Future Traffic Predictions for the Detroit Area

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Methods and assumptions used in the Detroit Metropolitan Area Traffic Study to forecast future traffic patterns are described. This includes the relation of traffic to population, economic growth, and changes in distribution of car ownership and population. Also presented is a forecast of land usage and the expected traffic generation. The method of developing future origin-destination patterns is touched on and the estimated effects on expressway loading and planning are summarized. Some of the short-comings of these methods and possible improvements are pointed out.

● IF THE USE of trend figures were a valid means of determining future transportation requirements, facilities planned on the basis of such figures 20 and 25 years ago should be adequate today. It is readily demonstrable that this is not so.

Under any circumstances, the mere trend expansion of an origin-destination survey will produce problems in a transportation network. If a too generous expansion factor is used, there will be overbuilding in some parts of the network. If a conservative factor is used, some parts of the net will be inadequate, because growth in a metropolitan area is not evenly distributed.

With the time needed for collecting and summarizing data, resolving plans and the building or improvement of facilities, any O-D survey is out-dated before it can be used — out-dated unless the O-D survey is used to design the means of projection rather than being itself projected.

Only by providing a basis for sound future estimates can an O-D study be justified as a planning device. The better the ability to anticipate the future, the better will be the planning.

THE PROBLEM

Because traffic service is a basic consideration in the location and design of facilities, the key problem was estimating future travel in sufficient detail so that usage of new facilities could be predicted with reasonable accuracy.

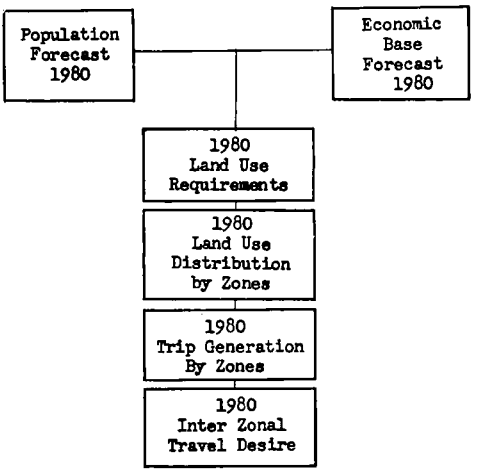
The Detroit O-D survey was made in 1953. A target year of 1980 was chosen as a planning point. This was sufficiently far in the future to represent that time when facilities conceived and planned would be in the midst of their useful life. The task was to prepare detailed estimates of probable travel movements between zones for 1980.

METHODS USED

To do this, a procedure was developed which is diagrammed in Figure 1. This outline shows that the forecast began with two estimating ingredients: people and economic activity. Economic growth can change population and sheer population growth can enlarge the amount of economic activity. Both, therefore, must be considered and related.

The earliest methods of forecasting expanded all travel records by a flat percentage. It would be possible to estimate the increase in traffic in that manner, but that method would result in a flat-rate increase and little would be known about the location of the travel in the metropolitan area.

The error in this method can be seen by remembering that the percentage growth in traffic is not equal at all points. Central business districts are completely and intensively developed. To grow, they must grow vertically but they cannot do this at the present rate of metropolitan growth. Annual cordon counts around central business districts show little or



no change in the number of travelers as the metropolitan area grows. Growth in these completely developed centers is limited if not on the verge of reversing.

Previously vacant suburban areas become completely developed areas very rapidly. Consequently, traffic volumes grow at different rates throughout the metropolitan region.

The simplest method of locating these growth differentials is to anticipate changes in land development. A new house means new trip origins and destinations. The same is true for new factories, new stores, new schools, or any other new activity or land use. By the same token, changes in land use will produce changes in the volume and character of trips going to those areas where such changes occur; and, parenthetically, change is continuous in any urban area.

ESTIMATING LAND USE

The next step in the block diagram is to determine what the land uses will be in the future. These uses can be determined as total amounts from the population and economic activity estimates.

With this determination made, it is possible to distribute new land uses to zones so as to balance with this total amount. Naturally this distribution must reflect local master plans and must account for redevelopment plans. This distribution of future land uses is based on a current land use inventory and should be done (as was the case in Detroit) in close cooperation with the public planning agencies.

This is a most critical step for it is from future land uses in each zone that future trip origins and destinations are to be estimated. This step is reasonable — factories must have workers; stores, customers; churches, members; schools, students; and so on for each activity with a location on the land. Each land use or land activity acts as an origin and destination point for travelers or for the movement of goods by commercial vehicles.

TRAFFIC GENERATING CHARACTERISTICS OF LAND USE

The traffic generating characteristics of specific land uses were determined from the basic O-D study. The number of persons traveling to stores, and the number to industrial plants, public buildings, schools, or other uses were ascertained on the basis of inventoried behavior. From this analysis it was possible to calculate the number of person trips per acre for each type of land use. In similar fashion separate factors were also determined for truck trips.

Knowing future land uses in each traffic zone, the new number of trips to and

from each zone should be simple to determine. The only difficulty is that, as yet, trends have not been properly treated. There is a known trend for higher incomes — steadily increasing car ownership and, resulting increased per capita travel.

Upon consideration, it was concluded that these trends were inherent to any future distribution of land uses. For example, car ownership rates per capita are low in densely built-up areas and high in sparsely settled areas regardless of family income. A low income family living in the suburban fringe will have one or more cars. These may not be expensive or new, but they will have them because they must. Conversely, high income families in tall apartment buildings near the center of the city are frequently without cars — an extreme example is Manhattan Island, where it is impractical and very expensive to have a car. Therefore, the increment of population growth will be greatest in the low density suburban areas; car owners will increase more rapidly than population.

This increased suburban residential growth is also a function of increased incomes. In Detroit, family income tends to increase with distance from the central business area. Moreover, trips per household increase at an even faster rate with distance out from the city center.

This leads to the assumption that travel by people was essentially a function of the needs of those people and the arrangement of places where those needs could be fulfilled. Thus, people in the densely built up central parts of Detroit can walk to a grocery store, whereas a suburban resident must drive. The chance of finding a grocery store within walking distance must increase as a function of floor space index, land use density, or whatever this measure concentration is called.

Because the reasons for travel are assumed to remain constant in the future, the number of trips made will continue to be related to the environment of the trip makers. Therefore, it was decided that the 1980 travelers would, depending upon their location, have travel habits comparable to those of the present occupants of each zone. Secondly, barring unusual changes, land use in a zone would have the same traffic generating potential in 1980 on a per acre basis as that same use in that zone had in 1953.

Of course, there has been disagreement regarding these assumptions. It is difficult to know whether long term growth in productivity and income are properly accounted for in the simple redistribution of land uses. This problem should receive continued attention but, lacking any contrary evidence, the two assumptions of constancy were felt to be the only rational basis for estimating Detroit's future travel.

RESULTS OF ASSUMPTIONS OF CONSTANCY

It was estimated that the population within the study area[1] would increase by 48 percent. After land use forecasts were complete, the population could be distributed. On the basis of trip-making habits of households as reported in 1953, it was possible to estimate the number of trips which would be made by the 1980 population. Because so many more persons lived in the suburbs, the number of trips expected increased by 65 percent. This shows that an increased trend in trip-making can be accounted for simply by the trends of rearrangements of total population.

If car ownership rates per zone were constant and car ownership were calculated for the 1980 population, car ownership was found to increase by 61 percent, or much faster than the increase of population. Lacking adequate evidence of a more basic trend towards universal increases in auto ownership, no other correction was made.

TRIP ORIGINS AND DESTINATIONS

From the future land uses, it was possible to estimate the trips to (and, by inference, from) each land use in each zone, providing an independent estimate

[1] Roughly all the area within a twenty-five mile radius of downtown Detroit.

of the number of trips terminating at each zone and in the entire system.

Again a check for consistency could be made between the total trips predicted by both methods. The predictions made from land use were within 1/10 of one percent of the totals predicted solely on the basis of population. Although the source of both population and land use forecasts were related, there was no reason why such close agreement could be expected, unless the land use, the population, and the trip estimates were consistent.

LINKING ORIGINS AND DESTINATIONS

After estimating the total trips expected and the trip generation at each zone, there remained the problem of predicting zone-to-zone transfers. The linkages between zones had to be consistent with the predicted trip totals at each zone and with typical behavior of urban travelers.

The first condition would have been difficult to meet without the work of Fratar (*1*) in the Cleveland Study. He developed a method of iteration to achieve reasonable interchanges which would still be consistent with predicted zonal totals.

In Detroit it was assumed that travelers from any zone would themselves apportion their destinations among other zones as those destinations provided the means for fulfilling their needs and in inverse proportion to the difficulty of reaching any destination in any other zone. Thus, the chances that a portion of 100 travelers leaving zone i in search of a destination would choose zone j, would be proportional to j's share of the total available destinations and dependent on the difficulty in reaching zone j as opposed to other possible zones.

It was assumed that the relative difficulty in traveling between any two points or zones in the area would be about the same in 1980 as in 1953. The assumption is that, excepting the unusual case, improvements in transportation service to be added by 1980 will be equitably distributed throughout the region and will not unduly favor any particular location.

Therefore, an estimate of 1980 travel was made by expanding every zonal interchange by the product of the growth factors of both terminal zones divided by the growth factor for the entire area, as follows:

$$Y_{ij}' = Y_{ij} \cdot \frac{GF_i \cdot GF_j}{GF} \qquad (1)$$

in which

Y_{ij}' = new interzonal trips between any zones i and j;
Y_{ij} = inventoried trips;
GF_i = the growth factor for trips at zone i;
GF_j = the growth factor for trips at zone j; and
GF = the growth factor for all trips in the region.

After all new zonal movements were calculated to give zonal totals, it was found that the zonal totals, although closer to the predicted amounts, did not balance. Using results of the first calculation and the desired zonal trip totals, new growth factors were then calculated and the process repeated until after five rounds the predicted zonal totals were satisfied.

This series of iterations or complete re-calculations produced changes in the travel volumes of an unknown amount after the first approximation. The answers seemed logical and consistent but there was no proof of the uniqueness of the answers obtained. Consequently, tests of the results were made.

TESTING THE RESULTS

To test for reasonableness, it was possible to examine and compare the two travel patterns, for 1953 and for 1980.

Two factors are critical here: the mileage driven and the distribution of trips according to trip length. Both items were calculated for both 1953 and 1980 zone-to-zone transfers (Table 1).

These results show that a similar trip distribution was developed for both points in time. The only difference was a slight increase in the proportion of

TABLE 1

Arterial Street Distance, miles	Total Vehicle Trips				Total Vehicle Miles			
	1953	Percent	1980	Percent	1953	Percent	1980	Percent
0 - 2.9	2,170,881	47.3	3,460,131	45.2	3,395,573	14.7	6,007,498	14.8
3 - 5.9	1,080,766	23.6	1,932,461	25.1	4,664,989	20.2	8,270,704	20.4
6 - 8.9	573,798	12.5	952,169	12.4	4,233,076	18.4	7,001,333	17.4
9 - 11.9	336,651	7.4	561,181	7.4	3,487,114	15.1	5,819,806	14.4
12 - 14.9	172,710	3.8	302,992	4.0	2,307,286	10.0	4,057,440	10.0
15 - 17.9	103,971	2.3	194,781	2.5	1,704,306	7.4	3,196,789	7.9
18 - 20.9	56,432	1.2	106,354	1.4	1,095,206	4.7	2,063,696	5.1
21 -	84,867	1.9	156,914	2.1	2,163,037	9.4	4,041,159	10.0
Total	4,580,056	100.0	7,666,983	100.0	23,050,587	100.0	40,458,425	100.0

longer trips to be found in 1980. This occurred because more travelers would live in the outer suburbs where longer trips are necessary. These results can be further examined by comparing all travel to the central business district by length of journey for both time points (Table 2).

TABLE 2
VEHICULAR TRAVEL TO THE CENTRAL BUSINESS DISTRICT*

Airline Distance of Trip, Miles	Total Vehicular Trips		Trip Growth Ratio 1980/1953
	1953	1980	
0 - 0.9	25,260	24,099	.95
1 - 2.9	80,729	77,084	.95
3 - 5.9	69,036	67,972	.98
6 - 8.9	54,846	58,299	1.06
9 - 11.9	29,484	34,126	1.16
12 - 14.9	11,142	17,612	1.58
15 - 17.9	4,596	8,964	1.95
18 - 20.9	4,887	8,235	1.69
21 and over	4,327	5,909	1.37
Total	284,307	302,300	1.06

* 1953 actual and 1980 predicted

Short trips to the central business district declined although longer trips increased. This is the result of low growth rates at the center, high growth rates in the suburbs, and a universal tendency to travel to the central business district. Travel from close by points declined in volume because the opportunities for travel to other destinations increased more rapidly than did opportunities for travel to the central business district for travelers coming from nearby (and, therefore, low-growth) zones. This then would reduce the number of trips that would be made from these nearby zones to the central district.

It is difficult to believe that any interzonal transfer volume would decline, especially where trips at either terminal zone did not decline. However, no other solution is plausible.

From these tests comes the conviction that a reasonable future travel pattern was forecast. Such a pattern is the essential ingredient of sound planning. Knowing the detailed traffic movements, it was possible to make future traffic assignments to proposed new facilities in detail thus providing good tests of the soundness of plans.

SUMMARY

A detailed forecast of 1980 travel patterns was obtained for the Detroit region. These methods can certainly be improved. There remain problems which were assumed away, such as the effects of trends. In spite of these criticisms, it appears that quite a reasonable and consistent estimate was made. This was shown to be internally consistent. The results are summarized in the following list:

Population increase (1980) 48 percent
Car ownership (1980) 61 percent
Person trips (1980) 67 percent
Minimium vehicle miles which would be driven using arterial streets, 75 percent

The simple fact of metropolitan growth is thus shown to increase mileage by 75

percent when the population increase was but 48 percent.

This system can be used to keep the Detroit study up-to-date and can be improved as new techniques and new information become available. Its virtue lies in two features: the use of a logically consistent balancing system to derive future travel estimates and the attempt to begin with the causes of travel and from these build a consistent methodology.

REFERENCE

1. FRATAR, T. J., "Comprehensive Arterial Highway Plan for the Cleveland Metropolitan Area." HRB Bulletin 153, pp. 28-43 (1957).