96 25	0.00	0.04	0	3.96 25	0.00
116	113	0.00 T 1	0.00	3504	0.10		0.00	3310	0.10	
116	122									
117	104	2.76 25	0.03	956	2.81 25	0.43	0.04	2041	3.73 18	0.93
117	105	3.00 22	0.03	727	3.27 20	0.66	0.03	686	3.22 20	0.62
117	118	2.36 28	0.02	126	2.36 28	0.08	0.02	118	2.36 28	0.07
117	123	1.78 32	0.02	157	1.78 32	0.09	0.02	39	1.78 32	0.02
118	112	2.11 47	0.02	88	2.11 47	0.03	0.02	129	2.11 47	0.04
118	117	2.36 28	0.02	585	2.38 28	0.35	0.03	1252	2.73 24	0.76
118	120	1.39 28	0.01	135	1.39 28	0.12	0.01	150	1.39 28	0.14
118	124	1.21 47	0.01	9	1.21 47	0.00	0.01	13	1.21 47	0.00
119	102	1.36 22	0.03	3185	3.36 9	1.33	0.04	3379	3.89 8	1.41
119	122	0.00 T 1	0.00	853	0.10		0.00	763	0.10	
120	107	3.00 22	0.03	144	3.00 22	0.13	0.03	150	3.00 22	0.14
120	114	4.50 22	0.04	0	4.50 22	0.00	0.04	0	4.50 22	0.00
120	118	1.39 28	0.01	365	1.40 28	0.33	0.02	1168	2.23 17	1.06
120	126	2.04 28	0.02	0	2.04 28	0.00	0.02	0	2.04 28	0.00
121	107	1.39 28	0.01	0	1.39 28	0.00	0.01	0	1.39 28	0.00
121	115	3.54 28	0.04	0	3.54 28	0.00	0.04	0	3.54 28	0.00
121	127	2.04 28	0.02	0	2.04 28	0.00	0.02	0	2.04 28	0.00
122	103	1.44 25	0.01	760	1.44 25	0.24	0.01	763	1.44 25	0.24
122	116	2.59 22	0.03	522	2.61 22	0.37	0.03	0	2.59 22	0.00
122	119	0.00 T 1	0.00	3185	0.10		0.00	3379	0.10	
122	128	2.88 25	0.03	112	2.88 25	0.10	0.03	0	2.88 25	0.00
123	103	2.76 25	0.03	1687	3.21 21	0.77	0.03	1249	2.90 24	0.57
123	117									
123	124	2.36 28	0.02	279	2.36 28	0.17	0.02	507	2.37 28	0.31
123	129	3.27 22	0.03	126	3.27 22	0.11	0.03	0	3.27 22	0.00
124	118	1.21 47	0.01	313	1.21 47	0.07	0.01	831	1.21 47	0.19
124	123	2.36 28	0.03	992	2.51 26	0.60	0.03	1210	2.68 25	0.73
124	126	1.39 28	0.01	118	1.39 28	0.11	0.01	141	1.39 28	0.13
124	130	1.53 47	0.02	180	1.53 47	0.05	0.02	427	1.53 47	0.13
126	108	3.00 22	0.03	130	3.00 22	0.12	0.03	141	3.00 22	0.13
126	120	2.04 28	0.02	0	2.04 28	0.00	0.02	0	2.04 28	0.00
126	124	1.39 28	0.01	291	1.39 28	0.26	0.01	110	1.39 28	0.10
126	132	2.57 28	0.03	5	2.57 28	0.00	0.03	0	2.57 28	0.00
127	108	1.39 28	0.01	17	1.39 28	0.03	0.01	0	1.39 28	0.00
127	121	2.04 28	0.02	0	2.04 28	0.00	0.02	0	2.04 28	0.00
127	133	2.57 28	0.03	4	2.57 28	0.01	0.03	0	2.57 28	0.00
128	122	2.88 25	0.03	384	2.90 25	0.35	0.03	0	2.88 25	0.00
128	129	4.77 22	0.05	112	4.77 22	0.10	0.05	0	4.77 22	0.00
128	134	3.43 28	0.03	0	3.43 28	0.00	0.03	0	3.43 28	0.00
129	123	3.27 22	0.03	542	3.36 21	0.49	0.03	0	3.27 22	0.00
129	128	4.77 22	0.05	384	4.80 22	0.35	0.05	0	4.77 22	0.00
129	130	2.36 28	0.02	238	2.36 28	0.22	0.02	0	2.36 28	0.00

FIGURE 56 - HNET REPORT 9

Report 9 displays, for those links selected by the RNODES keyword, key attributes which allow comparison of a traffic assignment output with observed base conditions, or with another traffic assignment. The example shown compares two UROAD traffic assignment results stored in the same Z-File. When two assignment results are compared, the middle section of Report 9 contains the same information as the assigned link data in the rightmost section (e.g., impedance, volume, time, speed, V/C ratio). For example, link 120-118 had 365 vehicles assigned by UROAD assignment 1 at an average speed of 28 mph, while UROAD assignment 2 assigned 1,168 vehicles to that link at an average speed of 17 mph. When an assignment is being compared with base network attributes the middle section of the report displays base link data which includes capacity, observed volume, time, speed, and distance.

The "LOADS" keyword on the &SELECT statement controls the contents of Report 9. LOADS contains two values: the first references the LAV number of the first UROAD assignment in the link Z-File and the second LOADS value references the UROAD assignment LAV number to be selected for comparison. For example:

LOADS=1,3,REPORT=9

will generate a Report 9 which compares the results (impedance, volume, time, speed, V/C ratio) of UROAD traffic assignment 1 with UROAD assignment 3 on the network contained on the input link Z-File.

The special case of LOADS=0,1 produces a comparison of a selected UROAD traffic assignment result with the observed base condition link attributes of the network.

FIGURE 57
HNET
OPERATIONS
PLOT NETWORKS

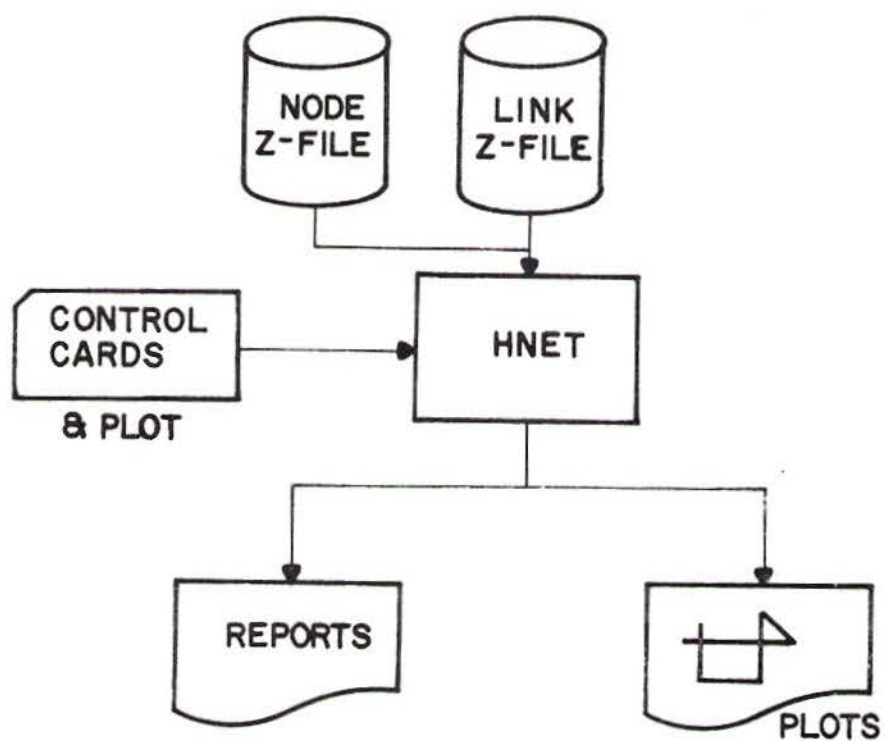


FIGURE 57 - HNET OPERATIONS (PLOT NETWORKS)

HNET can also produce network plots, both printer and mechanical, for use in network debugging, evaluation, and presentation. The node Z-File with node coordinates is required for network plotting as well as the link Z-File containing network attributes.

The plotting function is controlled by the &PLOT control statement and associated keywords. Mechanical plots can be generated by linking HNET to the appropriate plotting subroutines of the local computer system. Printer plots can be produced directly by HNET.

FIGURE 58
HNET OPERATIONS
PLOT NETWORKS (PRINTER PLOT)

```
//HNET EXEC HNET,CORE=256K,  
// Z1='DSN=UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',  
// Z2='DSN=UMTA.UTOWN.NZFILE,VOL=SER=UMTAI'  
//HNET.SYSIN DD *
```

HNET RUN TO PRODUCE PRINTER PLOTS

```
&PLOT POST='FFS',PLOTN=T,SCALE=0.5,PLOTXY=6,10 &END  
&PLOT POST='C',RI='C',600,1500,PLOTN=T,SCALE=0.5,  
PLOTXY=6,10 &END
```


FIGURE 58 - HNET OPERATIONS (PLOTS NETWORKS - PRINTER PLOT)

This JCL set-up illustrates an HNET run to produce two printer plots. The node Z-File (Z2) and link Z-File (Z1) are input and the two plots are generated by coding two &PLOT statements.

The first &PLOT statement will generate a network printer plot with node numbers printed at node locations (PLOTN=T) and each link will have the free flow speed posted on it (POST='FFS'). The POST keyword controls link annotation by referencing the desired link attribute LAV names in the link Z-File.

The second &PLOT statement will also generate a network printer plot with node numbers. However, the value posted to links will be capacity and only those links whose capacity is between 600 and 1500 vehicles/hour will be plotted (R1='C',600,1500). The R<N> keyword controls link plotting based on a range of values for a link attribute. If the link attribute value is not within the range of the R<N> keyword, the link will not be plotted. This feature can be used to highlight links with particular attributes in a large network and is useful in network evaluation. Up to 10 R<N>'s can be specified in one &PLOT statement and a link must satisfy all range constraints to be plotted.

FIGURE 59

HNET

RELATIONSHIP TO OTHER UTPS PROGRAMS

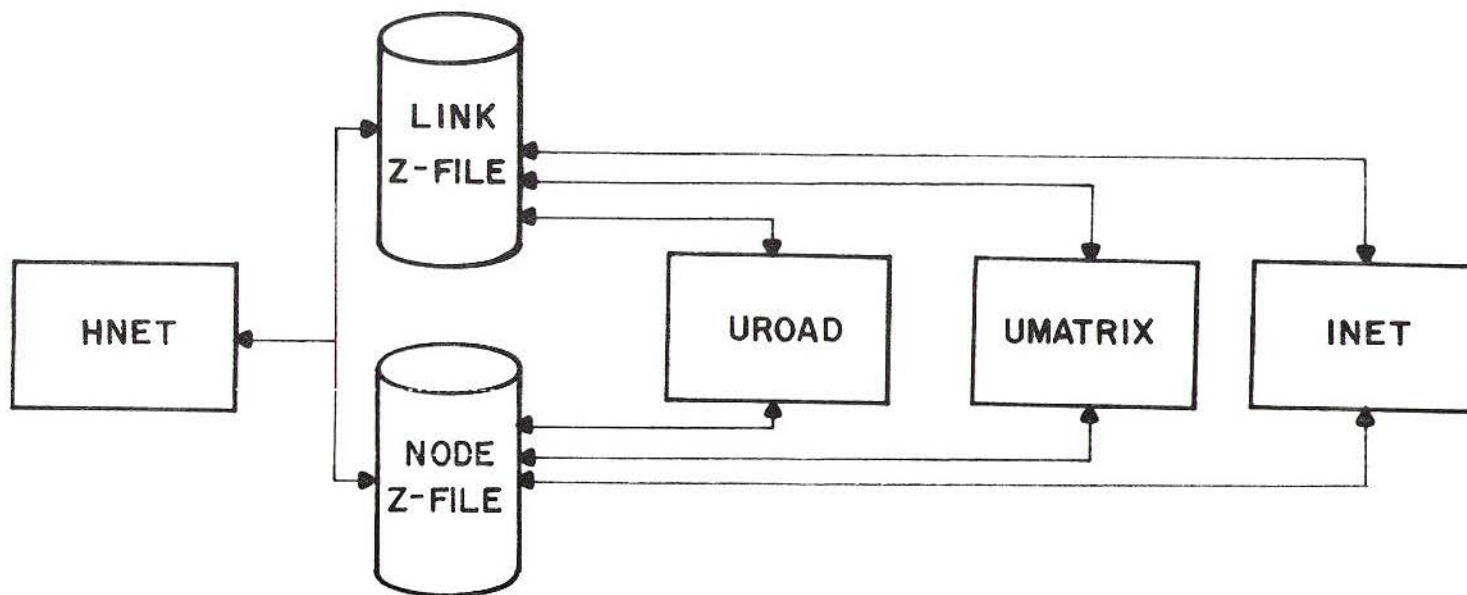


FIGURE 59 - HNET (RELATIONSHIP TO OTHER UTPS PROGRAMS)

In summary, HNET produces link and node Z-Files which describe the highway network. These files transmit and receive highway characteristics and impacts to and from other UTPS programs. These files allow the user greater flexibility in analyzing the highway system and manipulating and summarizing highway network information and impacts.



UROAD

FIGURE I
UROAD

TRAFFIC ASSIGNMENT

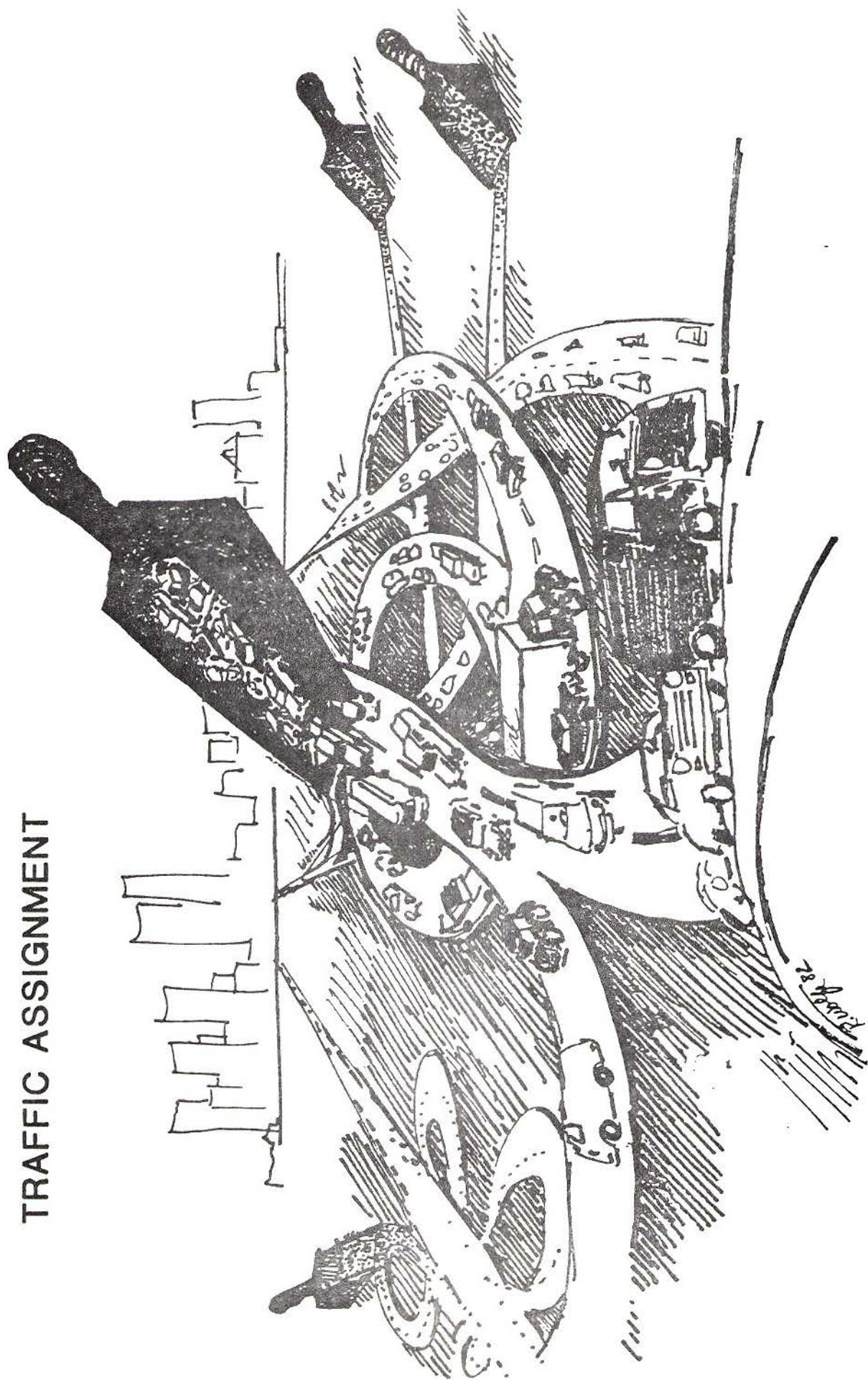


FIGURE 1 - UROAD: HIGHWAY TRAFFIC ASSIGNMENT PROGRAM

The purpose of this lecture guide is to describe the usage of the UTPS Program UROAD. UROAD is a multi-purpose program designed to analyze the performance of a highway network and produce data files on highway system performance which interface with other UTPS programs for further forecasting and analysis.

FIGURE 2

UROAD FUNCTIONS

PATHFINDING

SKIMMING

TRAFFIC ASSIGNMENT

- **ALL - OR - NOTHING**
- **STOCHASTIC MULTIPATH**
- **CAPACITY RESTRAINT**
 - **CATS INCREMENTAL**
 - **EQUILIBRIUM**
- **COMBINED METHODS**

FIGURE 2 - UROAD FUNCTIONS

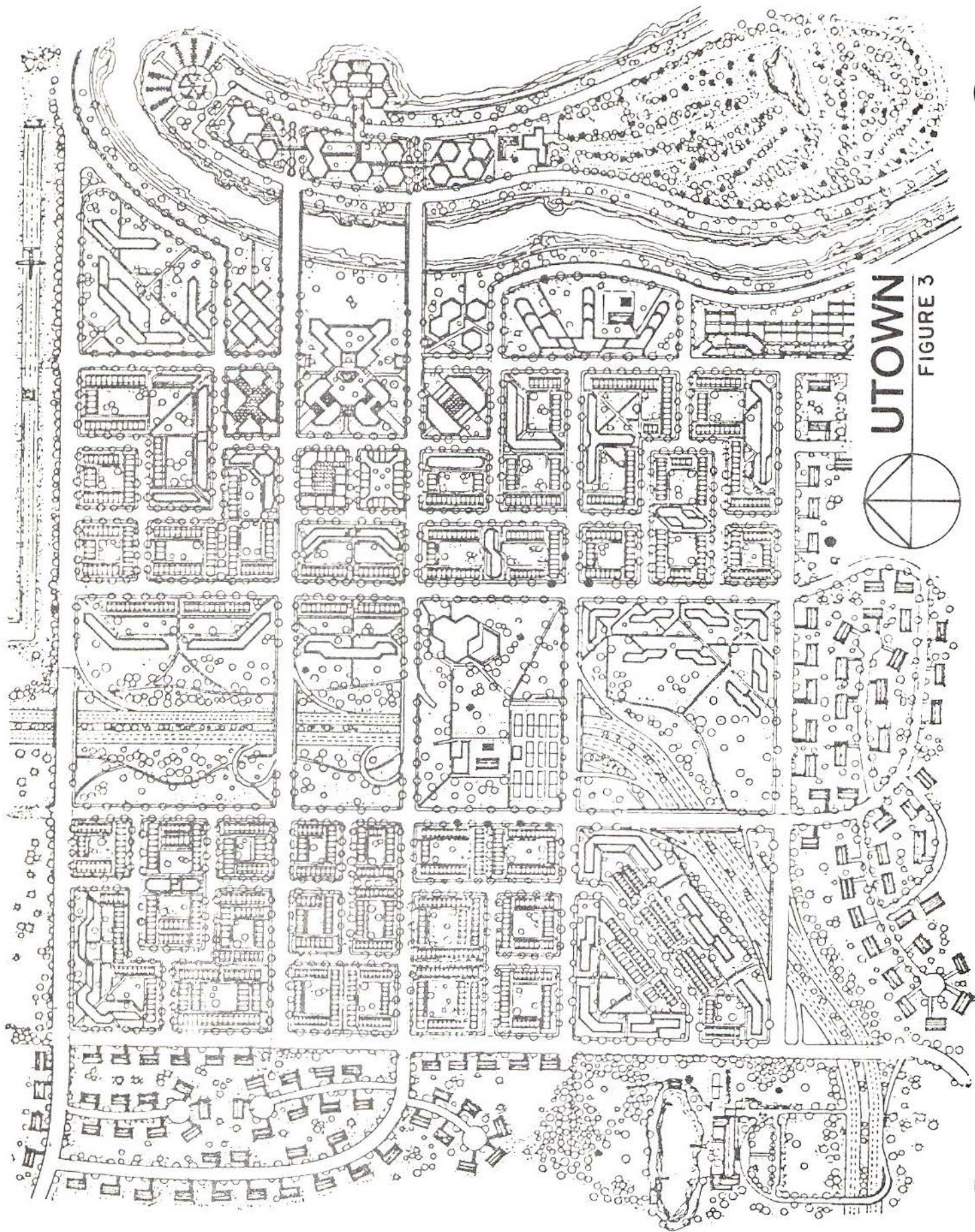
There are three major functions of the UROAD program: pathfinding, skimming and traffic assignment.

Pathfinding involves determining logical paths between zones through a network. These paths are determined by using link "impedance" which can be travel time, distance, toll cost or a weighted combination of the three. Either the single minimum path between zones or multiple reasonable paths can be determined.

"Skimming" is the process of determining the total zone to zone impedance for each zone to zone pair based upon the minimum path. In addition, values for travel time, distance and toll cost can be determined at the same time.

Traffic assignment involves the accumulation of zone to zone trips on specific network links to estimate traffic volumes. There are several techniques for assigning trips such as all-or-nothing, stochastic multipath and capacity restraint. We'll discuss these later. Assignment techniques which involve adjusting link times to reflect congestion levels are known as capacity restraint techniques. Examples of this type include CATS incremental and equilibrium assignment. Frequently, one assignment technique is used in combination with another to improve the assignment results.

The individual functions will be discussed in more detail as we proceed through the discussion of Program UROAD.



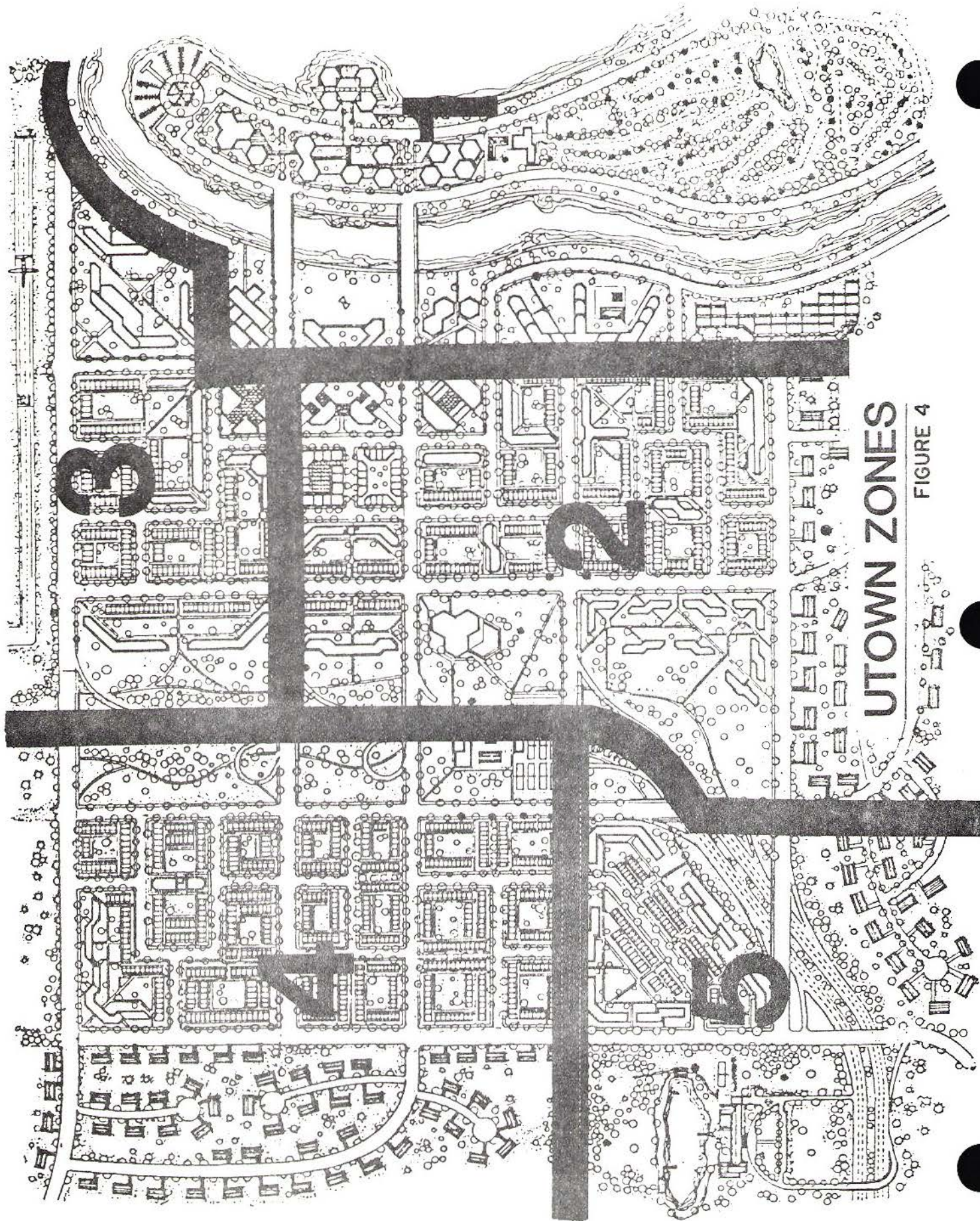
UTOWN
FIGURE 3

FIGURE 3 - UTOWN

Before getting into the specific functions of UROAD we should discuss the various inputs that are required.

Welcome to UTOWN! If you have not seen it before, UTOWN is a mythical town created to demonstrate the Urban Transportation Planning System (UTPS), of which UROAD is a part. We will demonstrate UROAD's capabilities in an extremely simplified manner based on this town.

The town is on a lake, at the right, with the downtown (CBD) on an island between the lake and a river. UTOWN has a fairly high population density near the downtown area, with suburbs to the left. You can see the street system--notice the freeway starting from the lower left and running up the center.



UTOWN ZONES

FIGURE 4

FIGURE 4 - UTOWN ZONES

As you probably know, for transportation planning, urban areas are divided into spatial units of similar land uses known as "zones." As you can see, UTOWN is divided into five such zones, with Zone 1 being the downtown. We use just five zones to simplify the presentation. Normal urban areas might have 200 to 1,200 zones.

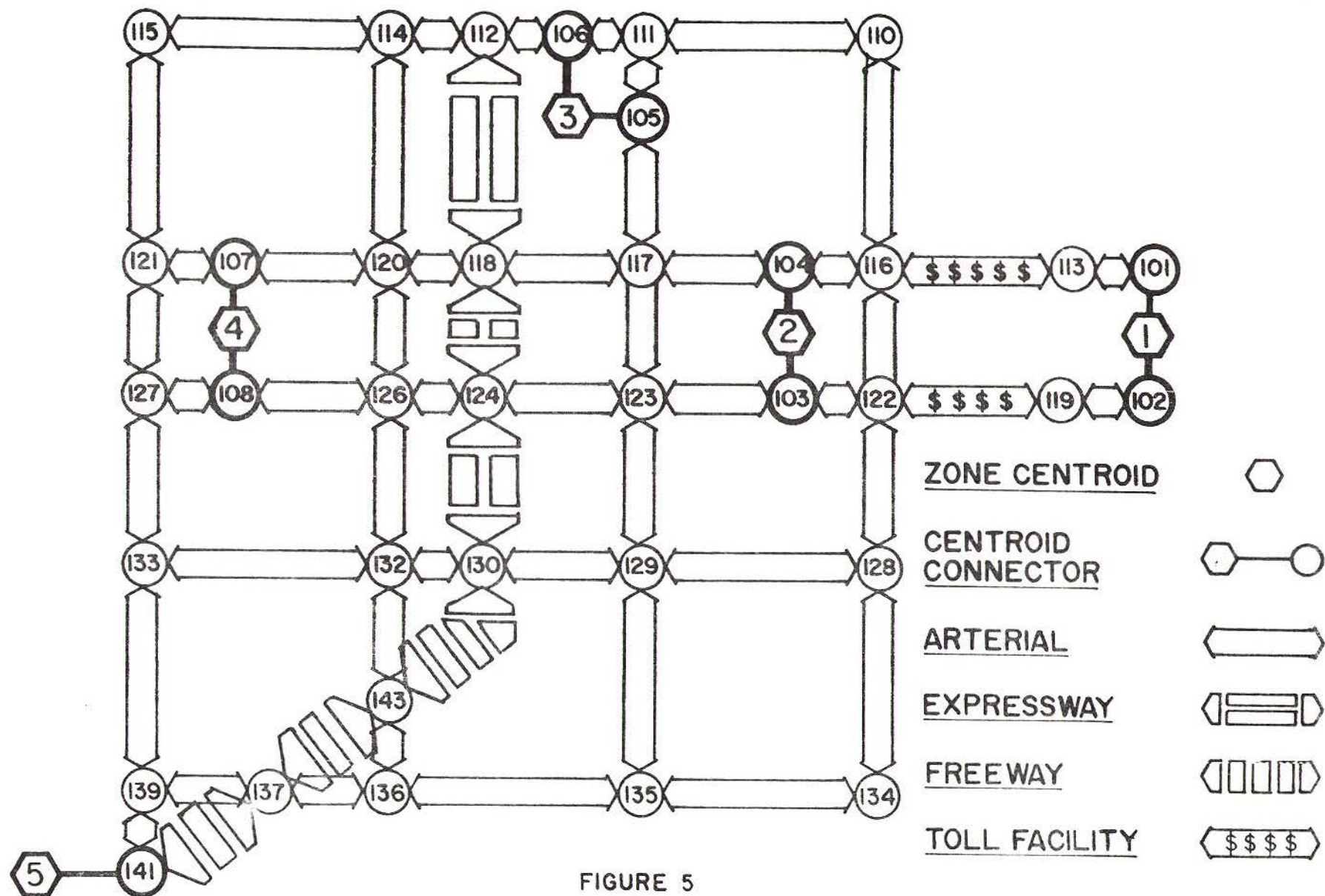


FIGURE 5
UTOWN HIGHWAY NETWORK

FIGURE 5 - UTOWN HIGHWAY NETWORK

This figure is the first step in translating the road and highway system into a format which the computer can process for transportation planning. This network map is an abstraction of what is actually in UTOWN. Not all streets are included since added detail does not greatly improve results but does dramatically increase coding and processing costs.

A network is defined by "links" which connect to each other at intersections known as "nodes." These nodes are numbered as shown: 116, 117, 118, 120,... and any two nodes define a link between them. UTOWN's zones (numbered 1-5 in the hexagons) are joined to the network by "centroid connectors" which represent the local streets by which vehicles or pedestrians gain access to the network. Most urban areas have coded highway networks which can be used for UROAD (with some possible additions).

Arterials, expressways and freeways have different operating characteristics and pass through a variety of areas which affect travel. These items are therefore noted on the network map to aid in the coding. Notice also that any toll roads or bridges are carefully noted for future consideration.

The network map will also be used to help display various functions and reports of UROAD in succeeding figures.

There are three aspects of the network we will cover in the next few figures. They are:

What is a network data base?

What is link impedance?

What are turn penalties and prohibitors?

FIGURE 6
HIGHWAY NETWORK DATABASE

LINK Z - FILE

BASIC LINK ATTRIBUTES

TRAFFIC ASSIGNMENT ATTRIBUTES

INTERFACE WITH OTHER UTPS PROGRAMS

HNET

UMATRIX

INET

NAG

FIGURE 6 - HIGHWAY NETWORK DATABASE

The primary input to UROAD is the highway network database. This is the computer file which contains the highway network description. This database is referred to in UTPS as a link Z-file and contains basic link attributes such as A-Node, B-Node, facility type, area type, distance, speed, capacity, toll class and use code. The database also can contain traffic assignment attributes such as assigned volume and speed at assigned volume.

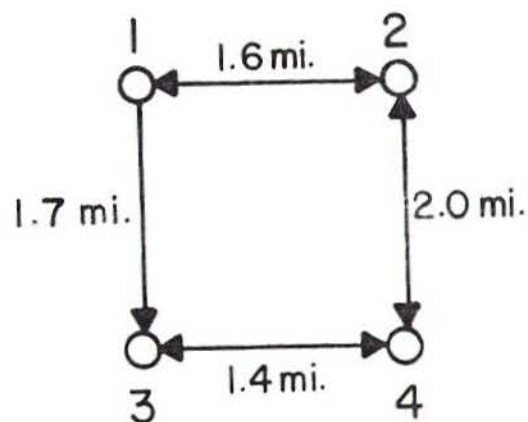
The link Z-file is a machine readable database that is originally produced by UTPS Program HNET and can then be used to interface with the other UTPS programs shown.

Although we will not be discussing the details of the internal construction of a link Z-file, the next figure illustrates the basic concept of a LAV which is important to the understanding of how to work with the UROAD program.

FIGURE 7
Z-FILE

LIST OF ATTIBUTE VALUES → LAV

EXAMPLE



D
(DISTANCE) =
LAV

	(LINK)
1.6	1-2
1.7	1-3
1.6	2-1
2.0	2-4
MV	3-1
1.4	3-4
2.0	4-2
1.4	4-3

MV = MISSING VALUE

FIGURE 7 - Z-FILE

A Z-file contains many LAVs or Lists of Attribute Values. Each link in the link Z-file has a unique position in the database. In the example here, Link 1-2 is in Position 1. Each attribute for Link 1-2 will then appear in Position 1 of that specific attribute list. The link distance attribute is shown here and is simply a list of the link distances for every link in the network illustrated. Similar lists would be stored for each of the other link attributes. Note that there is a missing value place-holder for the distance of Link 3-1. This is because Link 3-1 does not exist in the example network (Link 1-3 is one-way). The LAV still maintains a position for the attribute value of a missing link.

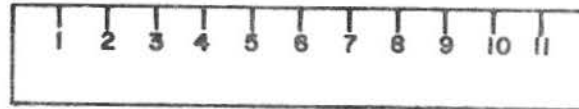
FIGURE 8

LINK IMPEDANCE



TIME

+



DISTANCE

+



TOLL

$$\begin{aligned}\text{IMPEDANCE} &= \text{CTIME} \times \text{TIME} + \text{CDIST} \times \text{DIST} \\ &= \text{CTIME} \times \text{TIME} + \text{CTOLL} \times \text{TOLL}\end{aligned}$$

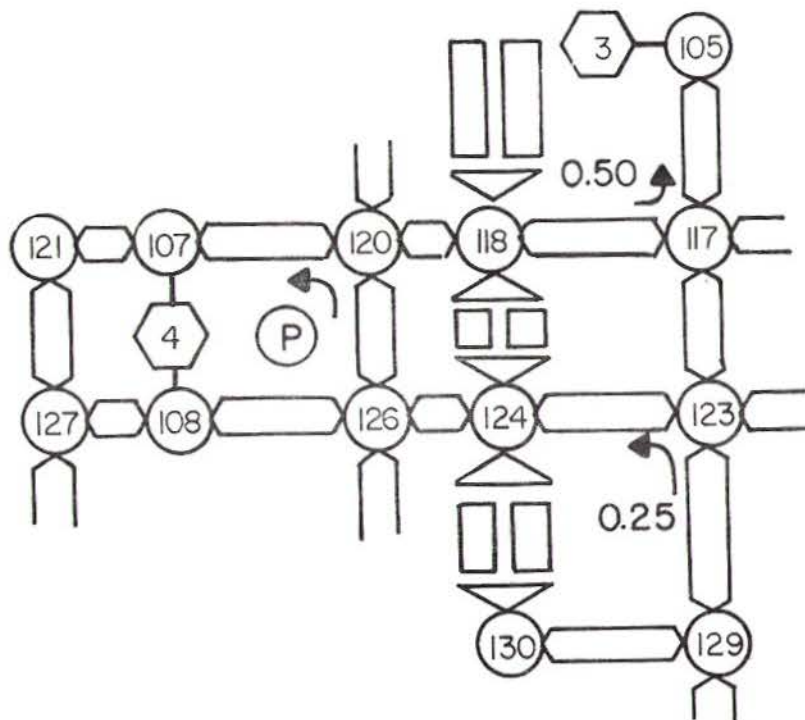
(Non Toll Links)
(Toll Links)

FIGURE 8 - LINK IMPEDANCE

The second aspect of network usage is the use and selection of an impedance value. UROAD uses impedance to determine the shortest or "n" shortest paths between zones in the network. Since travelers may choose different routes between the same two zones, the purpose of impedance selection is to try to account for the path selection that most travelers are apt to make.

Total zone to zone path impedance is determined by summing the individual link impedances of links which comprise a minimum impedance path between the two zones. Link impedance is a linear combination of link travel time and distance or toll cost. The UROAD user is free to determine the relative importance of each impedance component to the simulation of path choice behavior by specifying values for the parameters CTIME, CDIST and CTOLL. If the user wishes to use only one link attribute such as travel time for pathfinding, this can be accomplished by setting CDIST and CTOLL equal to zero. A value of CTOLL is usually determined during network calibration. Typical pathfinding and traffic assignment practice has been to use travel time as the sole measure of link and path impedance. UROAD provides the flexibility of adding these two additional components.

FIGURE 9
TURN PENALTIES/PROHIBITORS



PROHIBITED MOVEMENT

126 - 120 - 107

PENALIZED MOVEMENTS

118-117-105 0.50 MINUTES

129-123-124 0.25 MINUTES

TURN PENALTY CARD

Turn Prohibition																					Turn Penalty												Turn Penalty																																
FROM NODE					INTERSECT NODE					TO NODE					PENALTY					FROM NODE					INTERSECT NODE					TO NODE					PENALTY					FROM NODE					INTERSECT NODE					TO NODE					PENALTY										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61					
T			1	2	6				1	2	0													1	2	9				1	2	3					2	5					1	1	8					1	1	7					1	0	5					5	0

FIGURE 9 - TURN PENALTIES

Turn penalties and prohibitors are the last item we will discuss in relation to the input network. A section of the UTOWN network is shown here with three locations that have either a turn prohibition or penalty. Turn penalties represent additional time delays due to particular movements through nodes (intersections) such as left turns, which cannot be reflected in the link database. By supplying the turn penalty statements in the format shown at the bottom of the figure, UROAD is informed of intersection restrictions or time penalties it should consider during pathfinding. Note that a turn prohibitor is coded exactly like a penalty except that the penalty field is left blank.

Now that the basic network inputs and decisions have been discussed, we are ready to cover the functional areas of UROAD.

FIGURE 10

PATH FINDING

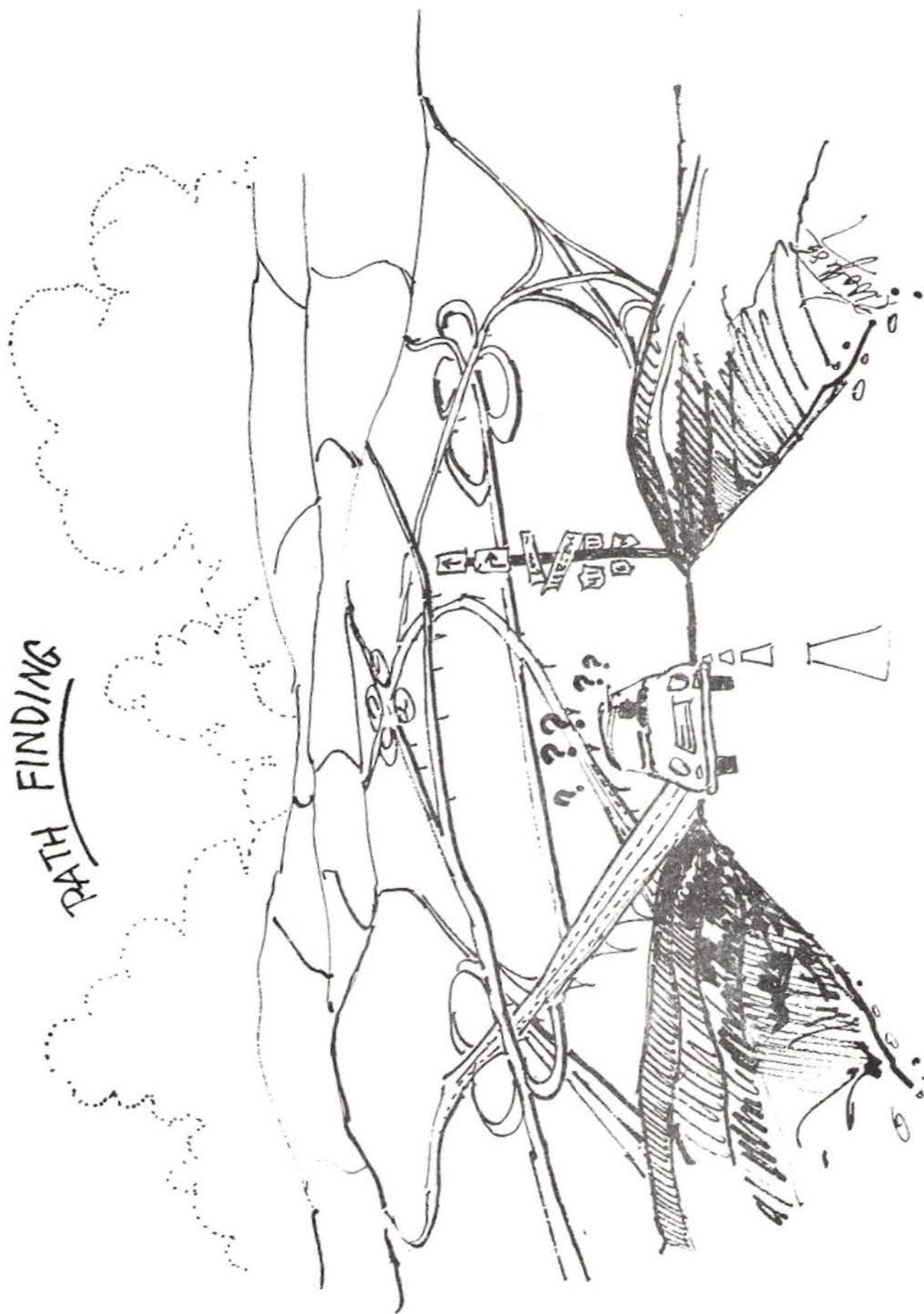
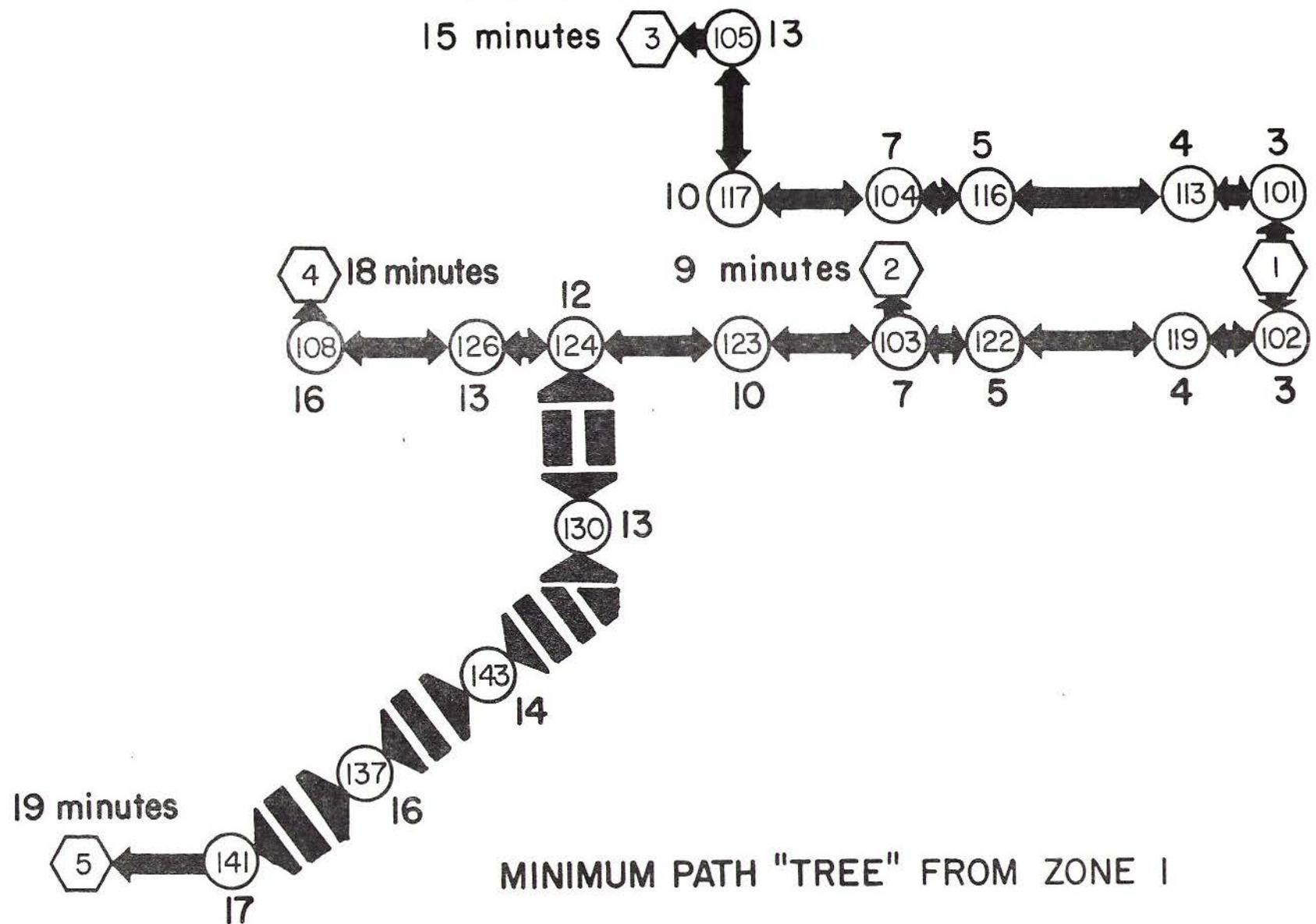


FIGURE 10 - PATHFINDING

The first major function of UROAD we will discuss is pathfinding. Pathfinding is the process of determining the series of links a traveler might choose in going from an origin zone to a specific destination zone.

Pathfinding is primarily used for the traffic assignment portion of UROAD but is also useful for network checking and for producing a zone-to-zone impedance matrix for other steps of the travel forecasting and transportation analysis process using UTPS programs such as AGM, UMODEL and UMATRIX.

FIGURE 11
PATH FINDING



MINIMUM PATH "TREE" FROM ZONE 1

FIGURE 11 - PATHFINDING

This figure illustrates a minimum path "tree" on the map of the UTOWN network, using time as the pathfinding criteria. A tree is the set of links which comprise the minimum paths from one zone to all other zones. Those links on a minimum path tree from Zone 1 are shown here. You can see the start of the branches where the path diverts at a common node--124 in this case. The numbers shown at each node are the cumulative times to each node. Note that if the pathfinding criteria changes (from time to distance), the paths could change as well. These values are used in path "skimming" which is shown next.

FIGURE 12
PATH "SKIMMING"

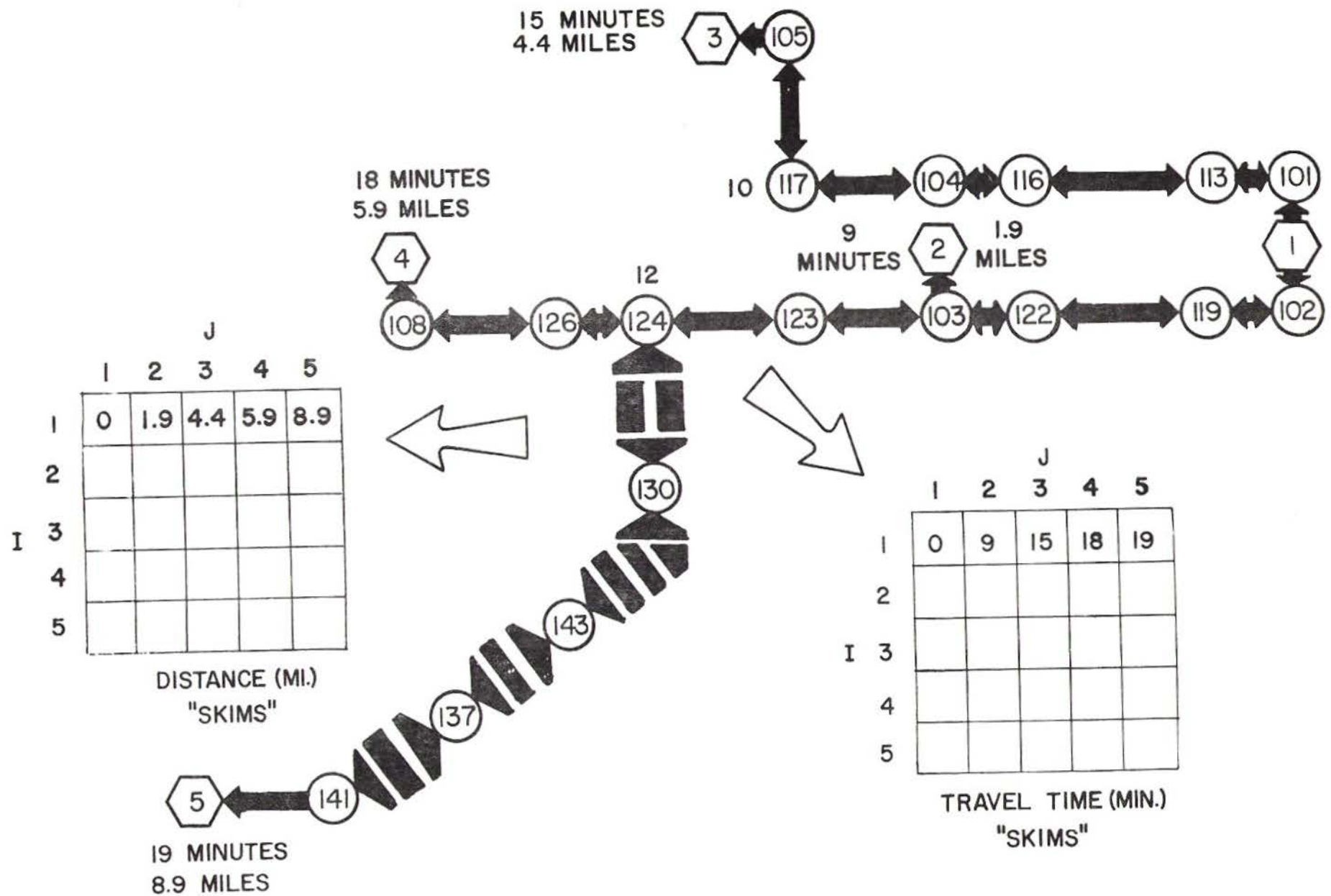


FIGURE 12 - PATH SKIMMING

Using the minimum path tree, UROAD can produce zone-to-zone matrices of travel time, distance, toll cost or total impedance. The user can select any or all of these matrices in a single run of UROAD.

We have illustrated here how Row 1 of two skim matrices, travel distance and time, is developed. Row 1 of each matrix represents the appropriate values from Zone 1 of the analysis area. Note that the time over the minimum impedance path from Zone 1 to Zone 3 is 15 minutes, which appears in the travel time matrix in the Cell 1-3. Row 2 would be developed from the minimum path tree from Origin Zone 2, etc. (Note that the letter "I" is generally used to denote the origin zone while "J" is used for the destination zone.) These skim matrices are useful in the planning process for modeling trip distribution, mode choice, accessibility, etc.

FIGURE 13
UROAD FUNCTION
PATHFINDING / SKIMMING

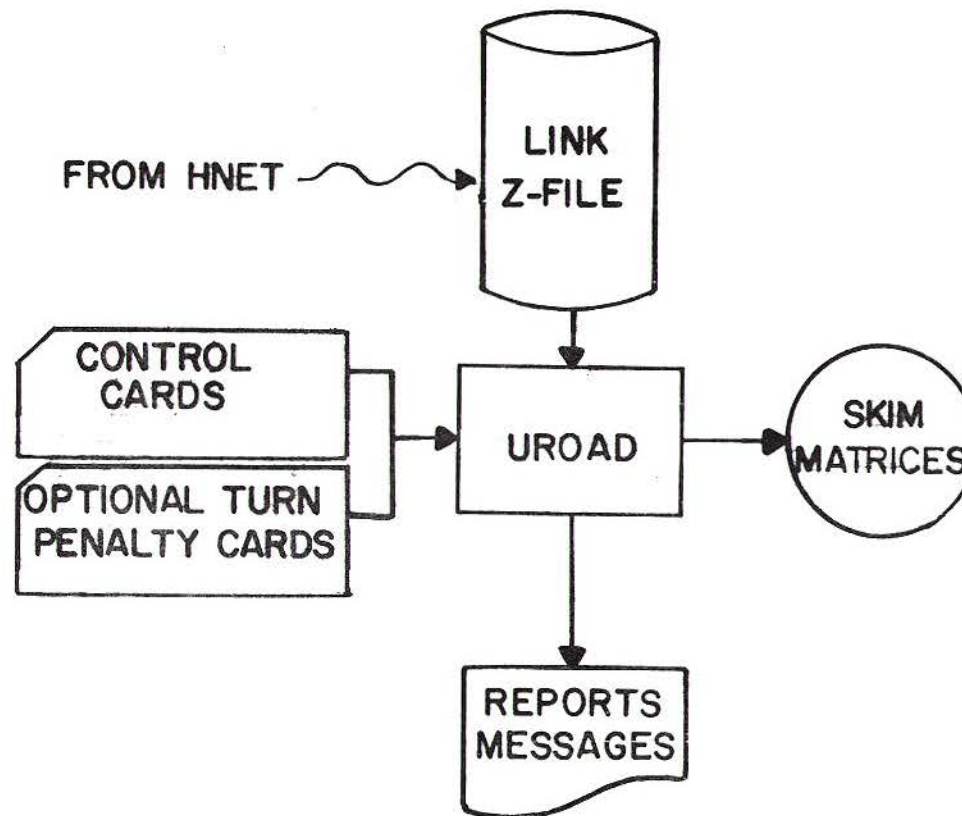


FIGURE 13 - UROAD FUNCTION: PATHFINDING/SKIMMING

The pathfinding/skimming functions are summarized here as a review of the basic inputs and outputs. There are three inputs: a link Z-file containing the highway network description, control cards or statements and optional turn penalty statements. UROAD produces computer readable skim matrices and printed reports and messages. We will be discussing this printed output in more detail as we proceed through the UROAD usage discussion. You may have noted that there is no computer readable output for the pathfinding function. Minimum impedance paths are determined and used as needed internal to UROAD and are typically not saved for any future use (with the exception of plotting).

Before leaving the pathfinding/skimming function we will cover a typical UROAD JCL set-up and UROAD Report 2 which prints selected minimum paths.

FIGURE 14

UROAD FUNCTIONS

PATHFINDING / SKIMMING

```
//UROAD EXEC UROAD,CORE=256K,  
// ZI='DSN=UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',  
// J9='DSN=UMTA.UTOWN.SKIMS,VOL=SER=UMTAI',DISPJ9=(NEW,KEEP)  
//UROAD.SYSIN DD *  
  
UROAD RUN TO BUILD AND SKIM PATHS  
&PARAM TLAV='FFT',SERVT(1)=1.00,TOLLS(1)=.20 &END  
&SELECT TIME='UTOWNTIMES',DIST='UTOWNDIST',TOLL='UTOWNTOLL',  
REPORT=1,2,5 &END  
&DATA  
  
(TURN PENALTY / PROHIBITOR CARDS GO HERE)
```

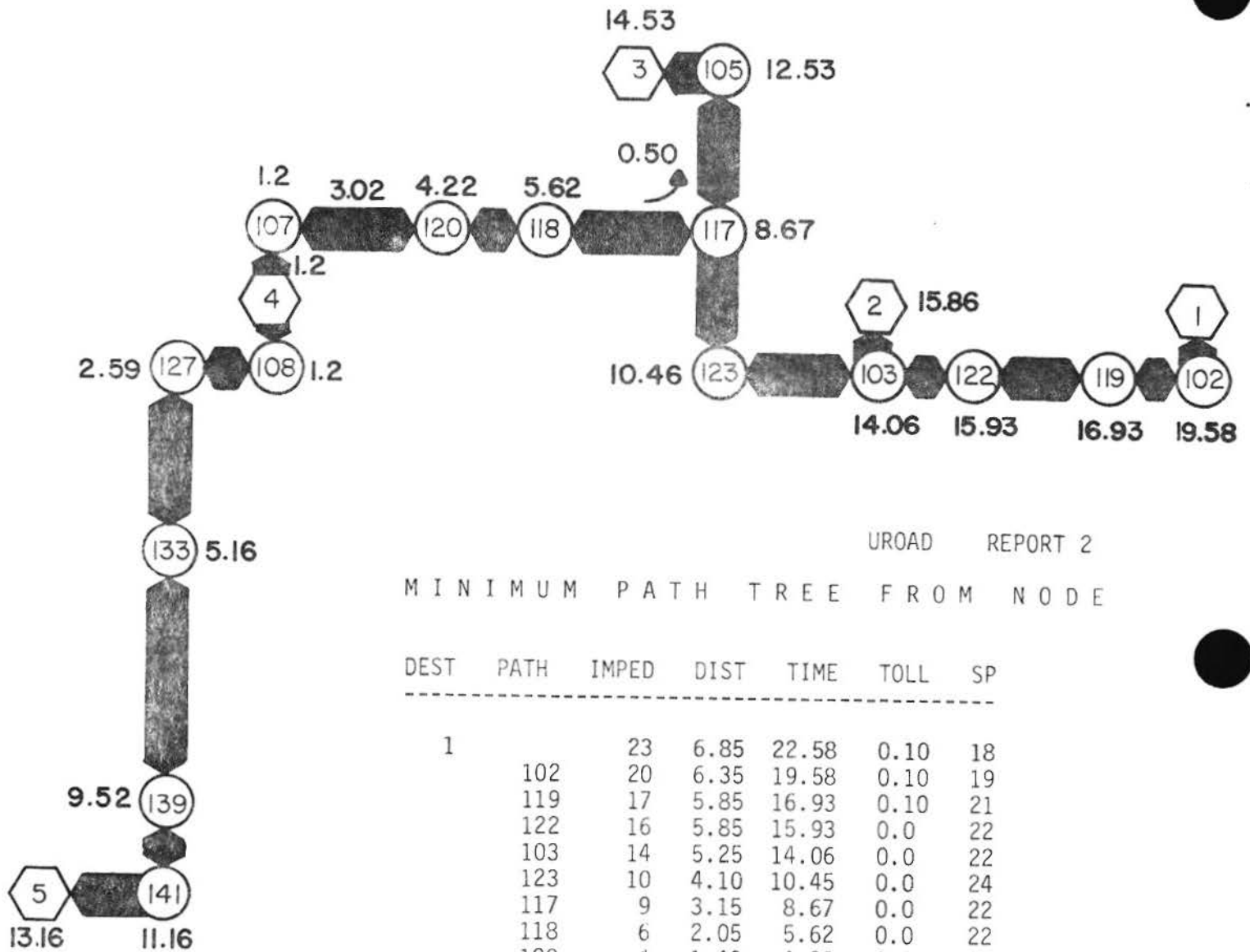

FIGURE 14 - UROAD FUNCTIONS: PATHFINDING/SKIMMING

The JCL set-up shown here is a simple application of UROAD where a network database is input (Z1) and three skim matrices are output (J9) along with Reports 1, 2 and 5.

The control statements shown use free flow time (TLAV="FFT") as the link time attribute from the input network. The TLAV keyword tells UROAD which LAV from the input highway network Z-File to use to obtain link travel time values. Three skim matrices are to be produced: TIME, DISTANCE AND TOLL. Since no zone selection is made in the &SELECT statement (I=), paths and skims will be determined for all five zones. For this small network, zone selection is not significant. For large networks, you may wish to use the select feature for both building and printing paths and for skim matrices, as pathbuilding can be an expensive UROAD function.

FIGURE 15

UROAD REPORT 2



UROAD REPORT 2

MINIMUM PATH TREE FROM NODE

DEST	PATH	IMPED	DIST	TIME	TOLL	SP
1	23	6.85	22.58	0.10	18	
	102	20	6.35	19.58	0.10	19
	119	17	5.85	16.93	0.10	21
	122	16	5.85	15.93	0.0	22
	103	14	5.25	14.06	0.0	22
	123	10	4.10	10.45	0.0	24
	117	9	3.15	8.67	0.0	22
	118	6	2.05	5.62	0.0	22
	120	4	1.40	4.22	0.0	20
	107	1	0.30	1.20	0.0	15
	16	5.55	15.86	0.0	21	
2	103	-1	5.25	0.0	0.0	0
	14	4.75	14.53	0.0	20	
3	105	12	4.25	12.53	0.0	21
	117	-1	3.15	0.0	0.0	0
4	HOME	0	0.0	0.0	0.0	0
5	13	4.85	13.16	0.0	22	
	141	11	4.35	11.16	0.0	23
	139	10	3.75	9.52	0.0	24
	133	5	2.15	5.16	0.0	25
	127	3	0.95	2.59	0.0	22
	108	1	0.30	1.20	0.0	15

FIGURE 15 - UROAD REPORT 2

UROAD Report 2 displays minimum time paths determined by the program. The minimum paths shown here are for all paths beginning in Zone 4. Refer both to Report 2 and the tree from Zone 4. The first destination zone is Zone 1. To trace the path from Zone 4 to Zone 1 you start at the bottom of the list of nodes under the heading "PATH" for Zone 1--in this case, Node 107. You then follow up the list, 120-118-117, etc., until you reach Zone 1. The "IMPED" column gives cumulative impedance at each point along the path. Similarly, the cumulative distance, time, toll and average speed are displayed.

To trace the path from Zone 4 to Zone 3 you once again start at the bottom of the "PATH" list for Zone 3--in this case, Node 117. Here we see under IMPED, a negative number. This -1 indicates that Node 117 is reached from Zone 4 the in same way for this path as for the path from Zone 4 to Zone 1. If you were tracing the path by hand on a map, you need only pick up at Node 117 and complete the trace as indicated.



FIGURE 16 - UROAD REPORT 5: SKIMMED VALUES

This report shows the "skim" values for each selected matrix and each origin zone selected for printing. The heading line for each matrix indicates the matrix name (UTOWN TIME) and the origin zone (ROW) being printed. The destination zone is determined by finding the appropriate tens row and moving across to the appropriate units column. Since our example only has five zones, there is only one tens row. If a larger matrix was being printed and the values for destination Zone 87 were desired, one would go to Tens Row 80 and read across to Units Column 7 to find the desired cell.

For this example, Report 5 displays the time, distance and toll cost skims values from Zone 4 of UTOWN. Refer to the previous figure showing the Report 2 path report for Zone 4 to compare values. Report 5 indicates that the travel time from Zone 4 to Zone 2 is 16 minutes, the distance is 5.6 miles, and the toll cost is 0.0. Report 5 displays time to the nearest minute, distance in tenths of miles, and toll cost in cents.

FIGURE 17

TRAFFIC ASSIGNMENT

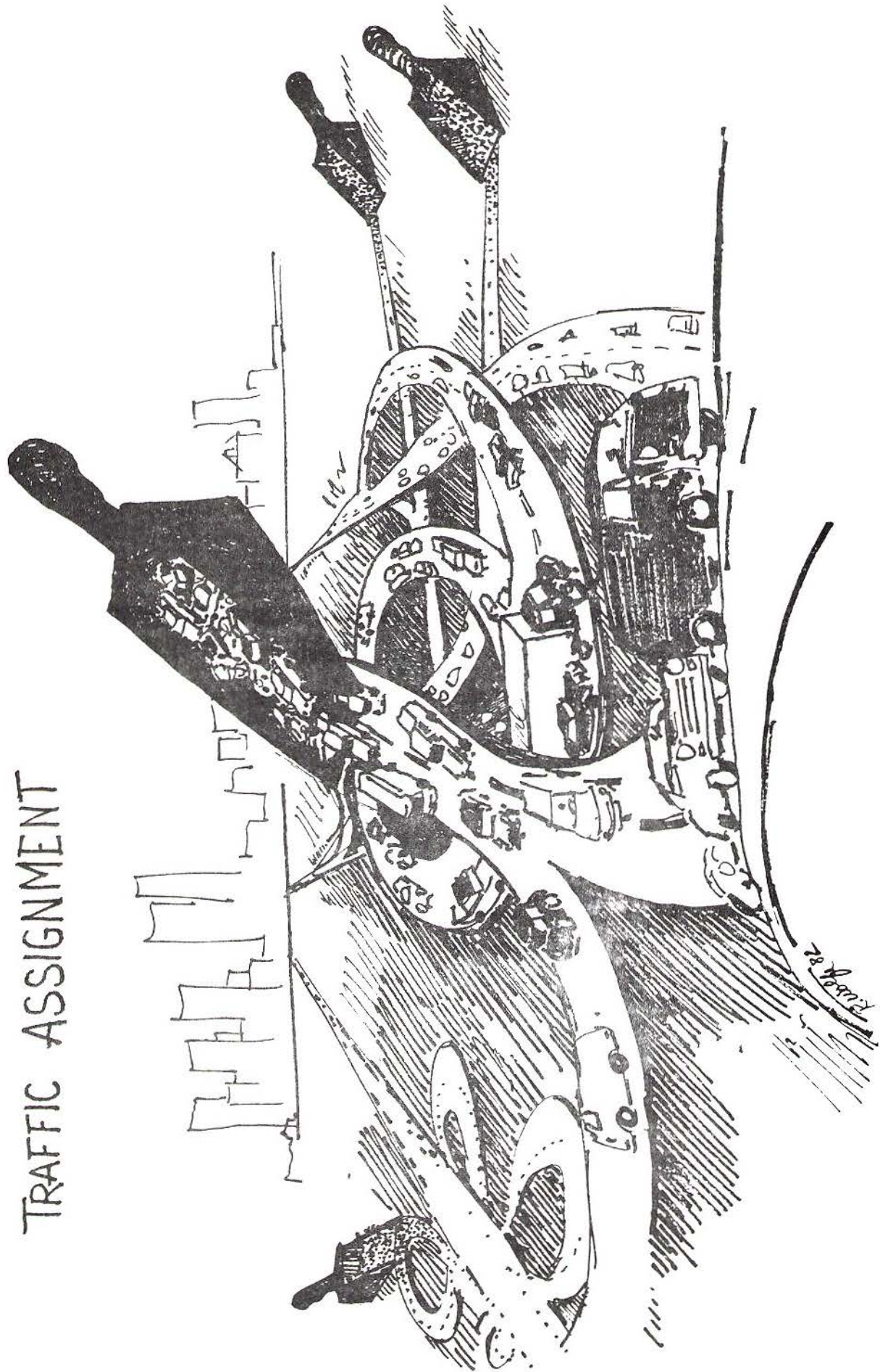


FIGURE 17 - TRAFFIC ASSIGNMENT

Traffic Assignment is the next major UROAD function we'll discuss. Traffic assignment is the process of loading vehicle trips on to a highway network in order to simulate or estimate traffic volumes on highway facilities and estimate the performance of the highway system and traffic related impacts such as energy consumption, noise, and emissions.

TRAFFIC ASSIGNMENT

LOADING TECHNIQUES

- ALL-OR-NOTHING
- STOCHASTIC MULTIPATH

CAPACITY RESTRAINT

- CATS INCREMENTAL
- EQUILIBRIUM

SELECTED COMBINATIONS OF EACH

FIGURE 18 - TRAFFIC ASSIGNMENT - METHODS

In assigning trips to links in the network, several techniques can be used, singly or in combination. These techniques can be divided into ways trips are loaded on the network and ways congestion effects of the loading process are accounted for. The simplest form of loading, which works best in uncongested areas, is all-or-nothing where all the trips between zones are assigned to the links comprising the minimum impedance paths between them. A stochastic multipath or probabilistic assignment allocates the trips among alternative paths between zones based on the relative impedance of each competing path.

Capacity restraint methods are used to change the impedance of a link as assigned traffic on it increases. This represents the impact of congestion on travel times and hence path determination and trip loading. Capacity restraint in UROAD can be invoked using a "CATS" incremental loading method or an equilibrium method as we'll describe. Capacity restraint can be used with either all-or-nothing or stochastic multipath loading techniques.

FIGURE 19

UROAD FUNCTIONS TRAFFIC ASSIGNMENT

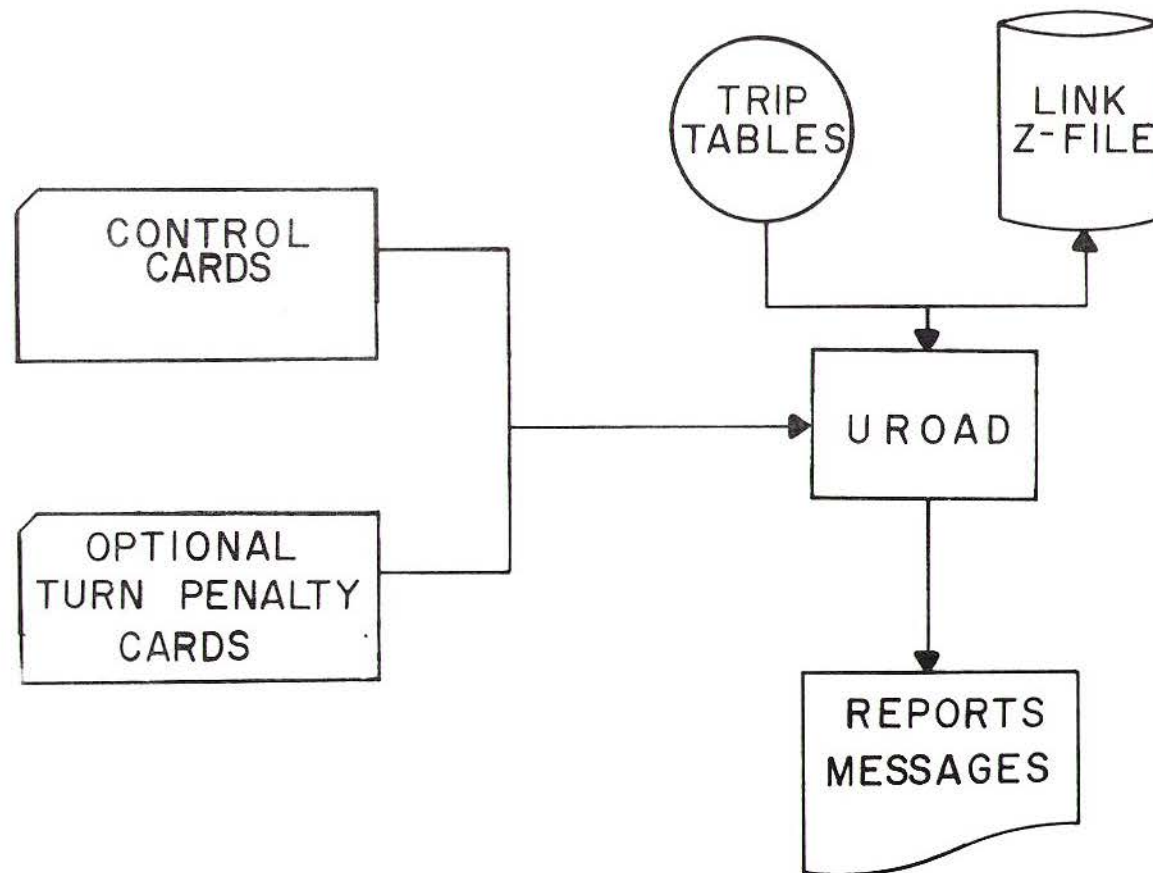


FIGURE 19 - UROAD FUNCTIONS: TRAFFIC ASSIGNMENT

The traffic assignment function is summarized here to review the basic UROAD inputs and outputs. There are three basic inputs: a Link Z-file, zone-to-zone vehicle trip tables, and control cards images or statements. Turn penalty/prohibitor statements are optional input. Outputs are reports on the assignment and associated statistics and impacts, and LAVs added to the Link Z-file. The added LAVs provide, in computer readable format, the assigned traffic volumes and congested speeds for each link. Reports available include link-by-link assignment results (volume, speed) and summary statistics and impacts by geographic area and link group.

FIGURE 20

TRAFFIC ASSIGNMENT

ALL-OR-NOTHING ASSIGNMENT

```
//UROAD EXEC UROAD,CORE=512K,  
// ZI='UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',  
// JI='UMTA.UTOWN.DAILY.TRIPS,VOL=SER=UMTAI',  
//UROAD.SYSIN DD *  
  
    UROAD RUN TO PERFORM A-O-N ASSIGNMENT  
    &PARAM TABLES=101,THETA=0,CONFAC=.10,SERV(1)=1.0,  
    LAVN=1,ASSIGN='UTOWN AON' &END  
    &SELECT T=103,REPORT=4,19 &END  
    &DATA  
    (TURN PENALTY CARDS GO HERE)
```

FIGURE 20 - TRAFFIC ASSIGNMENT: ALL-OR-NOTHING

The UROAD JCL set-up shown here is for an all-or-nothing traffic assignment of daily trips. The network link Z-file is indicated by Z1, and the trip table is indicated by J1. Both files are on disk UMTA1.

The THETA=0 in the &PARAM statement specifies an all-or-nothing assignment. THETA controls both the type of loading and the number of iterations of capacity restraint as we'll show in subsequent figures. TABLES=101 indicates that Table 1 of File J1 contains the trip table to be assigned. CONFAC=0.10 specifies that 10 percent of the daily vehicle trips are estimated to occur in the peak hour. Hence, UROAD internally converts all O-D vehicle trips to peak hour volumes by multiplying by the value of CONFAC. This is done to convert input vehicle volumes to hourly volumes for comparison with link capacity which is given in vehicles per hour. Thus, when a capacity restraint assignment is performed (as we'll discuss a little later) on a daily trip table, the link times will be modified based on assumed peak hour volume/capacity-speed relationships. However, all UROAD reports are in terms of total input trip volumes. Therefore, a peak hour trip table would have CONFAC equal to 1.0. SERV(1)=1.0 specifies that the average service time at the toll links in the UTOWN network is 1 minute. The assignment results for each link will be saved as LAVs written on the link Z-file (Z1) by UROAD.

Report 4, the final link and turn volume report and Report 19, the contents of the Link Z-file Z1 Report, will be printed. For larger networks, the link for which display of assigned volumes is desired should be selected, using the &SELECT keyword "N" to limit the size of the Report 4 printout. For the small UTOWN network the default of all link volumes is acceptable. T=103 specifies that turning volumes for Node 103 are to be printed out in Report 4. The next figure illustrates the contents of Report 4, the link and turn volume report.

FIGURE 21 UROAD REPORT 4 LINK VOLUMES

UROAD REPORT 4 LINK AND TURN VOLUMES

A NODE	B NODE	A-TO-B VOLUME	SPD	2-WAY VOLUME	AV. SPD	B NODE	A-TO-B VOLUME	SPD	2-WAY VOLUME	AV. SPD
1)	(101)	1258	10	4298	10	(102)	361	10	4246	10
2)	(103)	2219	10	3311	10	(104)	815	10	1971	10
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...
116)	(104)	1258	25	4298	20	(110)	...	25	...	25
	(113)	304	10	430	10	(122)	...	...	...	22
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...

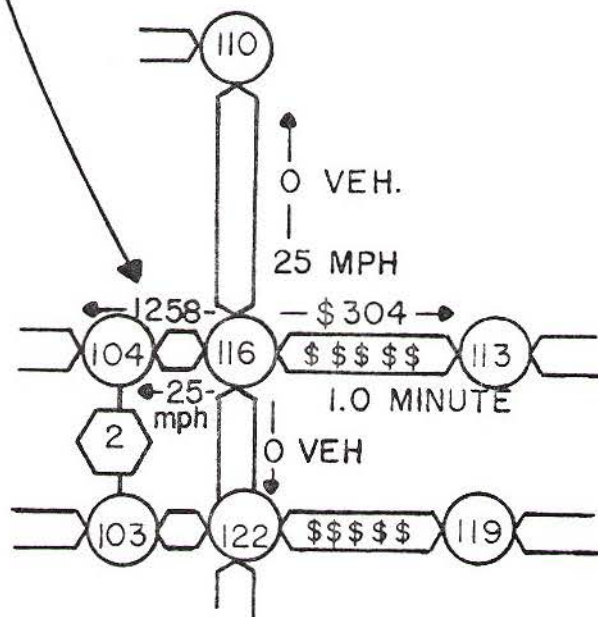


FIGURE 21 - UROAD REPORT 4

This report provides the link and turn volumes after the last assignment iteration. This figure and the next discuss how to read the contents of Report 4. First we'll show how to read link volumes and the next figure will show how to read turn volumes. For nodes where turn volumes were not requested, the link volumes are presented with two B-nodes per line. The symbols following the link volume represent the volume/capacity (V/C) ratio for the link: a blank indicates a V/C less than 0.75, '-' indicates a V/C between 0.75 and 1.00, '+' indicates a V/C between 1.00 and 1.25 and '*' indicates a V/C of 1.25 or greater.

Let's look at Report 4 for A-node 116. Note that the report displays four B-nodes for Node 116 as 104, 110, 113 and 122. Referring to the excerpt of the UTOWN highway network map, we see that these B-nodes comprise the links connected to Node 116. For B-node 104 in Report 4, observe that the value 1258 appears under the column heading "A-TO-B VOLUME." Therefore, this tells us that 1258 vehicles were assigned by UROAD's All-or-Nothing Assignment to Link 116-104 and that their average speed is 25 mph (under the "SPD" column). Report 4 also displays the total two-way link volume and weighted average two-way speed. Note that the volume number of 304 for Link 116-113 has a "\$" after it. This denotes that Link 116-113 is a toll link (as seen on the network map) and the 304 represents dollar revenue of the vehicles crossing the toll bridge. The SPD column for the toll link shows the time in tenths of minutes required to cross the toll link (in this case, 1.0 minutes, which was the input SERV value).

FIGURE 22 UROAD REPORT 4 TURN VOLUMES

LINK AND TURN VOLUMES

A NODE	B NODE	A-TO-B VOLUME	SPD	2-WAY VOLUME	AV. SPD	B NODE	A-TO-B VOLUME	SPD	2-WAY VOLUME	AV. SPD
(103)	(LINK)					(TURNS)	(2)	(122)	(123)	
	(2)	1042	10	3120	10	(2)	0	1922	156	
	(122)	2857-	19	3154-	20	(122)	0	0	297	
	(123)	453	25	2430-	20	(123)	1042	935	0	

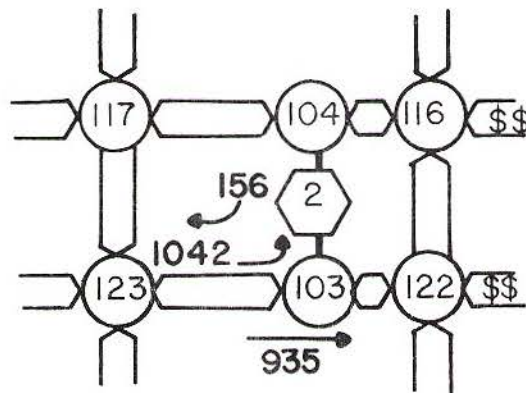


FIGURE 22 - UROAD REPORT 4: TURN VOLUMES

UROAD Report 4 also displays turn volumes at nodes optionally specified by the "T" keyword in the &SELECT statement. The partial listing of Report 4 shown here displays turn volumes at Node 103. The turn volumes are always displayed in the right-hand portion of the report and are denoted by a "(TURNS)" under the "B-NODE" column. The turn volumes are displayed as a table with the "from node" of the turning movement listed vertically under the "TURNS" indicator and the "to nodes" listed horizontally across in a row to the right of "(TURNS)". The table entry for the "from nodes" 123 and the "to Node" 2 shows us that 1042 vehicles are making the turning movement 123-103-2. This is displayed on the section of the map from the UTOWN Network. Similarly, 156 vehicles were assigned to the 2-103-123 turning movement. Through movement volumes are also displayed, e.g., 935 vehicles for the movement 123-103-122, which as can be seen from the map, is a through movement.

FIGURE 23

UROAD REPORT 19

CONTENTS OF Z-FILE Z1

LINKS= 126 CREATION: DATE=16SEP80 TIME=10.34.10 PROG=HNET
 CREATED FROM USN=UMTA,NCS,NFILE

SPACE TOTAL UNUSED EMBEDDED
 (WORDS): DATA= 1500 USED= 5400 AVAILABLE= 9400 FREE SPACE= 200

ATTRIBUTE ENTRIES: LAVS PRESENT= 25 MAX LAVS POSSIBLE=135

-----CREATION-----

LAV NAME	UNITS	TYPE	DATE	TIME	PROGRAM	DESCRIPTION
A	143	I*2	16SEP80	10.34	HNET	LINK ANODES
AT		I*1	16SEP80	10.34	HNET	AREA TYPE
B	143	I*2	16SEP80	10.34	HNET	LINK BNODES
CS1	MI/H	R*4	30SEP80	12.14	<u>UROAD</u>	SPEED - UTOWN AON
CT1	MIN	R*4	30SEP80	12.14	<u>UROAD</u>	TIME - UTOWN AON
D	MI	R*4	16SEP80	10.34	HNET	DISTANCE
DC		I*1	16SEP80	10.34	HNET	DIRECTION CODE
FFS	MI/H	R*4	16SEP80	10.34	HNET	FREE FLOW SPEED
FET	MIN	R*4	16SEP80	10.34	HNET	FREE FLOW TIME
FT		I*1	16SEP80	10.34	HNET	FACILITY TYPE
GL		I*1	16SEP80	10.34	HNET	GEOGRAPHIC LOCATION
I1	IMPED	R*4	30SEP80	12.14	<u>UROAD</u>	IMPEDANCE - UTOWN AON
LG		I*1	16SEP80	10.34	HNET	LINK GROUP
NL		I*1	16SEP80	10.34	HNET	NUMBER OF LANES
OC	VEH/LN/H	I*2	16SEP80	10.34	HNET	OBSERVED CAPACITY
OS	MI/H	R*4	16SEP80	10.34	HNET	OBSERVED SPEED
OT	MIN	R*4	16SEP80	10.34	HNET	OBSERVED TIME
OV	VEH	I*4	16SEP80	10.34	HNET	OBSERVED VOLUME OR COUNT
TC		I*1	16SEP80	10.34	HNET	TOLL CLASS
TVW0	VPH	I*2	23SEP80	12.59	INET	TRANSIT VOLUME FOR W=0
UC		I*1	16SEP80	10.34	HNET	USE CODE
UT	MIN	R*4	16SEP80	10.34	HNET	UNIFORM TIME
VC1		R*4	30SEP80	12.14	<u>UROAD</u>	VOL/CAP - UTOWN AON
V1	VEH	I*4	30SEP80	12.14	<u>UROAD</u>	VOLUME - UTOWN AON
Z	5	I*2	16SEP80	10.34	HNET	ZONE NUMBER

FIGURE 23 - UROAD REPORT 19

This report shows the contents of the link Z-file including any LAVs output in the current UROAD run. Each LAV is identified by name (defined by the program which created it) and is described in more detail on the right side of the report. This description also includes an optional 12 character identifier that UROAD will include from the "ASSIGN" variable in the &PARAM statement. The units and type are shown as well as the date and time the LAV was created and by which program. The report shows the LAVs written to the link Z-file by this sample UROAD run which includes CS1, CT1, I1, VC1 and V1.

FIGURE 24

TRAFFIC ASSIGNMENT STOCHASTIC MULTIPATH

```
//UROAD EXEC UROAD,CORE=512K,  
// ZI='DSN=UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',  
// JI='DSN=UMTA.UTOWN.TRIPS,VOL=SER=UMTAI',  
//UROAD.SYSIN DD *  
  
    UROAD RUN TO PERFORM STOCHASTIC ASSIGNMENT  
    &PARAM TABLES=101,THETA=.0015,CONFAC=.10,SERV(1)=1.0,  
    LAVN=2,ASSIGN='UTOWN STOCH' &END  
    &SELECT REPORT=4,6,11,19 &END
```


FIGURE 24 - TRAFFIC ASSIGNMENT: STOCHASTIC MULTIPATH

The JCL set up shown here is for a stochastic multipath assignment. It is almost identical to the set up for all-or-nothing assignment except that $\text{THETA}=.0015$ is specified. This means that the likelihood of a link being selected is determined by a curve, as discussed in the next figure.

The control statements also differ from the last set-up in that $\text{LAVN}=2$ and $\text{REPORT}=4, 6, 11, 19$ were specified. Accordingly, UROAD will save the LAVs on the same Z1 file as CS2, CT2, etc., and will output the additional reports: Summary of VMT and Speed by V/C Ratio, Geographic Location and Facility Type, and the Impact Report.

FIGURE 25

DIVERSION FUNCTION θ FOR PROBABILISTIC ASSIGNMENT

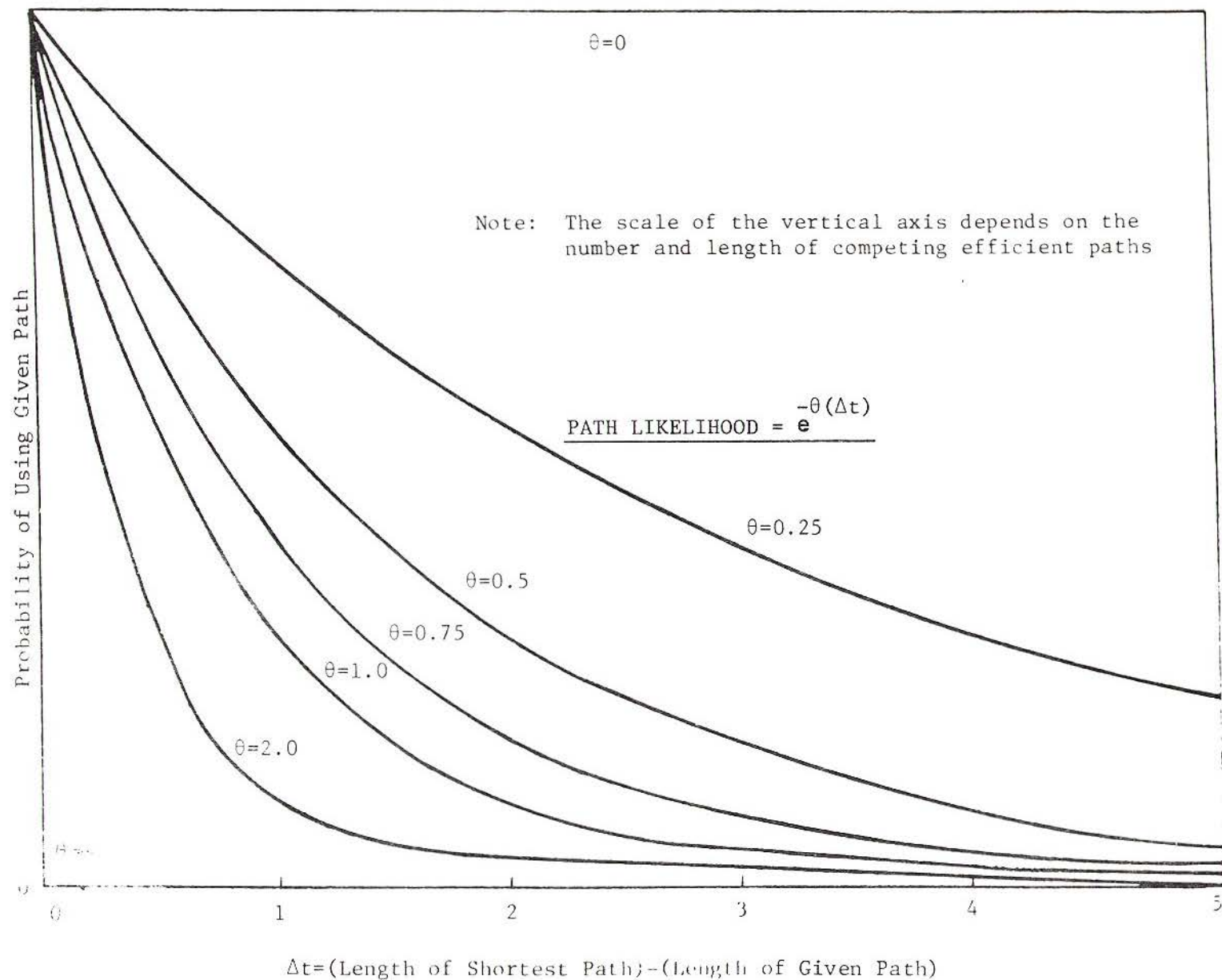


FIGURE 25 - DIVERSION FUNCTION

The curves explain how multipath assignment works. The bottom axis is Δt , the difference in time between the shortest path and a given path. The vertical axis is the probability of using that path. When two paths are about the same, there is a high probability that the traffic will be split between them fairly evenly. When there is a large difference, there is a low probability that anyone would choose the slower path.

The scale of the vertical axis depends on the number and length of competing efficient paths. THETA can vary from zero up, but the closer to zero, the higher the probability of diversion.

FIGURE 26
CAPACITY RESTRAINT

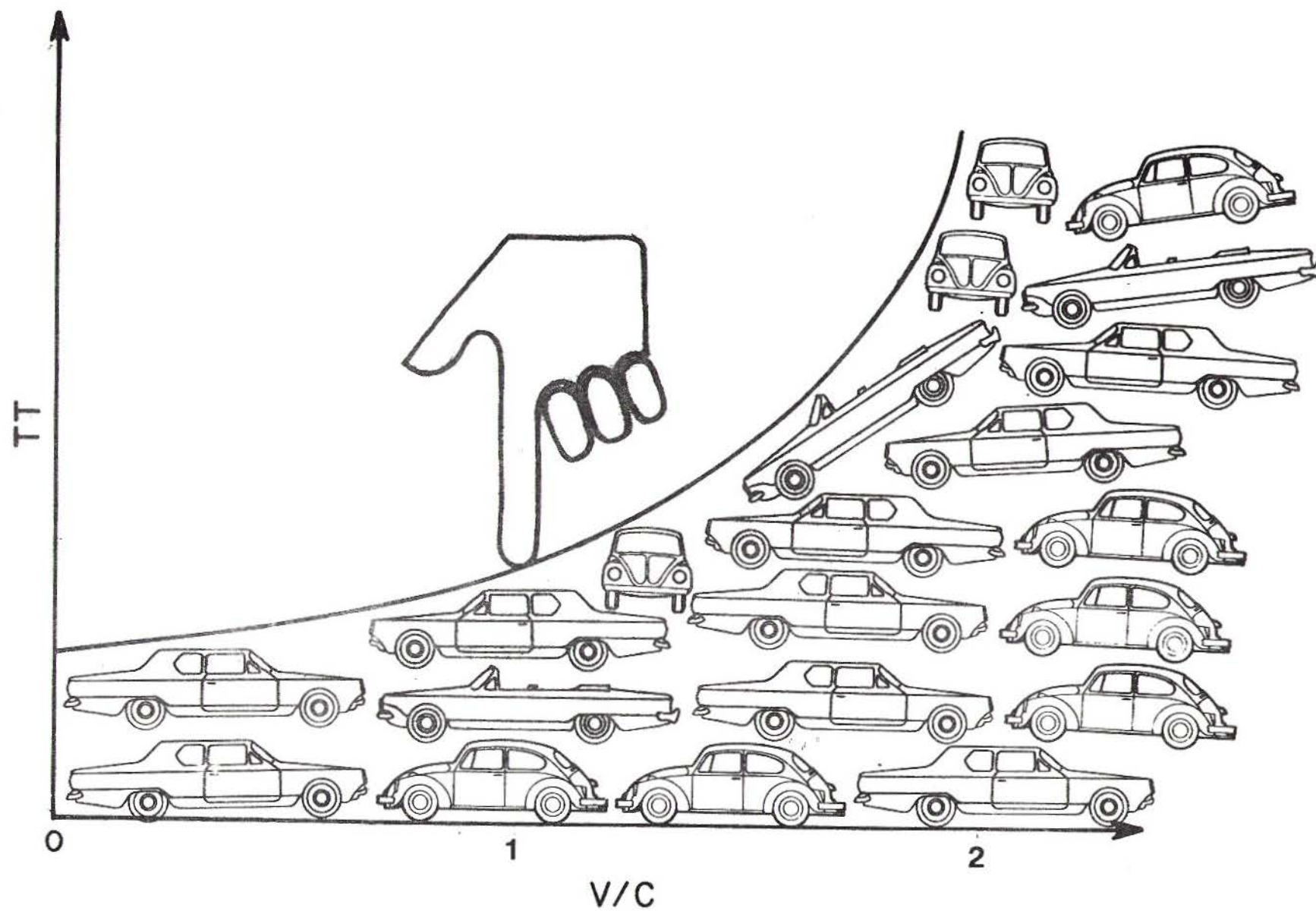


FIGURE 26 - CAPACITY RESTRAINT

This curve illustrates the impact of congestion on travel time in a technique which is called capacity restraint. As the volume/capacity (V/C) ratio on a link approaches one, the travel time over that link increases slowly. Once the V/C ratio passes one, the travel time increases rapidly, approaching infinity as the traffic on the link comes to a halt due to extreme congestion. In a capacity restrained assignment, link travel time is changed as congestion increases, to more accurately reflect path choice and produce realistic assignments where link capacity and assigned traffic are in reasonable balance.

FIGURE 27
CAPACITY RESTRAINT
"BPR FORMULA"

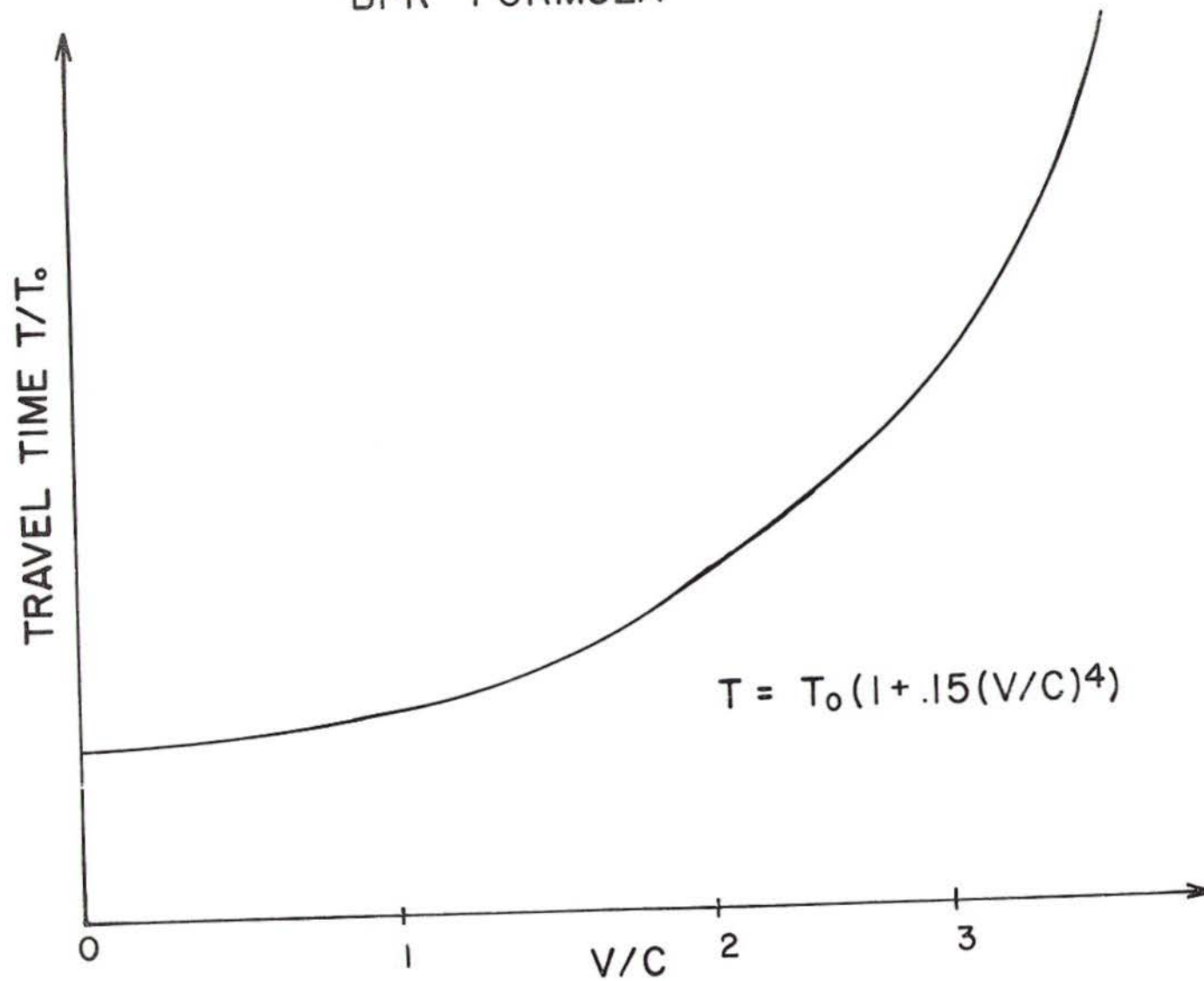


FIGURE 27 - CAPACITY RESTRAINT BPR FORMULA

UROAD uses the link capacity restraint formula developed by the Bureau of Public Roads (BPR, now FHWA) to describe the impact of traffic congestion on link travel time. The formula increases uncongested travel time by .15 times $(V/C)^4$, a number which, as the curve shows, grows slowly for a V/C ratio less than one and rapidly for V/C greater than one. This adjustment occurs after each assignment iteration.

UROAD provides for a choice of two methods of capacity restraint, one incremental and one iterative. We'll discuss each in more detail next.

FIGURE 28
CAPACITY RESTRAINT
CATS INCREMENTAL

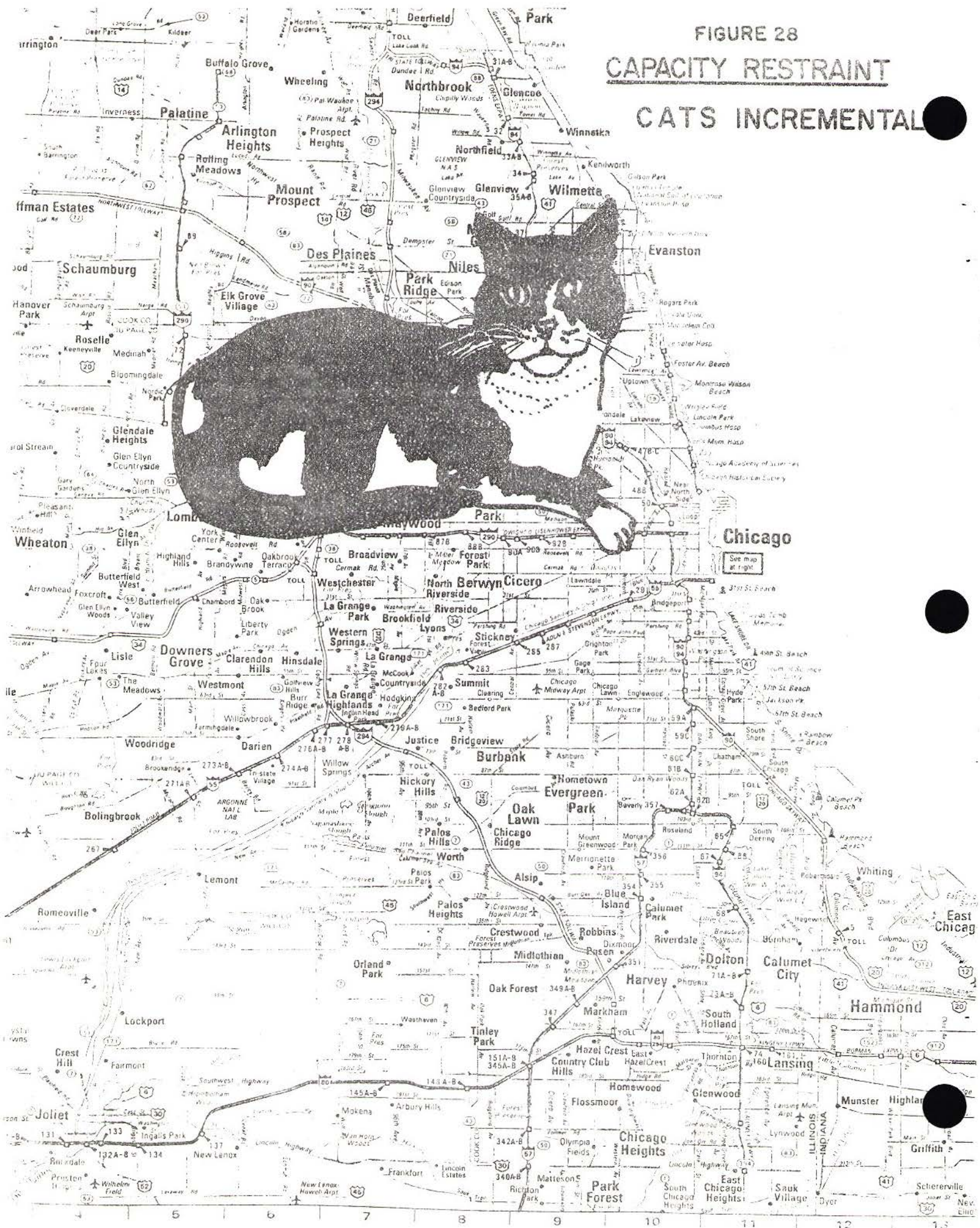


FIGURE 28 - CAPACITY RESTRAINT: CATS INCREMENTAL

The "CATS" capacity restraint loading method was developed at the Chicago Area Transportation Study in the 1960's. The CATS technique assigns all the trips from a specified number of the zones to the network in each increment, readjusting link times after each increment is assigned, based on the BPR formula. Paths for the assignment of trips from zones in later increments are determined based on these adjusted link times. For example, specifying CATS=5 will readjust link times after trips are assigned to the network for each increment of five zones.

The criticism of the CATS approach is that trips from low numbered zones are assigned to an uncongested network while trips from higher numbered zones are assigned to a more congested network. This fault can be obviated by randomizing the order in which zonal trips are assigned. The CATS approach is less expensive than the equilibrium assignment we'll talk about next, since paths are only built once in the assignment of all trips.

UROAD FUNCTIONS

CATS INCREMENTAL ASSIGNMENT

```
//UROAD EXEC UROAD,CORE=512K,  
// ZI='DSN= UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',  
// JI='DSN= UMTA.UTOWN.TRIPS,VOL=SER=UMTAI',  
//UROAD.SYSIN DD *  
  
UROAD RUN TO PERFORM CATS ASSIGNMENT  
&PARAM TABLES=101,THETA=0,CATS=2,SERVT(1)=1.0,LAVN=3,  
CONFAC=.10,ASSIGN='UTOWN CATS' &END  
&SELECT REPORT= 4,6,11,19 &END
```


FIGURE 29 - UROAD FUNCTIONS: CATS INCREMENTAL ASSIGNMENT

This is a sample JCL set up for a CATS assignment. CATS=2 in the &PARAM statement, tells UROAD to readjust link times each time after trips from two more zones are assigned. For our UTOWN example, all trips for zones 1 and 2 would be loaded, link times would be readjusted, zones 3 and 4 would be loaded, times readjusted again, and finally zone 5 loaded. Since THETA=0, the loading would in each case be all-or-nothing to the minimum impedance path. Probabilistic multiple paths could alternately have been determined for each increment. Results are saved in the same Z1 link Z-file using LAVN=3.

FIGURE 30

CAPACITY RESTRAINT

EQUILIBRIUM

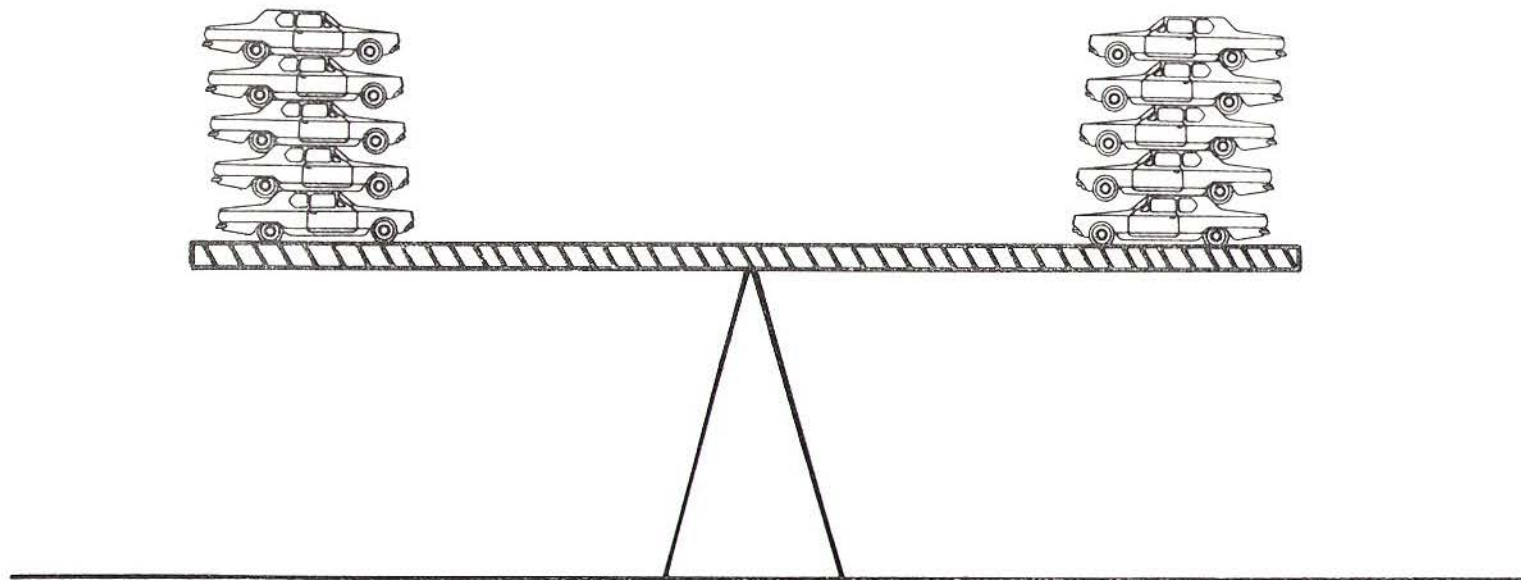


FIGURE 30 - CAPACITY RESTRAINT EQUILIBRIUM

In the real world, travelers try alternate paths between origin and destination, especially for work trips, until they find the path that works best for them--an all-or-nothing assignment won't produce that path unless there is no congestion-generated delay. Everybody will be assigned to the lowest impedance path. With all those people on it, it may no longer have the lowest impedance. The highway system is not in a state of equilibrium between "supply" (i.e., capacity) and "demand" (i.e., vehicle trips). A multipath stochastic assignment may be in equilibrium, but there is no guarantee. A network is in supply/demand equilibrium, or equilibrium for short, only when no one can improve their trip impedance by changing paths. Let's look at an example to further illustrate the concept of network equilibrium.

FIGURE 31
ALTERNATE PATHS

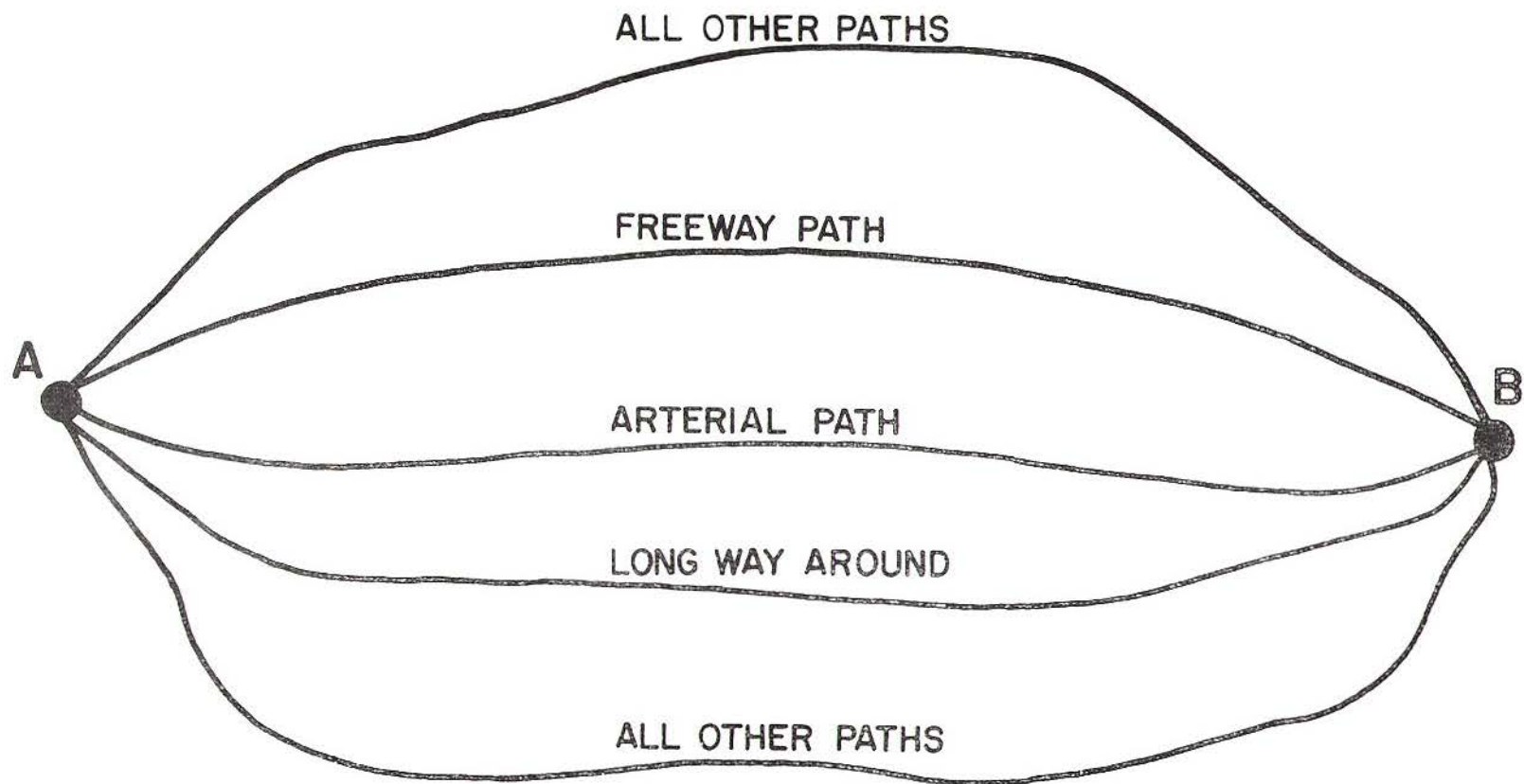


FIGURE 31 - ALTERNATE PATHS

Take, for example, the trips between zones A and B. The shortest path is probably the freeway path, and a single iteration of all-or-nothing assignment will assign all trips from A to B onto it, with no trips assigned to the arterial path, and no trips assigned to the other paths. A multipath assignment would still assign most trips to the freeway path, if it's much faster than the arterial and depending on the value of THETA, as would multiple iterations of capacity-restrained all-or-nothing assignments. For example, if there were 6,750 trips between zones A and B, assume the results of a non-equilibrium capacity-restrained assignment resulted in 6,000 trips on the freeway path, 600 on the arterial path and 150 on the "long way around" path. Let's see what that assignment does to the travel times of the trip makers.

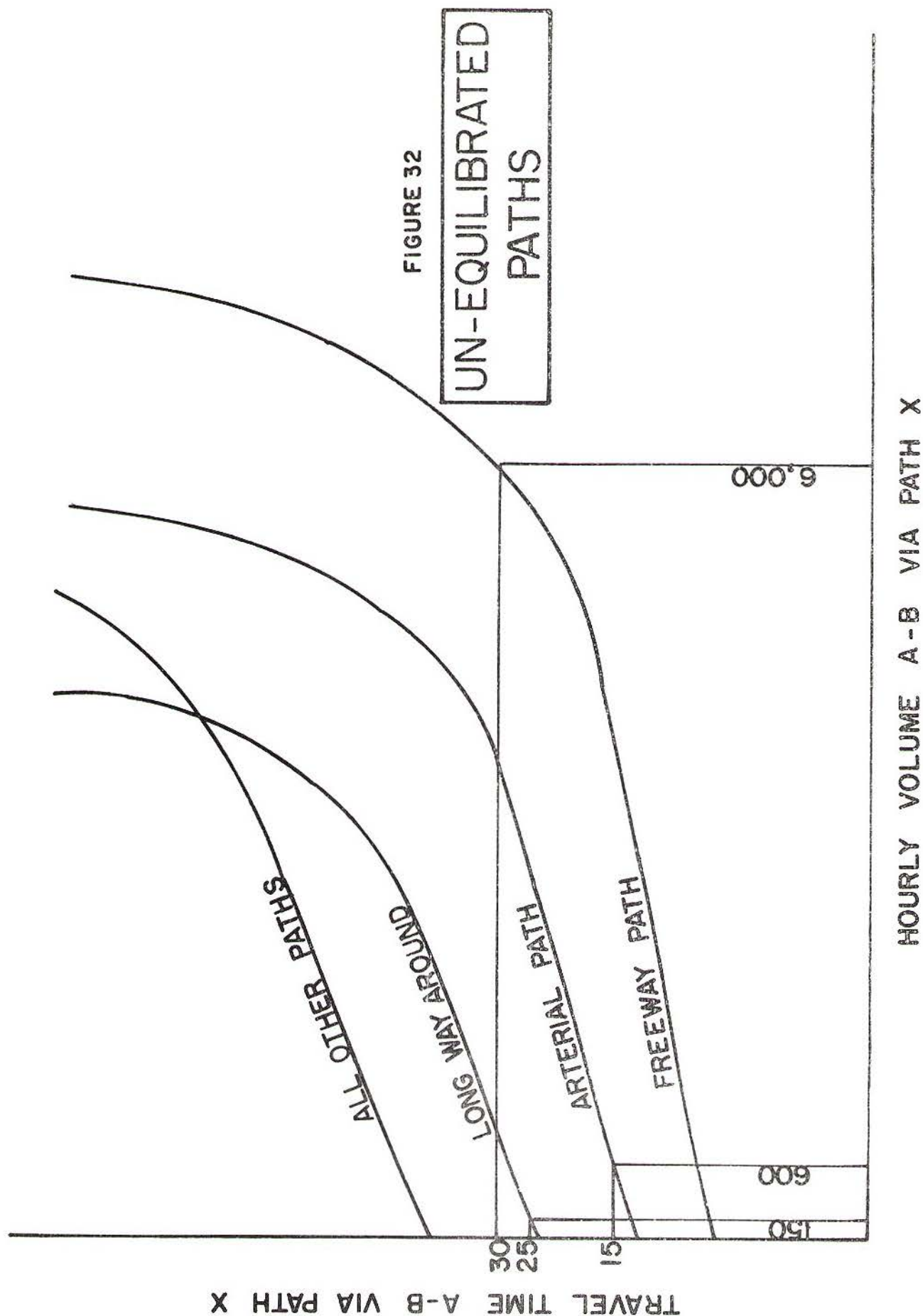


FIGURE 32 - UNEQUILIBRATED PATHS

As you can see from this graph of volume/capacity versus travel time for each path, the network is not in supply/demand equilibrium. The 6,000 trips assigned to the freeway spend 30 minutes to get from A to B, while the 600 arterial trips make it in 15 minutes. There is at least one assignment, however, where enough freeway trips have been shifted to the arterial path such that all trips take the same amount of time to get from A to B--the equilibrium assignment.

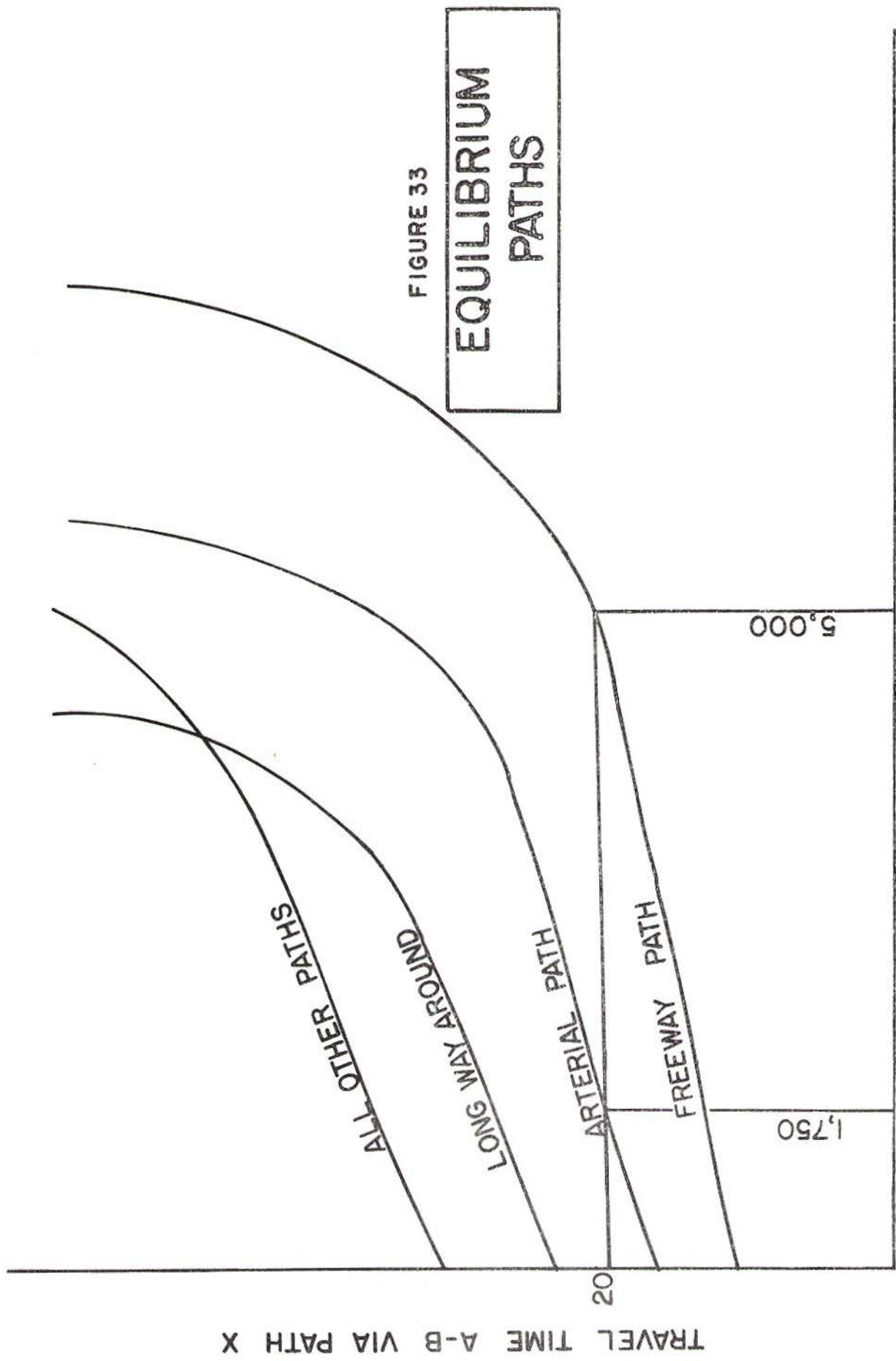


FIGURE 33

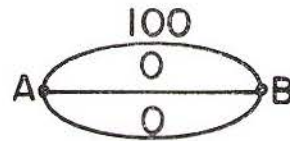
EQUILIBRIUM
PATHS

FIGURE 33 - EQUILIBRIUM PATHS

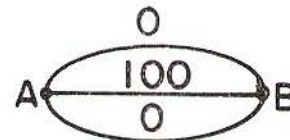
That assignment results in a travel time of 20 minutes on each path, which occurs when 5,000 trips are assigned to the freeway and 1,750 to the arterial. Nobody is assigned to the long way around.

Solving this problem for a matrix of trips instead of a single zone pair is not as simple. Fortunately, a linear programming solution to this problem has been programmed in UROAD which combines the assigned load from each capacity restraint assignment iteration with the previous iteration's loads in such a way as to produce an assignment after each iteration which is closest to this theoretical supply/demand equilibrium. The next figure illustrates how this combining process works in UROAD.

FIGURE 34
CAPACITY RESTRAINT
EQUILIBRIUM

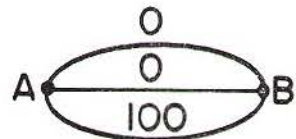
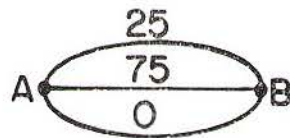


ITERATION 0



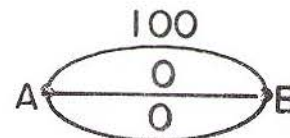
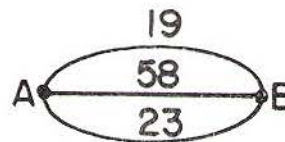
ITERATION 1

$$\lambda = .75$$



ITERATION 2

$$\lambda = .23$$



ITERATION 3

$$\lambda = .05$$

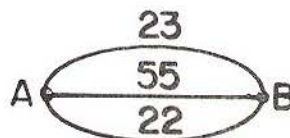


FIGURE 34 - CAPACITY RESTRAINT EQUILIBRIUM

In the example shown there are three paths between Zones A and B. In the first all-or-nothing assignment (the "zeroth" iteration) all 100 trips from A to B are assigned to the northern path. The first iteration of capacity restraint adjusts the link times on that path based upon the BPR curve and reloads the network, again using an all-or-nothing assignment. The result is 100 trips on the central path which is now the minimum path after the first adjustment of link travel times. UROAD then computes a combining factor (λ), using a non-linear programming algorithm such that the resultant loading is closer to final network equilibrium. In our example, $\lambda = .75$, and hence UROAD assigns 0.75 of the current iterations's load to the links of the middle path and the rest ($1-\lambda$) to the links of the previous iteration's path. The third all-or-nothing assignment (Iteration 2 of capacity restraint) is based on link times adjusted for the volumes resulting from that 75-25 assignment of link volumes. UROAD now finds the southern path to be the best and assigns all 100 trips to it, and then recalculates λ as 0.23 this time. That's good--the combining factor should be getting smaller as each iteration brings the loads closer to the desired state of equilibrium. UROAD assigns 23 trips (0.23×100) to the links of the new path and multiplies the previous assignment by 0.77 (i.e., $1-\lambda$). The northern path receives $0.77(25)$ and the central path receives $0.77(75)$, or 19 and 58 trips respectively. Note that 19 trips (northern) plus 58 (central) plus 23 (southern) equals 100 trips, the total to be assigned. After recalculating link times based on these new trip loadings, the third iteration puts all 100 trips on the links of the northern path again, calculates a new λ of 0.05, assigns an additional four trips to the links of the northern path and reapportions the remainder based on the results of the previous iteration.

	TERMS FOR THIS ITERATION	TERMS FOR REAPPORTIONING PREVIOUS LOADS	NEXT "BEST" LOADS
Northern:	$(0.05)(100)$	$+ (1-0.05)(19)$	$= 23$
Central:	$(0.05)(0)$	$+ (1-0.05)(58)$	$= 55$
Southern:	$(0.05)(0)$	$+ (1-0.05)(23)$	$= 22$
		Total	100

The process stops when λ gets close enough to zero, or the user specified number of iterations are completed. See appendix for detailed calculations performed for each iteration.

FIGURE 35
CAPACITY RESTRAINT
A-O-N EQUILIBRIUM

```
//UROAD EXEC UROAD,CORE=512K,  
// ZI='DSN=UMTA.UTOWN.LZFILE,VOL=SER=UMTAI',  
// JI='DSN=UMTA.UTOWN.TRIPS,VOL=SER=UMTAI',  
//UROAD.SYSIN DD *  
  
UROAD RUN TO PERFORM EQUILIBRIUM ASSIGNMENT  
&PARAM TABLES=101,THETA=0,0,0,CONFAC=.10,SERV(1)=1.0,  
LAVN=4,ASSIGN='UTOWN EQUIL' &END  
&SELECT REPORT= 4,6,8,11,12,19 &END
```

FIGURE 35 - CAPACITY RESTRAINT: A-O-N EQUILIBRIUM

This is a sample JCL set up for an equilibrium capacity-restrained assignment. In this case THETA=0,0,0 specifies that one all-or-nothing assignment followed by two iterations of capacity restraint equilibrium assignment will be executed by UROAD. An initial iteration of stochastic multipath with two iterations of equilibrium capacity restraint would be THETA=.0015,0,0. The assignment results of the final iteration will be written to the link Z-file as LAVs with names CS4, CT4, etc. (LAVN=4).

In this case, the following reports will be produced in addition to Reports 4 and 19: Report 6, the Geographic Location and Facility Type Summary; Report 8, the Link Group Summaries; Report 11, Impact Estimates; and Report 12, the Vehicle Cost of Travel Summary.

FIGURE 36

UROAD REPORT 6

EQUILIBRIUM ASSIGNMENT OF A. M. PEAK-HOUR TRIPS TO UOWN HIGHWAY NETWORK

28JUL81 17.10.25

UROAD REPORT 6

PAGE 15

GEOGRAPHIC LOCATION AND FACILITY TYPE SUMMARY

VMT (1 VEH-MI)
SPEED (MI/H)
DISTANCE (MI)

LINKS WITH VOLUME/CAPACITY FROM 1.0 TO 1.25

GEO LOC	FACILITY TYPE						TOTAL
	1	2	3	4	6	OTHER	
1	0	0	3399	0	2063	0	5462
	0	0	13	0	15	0	13
	0	0	2	0	1	0	2
2	0	4177	3713	0	0	0	7890
	0	30	12	0	0	0	17
	0	1	3	0	0	0	4
3	12421	0	0	0	0	0	12421
	37	0	0	0	0	0	37
	3	0	0	0	0	0	3
ALL	12421	4177	7112	0	2063	0	25773
	37	30	12	0	15	0	22
	3	1	5	0	1	0	10

TOTAL VMT = 1190 VEH-H
TOTAL DELAY = 515 VEH-H

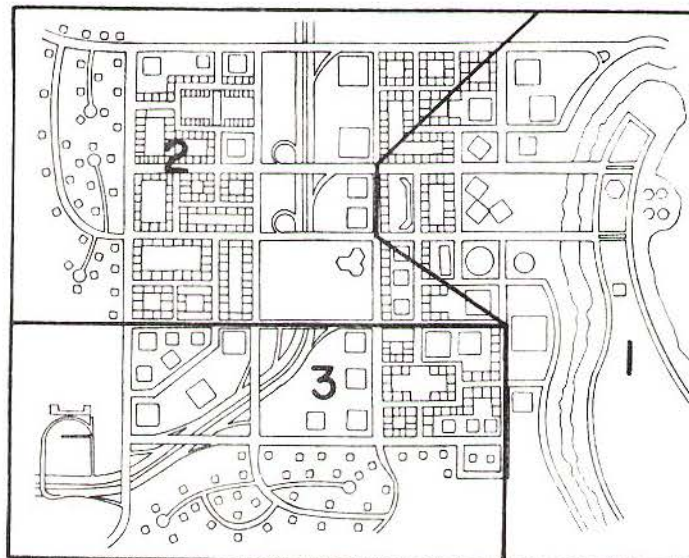


FIGURE 36 - UROAD REPORT 6

UROAD Report 6 summarizes vehicle-miles of travel (VMT), average speed, and link distances for links stratified by geographic location, facility type and volume/capacity ratios. The report illustrated displays VMT, speed and distance for links with V/C ratios between 1.0 and 1.25. The UROAD run produced similar tables for V/C ranges of less than 0.75, 0.75-1.0, greater than 1.25, and all links.

Geographic location is a user-defined unit for which UROAD aggregates assignment statistics and impacts. We have defined three geographic locations for UTOWN as shown. To obtain these summaries, geographic location values can be optionally coded on the highway links when the network is built.

Facility type refers to the type of roadway that each link represents as coded in the network. The default values in UTPS are 1=freeway, 2=expressway, 3=two-way arterial with curb parking, 4=one-way arterial, 5=centroid connector, and 6=two-way arterial without parking.

Looking at this particular report, we see that for links with assigned V/C ratios between 1.0 and 1.25 in geographic location 1, and of facility type 3, there were 3,399 VMT, at an average speed of 13 mph, over 2 miles of roadway.

FIGURE 37

UROAD REPORT 8

EQUILIBRIUM ASSIGNMENT OF A.M. PEAK-HOUR TRIPS TO UTOWN HIGHWAY NETWORK

28JUL81 17.10.25

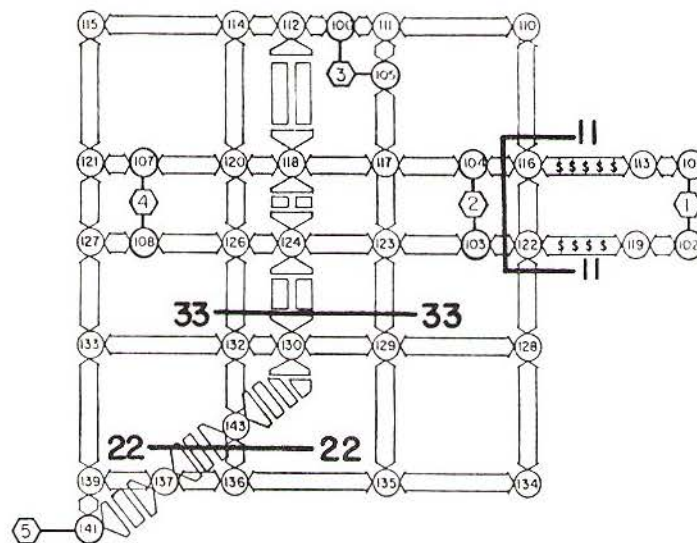
UROAD REPORT 8

PAGE 18

LINK GROUP TRAFFIC SUMMARY

VOLUME/CAPACITY RATIO
TOTAL VOLUME

(TENS)	-----LINK GROUP (UNITS)-----									
	0	1	2	3	4	5	6	7	8	9
10	0.0 0	0.82 7029	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0
20	0.0 0	0.0 0	0.82 3764	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0
30	0.0 0	0.0 0	0.0 0	0.64 3507	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0
90	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.0 0	0.01 86849



UTOWN HIGHWAY NETWORK
LINK GROUPS

FIGURE 37 - UROAD REPORT 8

Report 8 displays the volume/capacity (V/C) ratio and total volume of assigned trips for each user-specified link group in the network. A link group is a set of links which cross a specified cutline or screenline in the network. Cutlines and screenlines are used to check traffic assignment and other travel forecasting model results and to evaluate highway system performance. The map shows the three cutlines we specified in UTOWN and had previously coded on the appropriate link cards. If a link group value is coded for only the "inbound" direction of a set of two-way links, then volumes and V/C ratios reported will be for the inbound direction only. A different link group number can be coded on the corresponding "outbound" links to obtain the outbound volume and V/C ratio for these links. UROAD will report on up to 99 link groups in a network.

Looking at Report 8 shown here, we see that for Link Group 22 the V/C ratio was 0.82 for a total volume of 3,764 vehicle trips.

FIGURE 38 UROAD REPORT II

EQUILIBRIUM ASSIGNMENT OF A.M. PEAK-HOUR TRIPS TO UTOWN HIGHWAY NETWORK

28JUL81 17.10.25 UROAD REPORT 11 PAGE 20

IMPACT ESTIMATES BY GEOGRAPHIC LOCATION

GEO. LOC.	-----POLLUTANTS (GRAMS)-----						FUEL USED (GALS)	OPER COST (\$)	----ACCIDENTS----		
	-----HC-----			-----NOX-----					TOTAL	--PERSONS--	
	1977 (0)	1982 (0)	1987 (0)	1977 (0)	1982 (0)	1987 (0)			OCCUR	INJRD	FATAL
1	26347	15797	8992	10850	8445	6286	2527	3848	0.50	0.08	0.0
2	22647	13298	7374	12261	9565	7202	2448	3669	0.40	0.06	0.0
3	10857	6108	3193	8797	6998	5342	1347	1929	0.12	0.02	0.0
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	59851	35203	19559	31908	25008	18830	6322	9446	1.02	0.17	0.0

DUE TO SCALING THE SUM OF ENTRIES FOR ALL
GEOGRAPHIC LOCATIONS MAY NOT ADD UP TO THE TOTAL

FIGURE 38 - UROAD REPORT 11

UROAD Report 11 displays impact estimates of pollutant emissions, fuel usage, operating costs and accidents by geographic location and totals for the entire network. These values are based on default impact rates within UROAD for the year 2000 and a nationwide average urban vehicle mix. Using &DATA statements, the user may override the default rates corresponding to a different year or vehicle mix. These impact rates, which are available in UROAD Report 3, are applied to the VMT by facility type and speed to compute the impacts given in Report 11.

FIGURE 39

UROAD REPORT 12

EQUILIBRIUM ASSIGNMENT OF A.M. PEAK-HOUR TRIPS TO UTOWN HIGHWAY NETWORK

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VEHICLE COST-OF-TRAVEL SUMMATIONS

ITERATION	S1= V(LINK)*I(LINK)	S2= V(O-D)*I(O-D)	ERROR= (S1-S2)/S1	LAMBDA	FRACTION
0	--	1850.	--	1.000	0.890
1	5281.	2453.	0.53547	0.042	0.039
2	4683.	2459.	0.47498	0.036	0.035
3	4276.	2466.	0.42336	0.036	0.036
4	3947.	--	--		

IC = IMPEDANCE DUE TO CONGESTION = $S1(4) - S2(0) = 2097.$
 RI = CONGESTION INDEX = $IC/S1(4) = 0.5313$

FIGURE 39 - UROAD REPORT 12

As we previously discussed, after each iteration UROAD computes a proportioning factor λ which combines link volumes from the "old" and the "new" loading to produce a "best" volume estimate to that point, based on the theory of network equilibrium. This proportioning factor, λ , is reported for each iteration along with an error measure which indicates how far the "best" loading up to that point is from network equilibrium.

Report 12 provides statistics concerning this iterative procedure. The first column, "Iteration", provides a counter with zero (0) meaning the loading "prior to the first restraint," and one (1) meaning the loading "after the first restraint," etc. "S1" is the sum of the products of link volumes multiplied by the link impedances (depending on "CDIST", "CTIME", and "CTOLL") specified by the user for pathfinding. Thus, if time alone is specified for pathfinding (CTIME=.6), S1 is vehicle hours of travel times 0.60. "S2" is the sum of the cell by cell products of interchange volumes (trip table) multiplied by interchange impedance (skims). A condition for equilibrium is that S1 and S2 be equal. Thus, as iterations proceed, these should converge, and the "error" $(S1-S2)/S1$ should decrease. "LAMBDA" (λ) indicates the weighting of the new load from each iteration with the preceding "best" load and should generally decrease as the preceding best load becomes better (i.e., closer to equilibrium) with each iteration. The final column, "FRACTION" indicates the resultant weighting of each iteration's loads in the final load as reported from the assignment.

FIGURE 40

UROAD TRAFFIC ASSIGNMENT

ASSIGNMENT OPTIONS

SIMPLE ALL OR NOTHING: $\text{THETA} = 0$

STOCHASTIC MULTIPATH: $\text{THETA} = .0015$

CATS INCREMENTAL AON: $\text{THETA} = 0$, $\text{CATS} = 5$

CATS INCREMENTAL STOCHASTIC: $\text{THETA} = .0015$, $\text{CATS} = 5$

ALL OR NOTHING EQUILIBRIUM: $\text{THETA} = 0, 0, 0, 0$

EQUILIBRIUM FOLLOWING STOCHASTIC: $\text{THETA} = .0015, 0, 0, 0$

EQUILIBRIUM FOLLOWING INCREMENTAL: $\text{THETA} = 0, 0, 0, 0$, $\text{CATS} = 5$

EQUILIBRIUM FOLLOWING INCREMENTAL

STOCHASTIC: $\text{THETA} = .0015, 0, 0, 0$, $\text{CATS} = 5$

FIGURE 40 - ASSIGNMENT OPTIONS

In summary, there are a variety of options that can be specified in UROAD to perform a traffic assignment:

- Simple All-or-Nothing
- Stochastic Multipath
- CATS Incremental A-O-N
- CATS Incremental Stochastic
- A-O-N Equilibrium
- Equilibrium with Stochastic
- Equilibrium with CATS Incremental
- Equilibrium with CATS Incremental Stochastic

These represent logical combinations of the two loading techniques (all-or-nothing, multipath) and two capacity restraint techniques (CATS, equilibrium). In addition, the number of increments, the number of iterations, and the THETA value can all be varied within each of these assignment options. Which assignment procedures to use depend upon the problems being analyzed, the size and other characteristics of the network, and the relationship with other travel forecasting models. Turn penalties/prohibitors can only be used with A-O-N assignments.



1
2
3



4
5
6

