Forecasting Traffic with a Modified Growth Factor Procedure

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● THIS paper presents a comparison of three methods of traffic projection and reduction to 1975-level desire lines. The basic origin-destination (O&D) data which were used were obtained in 1944; supplemental O&D data were obtained in 1950 from which the earlier information was up-dated to 1950. This adjusted 1950 O&D data are those which have been used in all traffic projection and assignment work in the Memphis Metropolitan Area. During the course of the last seven years there has been occasion to work with the basic O&D data in preparing a major street and highway plan, in preparing interstate route location studies, in preparing the 108(d) and 104(b) 5 cost estimates, and in preparing final construction plans. As this data has been processed, varying techniques of projection and of assignment have been used intentionally to give a cross-check of the one method against another. By virtue of their inconsistencies it has been found both proper and necessary to apply considerable engineering judgment in the use of this material.

This paper presents a comparison of total trip-end desires for each O&D zone in 1975 (Table 1), a comparison of a random selection of zone-to-zone travel desires for 1975 (Table 2), a comparison of the semi-assigned 1975 desires by corridors in 1975 (Table 3), a graphic comparison of the trip-ends by zones and physical location within the metropolitan area (Fig. 1), and semi-assigned cardinal corridor design hour traffic vs capacity (Figs. 2 and 3). The assigned desires by cardinal corridors are the desires as obtained by the judgment-applied factors method.

This presentation does not purport to be a learned discourse on the relative merits of the three projective techniques. It is the sincere belief of the writer that, among the several projective techniques which are now in existence, some light needs to be shed. It is felt that this light can best be shed by a comparison among all of the techniques for a selected group of large, medium and small urban areas wherein, using the same basic data, the several techniques are applied, their end products carefully compared, and the significance of their differences explored and resolved to ultimate meaning. It is felt that such an approach could well lead to a demonstrably valid and grossly simplified and more economical approach to determining reasonable future traffic desires for planning and design use. It is maintained that the final test of necessary level of accuracy of the final projected product is that level which will always clearly establish the individual lane call. Working upward from peaking percentages and directional distribution percentages to the equivalent average daily desire served by the capacity of a lane, it may be seen that a reasonably sizeable variation in average daily desire will, when reduced to corridor orientation for analysis, not necessarily be unusually significant. The likelihood of this significance being unusually great is also minimized by the fact that the semi-assignment to corridors of the individual zone-to-zone trip values results in a necessary grouping of a number of separate values, some of which are high and some of which are low—hence a further dampening effect.

As work continues with O&D data and its projection in various parts of the nation, incorporation of as much research as possible in this matter of the most intelligent and logical use of O&D data is attempted. A demonstrably sound rationale has been obtained which allows forward movement from traditionally obtained O&D data to a reasonably valid projected set of desires with trip-end balance, to the assignment of these desires to corridors for reduction to peak period desires, to the comparison with

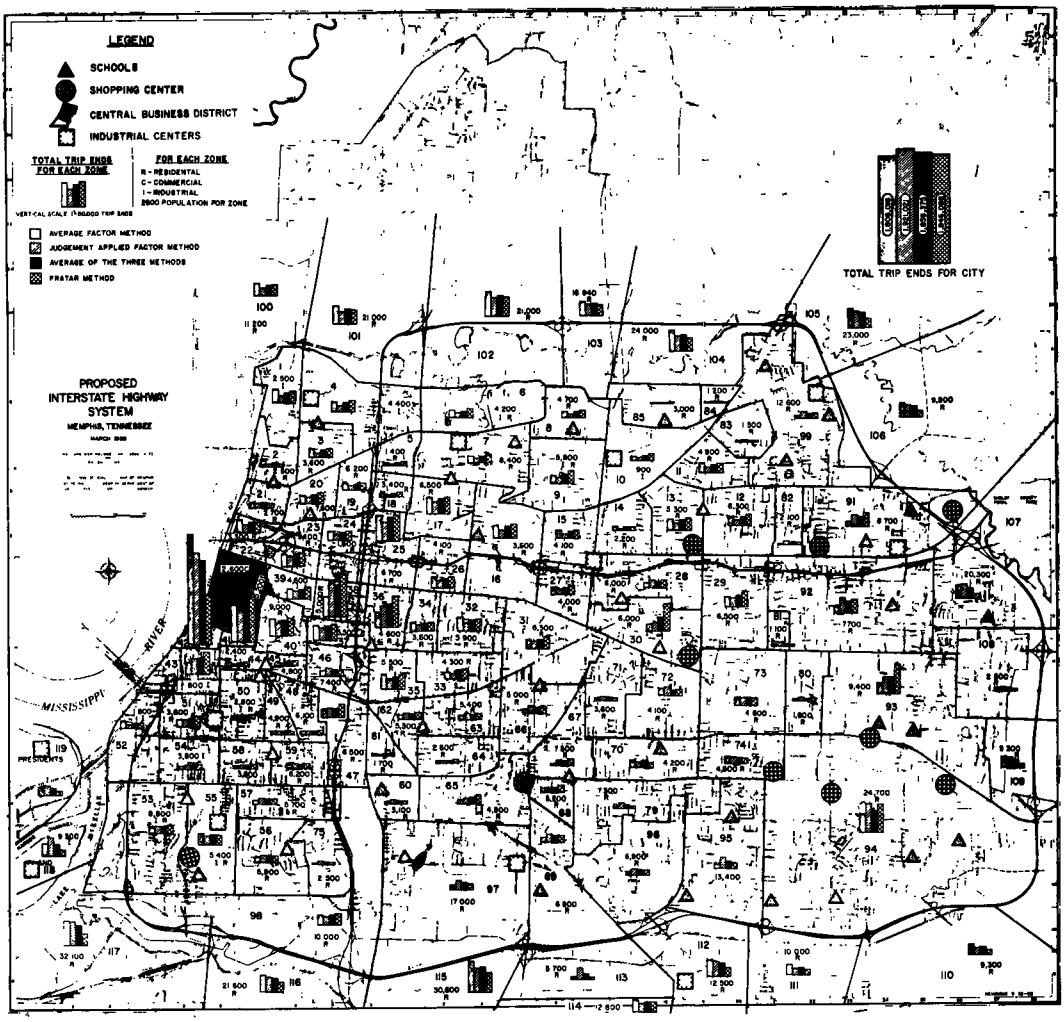

Figure 1.

existing capacity availability, and hence to the final guide to area-wide street and highway planning—a capacity-deficiency determination by location and orientation within the community. It is believed and hoped that traditional approaches from further analyses of these procedures will be simplified. It is admitted that these procedures are somewhat cumbersome and more time consuming than some of the techniques which are now in existence. However, it is believed that the basic validity of these more cumbersome techniques warrants their continued application to a satisfactory point of proof and to an ultimate reduction to a greatly simplified technique which is machine applicable. A corollary benefit in using these cumbersome techniques is that of being able to inculcate into young traffic engineers and planners a true understanding of relationships which bear on the entire matter of traffic generation.

This brief paper does not set forth the detailed step-by-step procedure which is currently being used because it would not seem to be germane to the action which this paper hopes to seek. This area of traffic projection, assignment, and ultimate analytical use is an area which constantly seems to become more complicated as each investigator applies himself to this area of thought and investigation. The basic question of whether the theorists are indeed making significant contributions or whether

TABLE 1

COMPARISON OF TOTAL TRIP-END DESIRES FOR EACH ZONE IN 1975

Zone	Average of Three Methods	Fratar Method	Average Factor Method	Judgment-Applied Factor Method
1	18,781	21,669	23,212	11,463
2	6,191	5,751	9,388	3,435
3	11,986	14,465	14,546	6,948
4	14,425	18,295	16,018	8,963
5	4,631	6,195	4,270	3,430
6	8,819	14,919	11,982	8,524
7	10,945	13,867	11,320	7,649
8	9,805	12,429	10,158	6,827
9	15,183	21,241	13,736	10,571
10	8,409	11,941	7,318	5,968
11	13,800	15,795	16,376	9,229
12	14,979	18,937	16,206	9,793
13	17,666	20,019	19,892	13,088
14	5,223	5,527	6,454	3,689
15	11,388	12,707	14,764	6,693
16	20,384	23,967	22,912	14,273
17	26,219	27,755	29,142	21,761
18	5,861	7,277	6,214	4,093
19	10,817	12,687	11,604	8,160
20	14,841	18,165	14,844	11,514
21	9,151	9,233	10,792	7,428
22	18,568	19,553	22,718	13,433
23	19,727	23,331	20,396	15,454
24	13,236	15,105	14,540	10,063
25	39,775	44,869	43,258	31,205
26	16,420	18,553	18,240	12,466
27	12,786	15,357	13,092	9,908
28	11,781	13,591	8,978	12,775
29	19,703	25,807	15,700	17,602
30	24,754	47,725	12,000	14,536
31	16,232	19,513	16,046	13,138
32	19,380	19,957	23,774	14,408
33	14,299	16,583	16,560	9,755
34	13,481	15,241	15,408	10,874
35	21,816	24,297	25,744	15,408
36	38,934	52,905	25,996	37,900
37	24,539	27,253	25,210	21,153
38	53,918	71,103	34,334	56,316
39	16,945	19,773	16,908	14,154
40	27,833	30,419	29,982	23,099
41	63,372	74,677	63,836	51,603
42	140,875	83,847	185,562	153,215
43	28,117	37,009	21,218	26,123
44	5,410	6,359	5,836	4,035
45	5,377	6,415	4,930	4,787
46	11,434	9,911	10,006	14,385
47	14,665	16,605	13,362	14,029
48	5,589	6,251	5,510	5,006
49	5,420	5,769	5,430	5,062
50	6,067	6,589	5,756	5,855
51	14,439	16,767	13,422	13,129
52	9,300	9,347	12,128	6,427
53	12,808	14,957	10,686	12,781
54	6,512	6,547	6,040	6,949
55	17,882	16,963	20,496	16,186
56	10,652	10,061	9,876	12,020

they are, conversely, "straining at nits" is the next most significant determination to be made in this area of exploration.

DESCRIPTION OF THREE METHODS OF TRAFFIC PROJECTION USED

Judgment-Applied Factor Method

Expansion Method. — This procedure uses the best of the averaging method and the Fratar Method. The method does not adapt directly to machine methods which are purely mechanical; however, a computer program is being worked on to apply a close approximation of the method. The adjustment to create trip-end balance requires time and study, letting sound judgment (guided by intimate local planning and engineering information) be the basis for the addition or subtraction of trips from the movements. The method is as follows:

1. Apply an increase factor to the 1950 trip ends for each zone-to-zone movement. This increase factor is an average of the increase factors for each of the two zones unless one of the zones in question possesses a strong bond of attraction. This strong bond should be recognized and adjustments made to give a more realistic presentation of the future desires between the two zones.

57	8,738	8,981	7,548	9,684
58	5,914	6,149	5,300	6,293
59	7,374	7,689	6,242	8,190
60	5,108	5,139	3,446	6,738
61	3,753	4,169	3,918	3,172
62	10,773	11,701	8,842	11,777
63	7,167	10,343	7,430	10,894
64	4,871	5,405	4,352	4,857
65	10,567	14,785	6,934	9,981
66	11,699	12,827	8,642	13,627
67	8,623	10,701	4,094	11,073
68	9,142	11,995	6,640	8,790
69	12,623	13,025	9,692	15,151
70	11,329	9,409	13,840	10,737
71	6,068	5,369	5,282	7,554
72	12,665	9,637	12,962	15,397
73	14,135	13,579	14,628	14,198
74	10,630	8,321	12,534	11,035
75	3,866	3,185	2,660	5,752
79	5,688	3,563	4,138	9,363
80	4,616	4,323	3,858	5,667
81	3,860	2,651	2,626	6,305
82	4,823	4,335	2,972	7,162
83	2,767	2,375	2,882	3,043
84	1,371	1,091	1,486	1,535
85	1,603	1,661	1,556	1,593
91	17,448	23,043	8,560	20,740
92	20,460	23,289	11,438	26,655
93	34,755	50,941	19,016	34,308
94	36,176	48,739	10,737	49,053
95	12,227	9,565	7,316	19,801
96	8,548	8,885	6,506	10,252
97	12,135	11,889	8,216	16,300
98	17,022	19,227	16,900	14,938
99	8,459	8,863	5,306	11,207
100	17,742	18,447	21,004	13,776
101	25,790	24,209	31,634	21,527
102	35,853	33,527	42,032	32,001
103	20,155	17,955	23,364	19,145
104	28,791	23,365	36,020	26,988
105	26,282	16,787	33,714	28,344
106	18,370	10,389	24,234	20,486
107	17,978	7,771	22,262	23,901
108	4,788	2,803	5,226	6,336
109	13,419	5,503	17,518	17,235
110	13,592	8,909	18,280	13,586
111	12,729	9,243	17,162	11,783
112	23,210	14,601	28,990	26,039
113	9,805	4,289	4,554	20,573
114	16,769	16,227	19,406	14,673
115	43,306	33,175	53,756	42,986
116	23,434	16,245	28,972	25,085
117	34,627	19,667	42,890	41,324
118	20,848	9,515	21,730	31,299
119	12,470	7,083	13,654	16,672
Adjusted totals	1,858,375	1,858,375	1,858,375	1,858,375
Unadjusted totals		1,846,088	1,808,016	1,921,021
Percent variation from average		+1	+3	-3

2. Prepare the trip-end projections obtained by applying the appropriate expansion factors for each zone with the trip ends totaled from the expansion of each zone-to-zone movement.

3. Adjust the total trip ends for each zone to meet the desired total. This can be accomplished by studying each zone-to-zone movement—with respect to the growth expected in each zone, the proximity to each other, the land use, and location within the city. In most cases the high growth areas will be the outlying areas of the city. These areas are spotty as far as 1950 O&D information is concerned. There are many zone-to-zone movements which did not have any movements in the 1950 O&D survey, but due to the land use, proximity, development, etc., there should be trips between them. In most cases this will help both zones in achieving trip balance. The zones which require some reduction in trips are studied in the same manner and the reductions made in light of these factors. It may take two or three run-throughs to balance the system.

Expansion Factors.—(a) vehicle ownership, 1.58 (city wide); (b) vehicle use, 1.10 (city wide); (c) population, computed for each zone (1.76 city-wide average); and (d) CBD, 1.25.

TABLE 2

COMPARISON OF SELECTED ZONE-TO-ZONE TRAVEL DESIRES FOR 1975

Zone		Average of Three	Fratar Method		Average Factor Method		Judgment-Applied Factor Method		Land
From	To	Methods		(%)[1]		(%)		(%)	Use
42	4	357	164	-59	468	+31	440	+23	C-1
42	14	272	109	-60	388	+43	320	+18	C-R
42	109	1088	564	-48	1350	+24	1350	+24	C-R
42	72	716	338	-53	905	+26	906	+26	C-R
42	94	841	1654	+97	445	-47	1646	+96	C-R
42	46	651	245	-62	855	+31	854	+31	C-R
42	96	279	325	+16	205	-26	306	+10	C-R
42	114	1115	586	-47	1380	+24	1378	+24	C-R
42	31	1004	607	-40	1155	+15	1250	+25	C-R
42	55	436	298	-31	505	+16	506	+16	C-(I-R)
42	99	319	356	+12	264	-17	336	+ 5	C-R
113	27	94	100	+ 6	91	- 3	92	- 2	R-R
113	38	582	564	- 3	316	-45	866	+49	R-R
113	12	64	72	+12	59	- 8	60	- 6	R-R
113	94	280	315	+13	62	-78	462	+65	R-R
97	24	180	218	+21	161	-10	160	-10	R-R
94	41	932	1962	+110	267	-71	566	-40	R-I
55	32	53	44	-17	75	+42	40	-25	(I-R) -R
1	70	0	0	0	0	0	0	0	I-R
67	106	13	40	+200	0	-100	0	-100	R-R
104	10	244	377	+55	174	-29	180	-26	R-I
106	41	566	802	+42	448	-21	448	-21	R-I
101	33	9	29	+200	0	-100	0	-100	R-R
56	60	0	0	0	0	0	0	0	R-R
56	115	966	1202	+24	696	-28	1000	+ 4	R-R
7	25	840	876	+ 4	795	- 5	850	+ 1	R-R
73	35	0	0	0	0	0	0	0	R-R
47	92	8	0	-100	0	-100	25	+200	R-R
70	36	134	171	+28	92	-31	140	+ 4	R-R
69	91	39	53	+36	32	-18	32	-18	R-R
119	117	872	914	+ 5	987	+12	724	-17	I-R
53	75	107	123	+15	84	-22	114	+ 6	(I-R) -R
18	98	97	110	+13	82	-15	100	+ 3	R-R
50	98	8	9	+12	7	-12	8	0	(I-R) -R
101	3	63	189	+200	0	-100	0	-100	R-R
102	17	28	84	+200	0	-100	0	-100	R-R
2	23	113	107	- 5	123	+ 9	110	- 3	R-R
104	9	182	231	+27	174	+ 4	140	-23	R-(I-R)
106	109	134	228	+70	87	-35	88	-35	R-R
45	75	84	90	+ 7	75	-11	86	+ 2	R-R
6	10	130	147	+13	96	-26	146	+13	(I-R) -I
20	12	88	98	+11	77	-13	90	+ 2	R-R
17	7	779	855	+10	702	-10	780	0	R-R
33	34	373	443	+19	257	-31	420	+13	R-R
29	92	156	75	-51	38	-76	355	+128	R-R
Average variation				+20		-20		+ 4	

[1]Percentage variation from the average of the three methods.

Average Factor Method

Expansion Method.—The 1950 O&D desires between zones were expanded to 1975 by applying an increase factor that was the average of the two individual increase factors for each zone. Undeveloped zones in 1950 were compared with developed zones having similar land use and orientation to obtain the 1975 desires. In this expansion no attempt was made to attain trip-end balance.

Expansion Factors.—(a) vehicular registration, 1.58 (city wide); (b) gasoline consumption, 1.10 (city wide); (c) population growth computed for each zone (1.76 city-wide average); and (d) CBD, 1.26.

TABLE 3

CORRIDOR ANALYSIS COMPARISON

Corridor	1 Judgment-Applied Factor Method Assignment	Average Percent Variation of 1 With Fratar Method Within Corridor	Average Percent Variation of 1 With Average Factor Method Within Corridor
E-W-"E"	30,000	+10	-10
N-S-"O"	17,100	- 2	- 3

Fratar Method

The Fratar Method of traffic projection has been described elsewhere (1). The basic elements are as follows:

1. For each zone the estimated future traffic volume is distributed to the movements to and from it and within it, in proportion to the relative attractiveness of those movements.

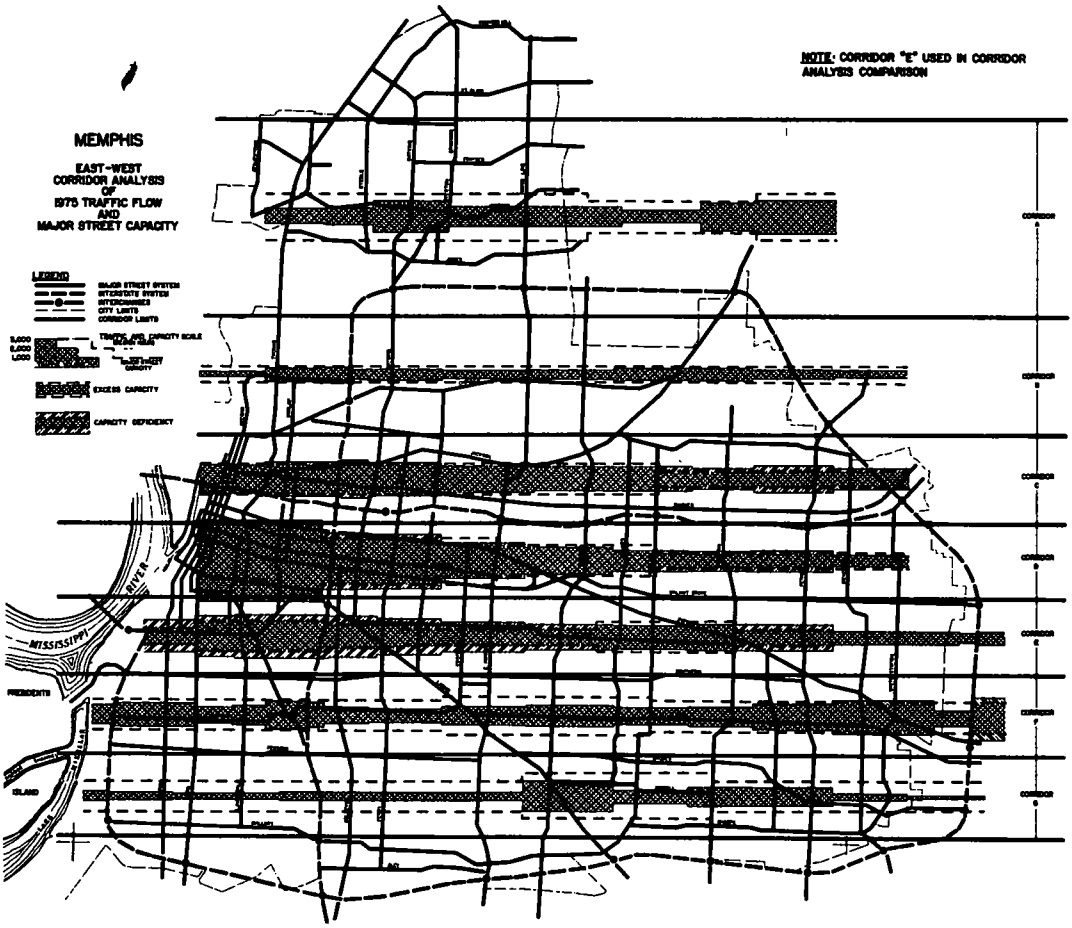

Figure 2.

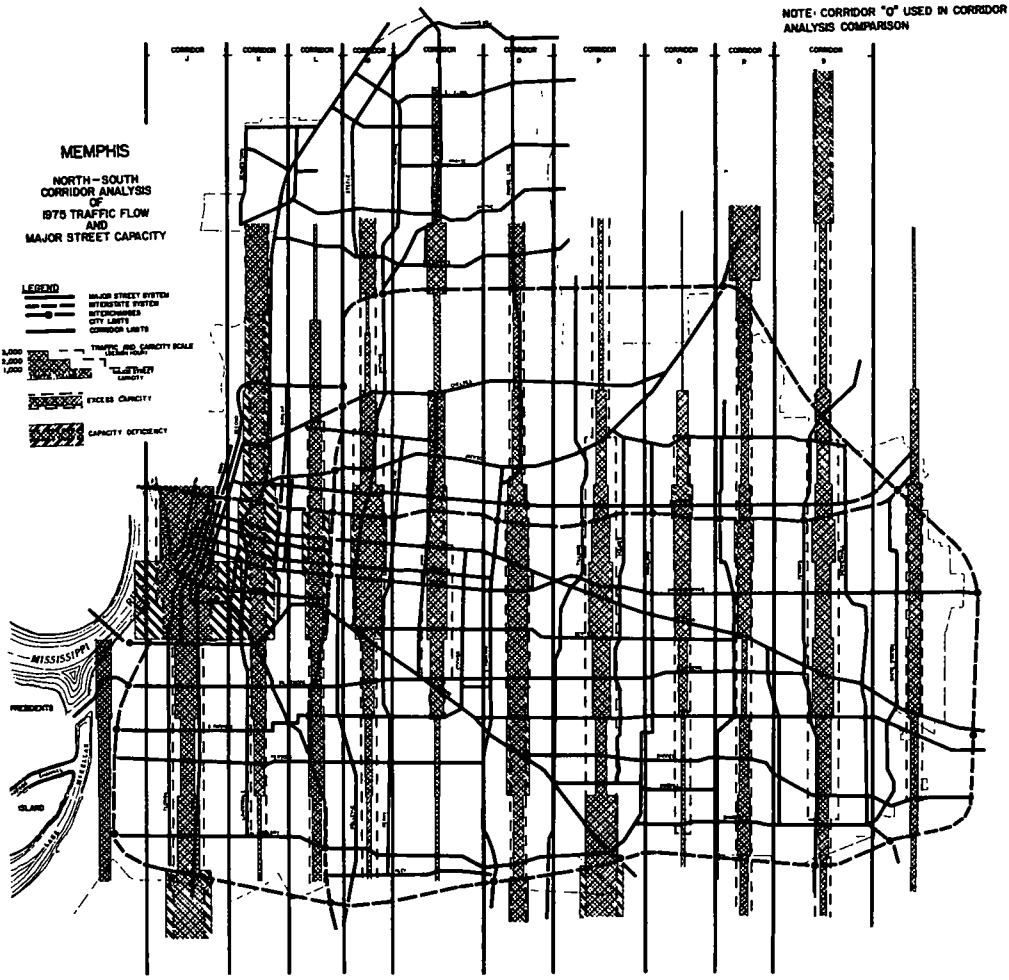

Figure 3.

Reasonable indicators of relative attractiveness are existing traffic movements and estimated zonal traffic growth factors.

As a practical matter, the intrazonal movement of the zone may be treated in the same way as an interzonal movement, with due regard to the difference between a trip and a trip end.

2. At the end of the first distribution, each movement—except intrazonal movements—has two volumes resulting from the zonal distributions at each end of the movement. The pairs of volumes are averaged to obtain a first approximation of zone-to-zone movements and intrazonal movements.

3. The averages for the interzonal pairs of trips radiating from each zone and the first approximation of intrazonal volume are summarized to determine adjustment factors for the zones to be used in the second approximation.

4. For each zone the originally estimated trips are again distributed to interzonal movements and to movements within the zone in proportion to the volumes and adjustment factors obtained by the first approximation. The pairs of tentative volumes obtained for interzonal movements by this distribution are averaged as before, and the process repeated until the desired conformity is obtained.

It was found that for the procedure outlined, the convergence was very rapid and otherwise satisfactory. With punched cards and IBM equipment the mechanics of the procedure are relatively simple.

The successive approximations method, with some refinements, was used for the traffic study recently completed for Detroit under J.D. Carroll's direction.

A computer program was borrowed from the IBM Library by the State of Tennessee for use in this analysis. Three iterations were accomplished with this program to attain trip-end balance. The expansion factors used in this program were: (a) vehicle ownership, 1.58 (city wide); (b) vehicle use, 1.10 (city wide) (c) population, computed for each zone (1.76 city-wide average); and (d) CBD, 1.25.

ACKNOWLEDGMENT

The cooperative attitude of the cities and states that supplied information is appreciated as is the willingness of the U.S. Bureau of Public Roads for permitting the authors to experiment with variations of technique in projecting and analyzing traffic data.

REFERENCE

1. Fratar, T.J., "Comprehensive Arterial Highway Plan for the Cleveland Metropolitan Area." HRB Bull. 153 (1957).