

Development Patterns in American Cities

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●DURING the past year new techniques have been used to analyze growth characteristics of urban areas. These analyses were made in connection with several urban transportation studies in an effort to develop a sound basis for the land-use projection essential in traffic forecasting. The studies were made in Hartford, Conn., Baltimore, Md., Washington, D. C., and a group of Iowa cities including Des Moines, Stouxs City, Council Bluffs, Waterloo, Cedar Rapids, Dubuque, and Davenport.

Though these communities may not be truly representative of all American cities, the findings definitely have shown that some of the former concepts of urban development are rapidly changing, along with social, economic and technological changes, particularly as they relate to the rising standard of living.

The exact pattern of growth that materializes in a community is the result of many individual decisions—a manufacturer decides where to locate his next plant, a merchant decides which of his stores to expand, a government agency decides where to relocate, a family decides where to rent or buy a home. It is quite clear that the final choice in all such cases depends on the alternatives provided at the given time.

In making these decisions many factors are weighed. For example, a family will consider type, size and kind of house, the cost, financial arrangements, neighborhood amenities, distance to stores and schools, accessibility to jobs and adequacy of governmental service, as well as many other factors.

The studies undertaken in these cities attempted to measure the importance that people place on these and other factors in making their decisions. Though different individuals may weigh these factors differently, on a group basis the more significant factors can be defined and measured. From the analyses, it was possible to develop mathematical formulas to indicate how much weight people give to these various factors. Such formulas, when used to configure such a complicated process as urban growth, are usually referred to as models.

Models have other advantages in addition to serving as an analytical device to appraise past growth trends. They also can be used in estimating the potential impact of various public policies or decisions. Thus they can be used to predict the pattern of growth that will be brought about by different urban plans or highway programs, as well as the influence that various zoning plans might have on urban growth. Cities like Hartford, Washington, D. C., and Baltimore have been employing urban growth models to evaluate alternative schemes of land development, just as assignment procedures are used to test various freeway systems.

Models developed in connection with these studies generally fall into the gravity model class and are quite similar to those proposed by Hansen (1). However, in these studies it was apparent that there were many more urban growth factors that would have to be taken into account than had originally been considered in the Hansen model. Thus improvements achieved in the analyses stemmed largely from incorporation of additional variables into an effective model.

Usually four or five models were used to analyze various aspects of urban growth. For example, in the Hartford area separate models were developed to analyze manufacturing employment, service employment and retail employment, as well as population (2).

To establish past growth trends of manufacturing employment in the Hartford area, nine variables were used in the analysis. Some of the variables considered were highway accessibility, availability of industrial land, tax rate, sewer and water service, rail service, proximity of industrial land to freeways, proximity of industrial land to airports, size of existing industrial activities and promotional aspects.

With some of the variables such as highway accessibility, tax rate and proximity of airports, it was fairly easy to get a quantitative measurement. However, for such things as promotional aspects, subjective evaluations were necessary to develop a rating index.

The influence that these various variables had on urban growth was appraised by multiple correlation. In effect, a formula was developed by multiple correlation analysis which would give a growth index for a particular zone. This growth index, when compared with the sum of the indices for all the zones, reflects the amount of the growth that can be expected in a zone anticipating a certain amount of over-all growth. The formula is as follows:

$$GI = 12 A + 37L + 5TR + 34S + 2W + 12R + 5AF + 19TA + 1 P + 120$$

in which

GI = growth index—manufacturing employment.

A = highway accessibility to the labor force. This was developed on the basis of the following equation in which P is the population in a zone and T is the travel time between the employment area and the residential zone:

$$A_1 = \frac{P_1}{T_{1-1}^x} + \frac{P_2}{T_{1-2}^x} + \dots + \frac{P_n}{T_{1-n}^x}$$

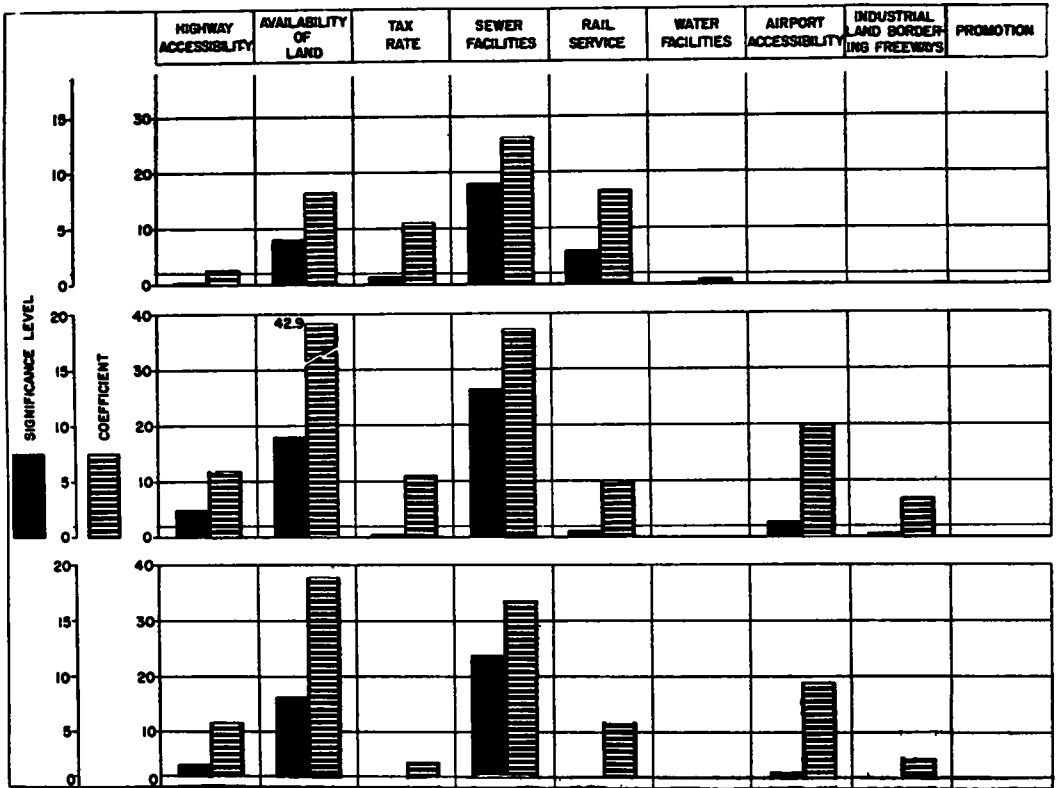


Figure 1. Multiple correlation analysis. (Source: Hartford Area Transportation Study, Connecticut State Highway Department)

- L = available industrial land in each zone.
 TR = tax rate.
 S = sewer service in the zone. This was related primarily to the capacity of the sewer system in the zone.
 W = water service. This was related primarily to the capacity of the system in the zone.
 R = rail service in the zone.
 AF = industrial land adjacent to freeways. Each zone was rated as to the amount of industrial land adjacent to freeways.
 TA = travel time to airport.
 P = promotional activities related to industrial development.

Figure 1 shows the results of the multiple correlation analyses. The cross checkbar represents the coefficient of each variable, whereas the solid bar represents the level of significance of each variable. The first row of "bars" depicts the analysis based on six variables; the second row shows the analysis based on eight, and the third row portrays the analysis based on nine variables. (To make it possible to compare the importance of the various factors, all the parameters were adjusted so that their values ranged between 0 and 50.)

This particular test seemed to indicate that the most important factors were available land and sewer service. Next in order of importance were accessibility to airport, highway access and rail service. The other factors seemed to be of relatively minor significance.

As might be expected, it was found that by adding more variables the results improved. Unfortunately, however, the formula that took into consideration all nine variables did not simulate urban growth perfectly. Therefore a continuing search is being made for other variables. The fact that the importance of some of these variables could be evaluated has been quite an advantage. This has made possible a comparison of the estimated urban growth (based on the results of applying the model with indicated variables) with the actual growth pattern.

The experiences gained the past year in these cities represents a wealth of information on the numerous factors that are influencing community growth. Certainly not all of the factors have been isolated, but these studies have revealed a lot of them. The exact interrelationship between the variables needs considerable further research. Some people are of the opinion that an urban growth model should be a linear programming model that insures optimization of all the influencing factors (3). Others feel that Monte Carlo methods might be applied (4). Still others think that these models should be expressed solely in economic terms (5).

However, at the present stage of development it is vital to know what variables in urban growth appear to be most significant, and what their general influence is. Such knowledge is essential to the formulation of sound urban growth models. It is with this thought in mind that the following summary is made of the basic findings derived from these ten cities.

Not all of the findings were quantified to the same degree that they were, for example, in the Hartford area. As an illustration, in the Cedar Rapids study a very simple procedure was used for analysis of urban growth: a model based on only two factors—availability of land and accessibility of each parcel of land (6). From this the theoretical growth that should have occurred in each region was determined and then compared with the actual growth.

In other words, a growth index was developed for each zone on the basis of available land and accessibility. This can be expressed by the following

$$GI = C \times A \times K$$

in which

- GI = growth index,
 C = capacity,
 A = accessibility index, and
 K = influence of various other factors affecting urban growth.

By comparing the actual growth with the theoretical growth and considering all the characteristics of each zone, it was possible to evaluate subjectively the importance of many of the factors that were involved in growth (Fig. 2).

POPULATION PATTERNS

When it came to reviewing population and residential growth trends, the studies recognized that if builders are to build for the low-cost homes market, they must search for cheap land. Doubtless, that is why it was found that low land costs are probably the most influential factors affecting urban growth. The analysis in these

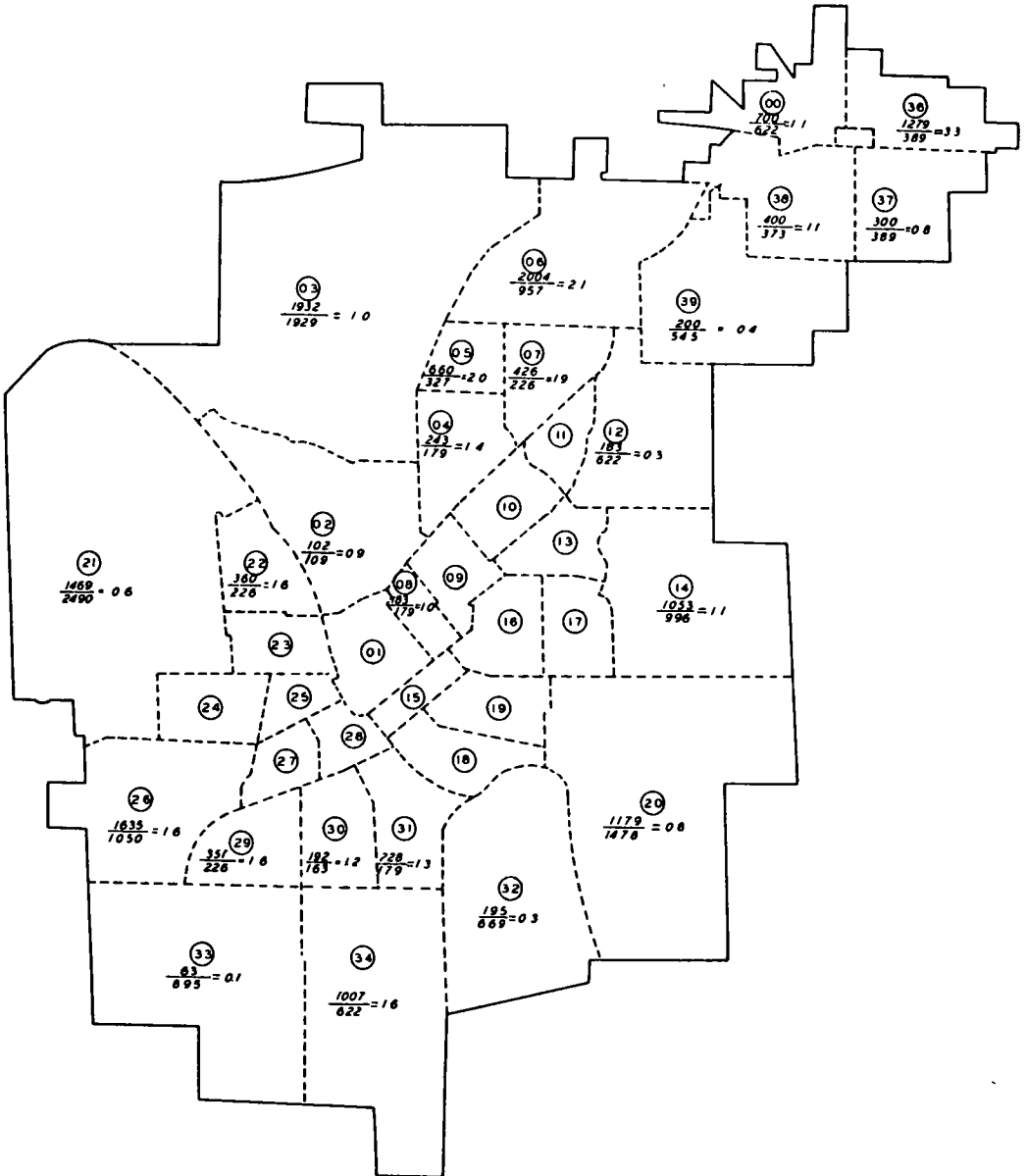


Figure 2. Transportation zones of Cedar Rapids-Marion urban areas with zone ratios of actual/calculated population growth. (Source: Iowa State Highway Commission)

cities reveals that other things being equal, an area with cheap land may develop up to three or four times as fast as it theoretically should, on the basis of accessibility and availability of land. Evansdale, Iowa, a small incorporated area outside of Waterloo, grew at this rapid rate during the last decade because of cheap land. But the pattern has changed abruptly since FHA withheld mortgages in the town because of sewer problems.

As people rise in the income scale, however, they tend to place more emphasis on the type of area in which the home is located. Is it an attractive neighborhood? Are the public services, such as schools and police protection adequate? Does the locality have any claim to distinction as a "prestige area"? Areas that meet these tests grow nearly twice as fast as those which do not. Notable examples of phenomenal growth of prestige areas are found in Montgomery County, northwest of Washington, D.C., and the Towson area, north of the City of Baltimore.

But as already indicated, there are many other elements involved in the rate of growth of a residential area. Lack of sewer or water service, for example, has held growth rates to about one-third of normal, everything else being equal. Otherwise attractive areas where land owners are deferring sale of property for tax advantages, or to make large capital gains, often have only one-half the growth that might be anticipated. A good example of this was Suffield, Connecticut, a town north of Hartford near the state line. This factor is much more prevalent than one might expect, particularly in the large metropolitan area.

Sections of a region near established communities have often grown several times as fast as outlying zones in which there were no established communities. Marion, Iowa, northeast of Cedar Rapids, is an illustration.

Nevertheless, one of the prime factors is the availability of land. The extent and intensity of its use, of course, depends on the zoning policy for the area.

These studies also have shown that, though accessibility of an area is an important consideration to a family, it gives a great deal of weight to the other factors that have been cited. This undoubtedly reflects the fact that most areas in a metropolitan area are served by highways. The difference in accessibility as between one place and another may be only a few minutes. Hence it is apparent that transportation facilities and services do not exert the dominant influence on urban growth, as they formerly did. The automobile has freed the family so that it can afford to weigh other factors in the selection of a home.

EMPLOYMENT PATTERNS

In considering the spatial distribution of employment, it was recognized that different types of activities place varying emphasis on locational factors. Therefore the various categories of employment were grouped by their locational requirements.

In Hartford, a pilot study was undertaken to determine the number of employment categories that should be used. From this work, it was decided to study at least three types of employment separately: manufacturing, which included S.I.C. (7) numbers 19 and 28-40; retail which included numbers 52-59, 72 and 75-89; and the "other" category, which included all the rest. Similar breakdowns were followed in the other studies.

Manufacturing

As in residential selection, the employer also has been freed by the automobile in his choice of plant location. He now knows that he can locate almost any place within an urban region and be assured of the necessary labor force. In short, accessibility to the labor force is not as important a factor to an industrialist or other employers today as it was in the past. More often the chief interest is in a specific site requirement such as water, sewer, freeway, port or rail service.

In the Baltimore area most of the largest manufacturing industries have gravitated to the corridor lying to the east and northeast of Baltimore City which has good rail and highway access as well as accessibility to water. This section seemed to best meet the requirements of industries locating in the area.

Only a few manufacturing activities are attracted to residential areas. Usually these are light industries looking for "prestige sites", as is true particularly in the area north of Baltimore where a number of smaller industrial plants have located. Over-all, however, five-sixths of the industrial expansion that occurred in the Baltimore region was influenced largely by site requirements. Only one-sixth of the expansion was influenced primarily by the residence of population.

The studies likewise revealed a definite tendency for existing large employment centers to draw new industrial activities to the general vicinity. Similarly, greater growth was evidenced where there were promotional programs for industrial land development.

Certainly the availability of rail, port and highway played a part in the location of some manufacturing plants. Areas with relatively low residential prestige often provided land to industrial developers at a price they could afford and, as a result, these areas had considerable growth. However, if the parcels of available land in such areas were too small the growth was retarded.

An interesting sidelight in these studies is that industrialists are more interested in the capacity of the sewer system than in the cost of connecting to it. On the other hand, home builders are more interested in the cost of sewer service. They really do not care whether there is adequate capacity; that is the home owner's problem.

Retail

Retail employment trends in the study cities quite apparently changed with the changing pattern of population. As the families shifted to the suburbs, the neighborhood retail trade has gone along. However, retail expansion generally follows the first wave of residential development. Retailers like to have an "insure" market before they move out. The exact location of the store will depend largely on accessibility factors.

About the only other factor that may influence this pattern is the regional shopping center. The present location and size of such centers have a marked impact on the location of new centers. Generally the new centers will locate within three or four miles of an existing center that has an adequate range of merchandise. But the pace of residential development probably will determine whether the old center is expanded or a new one developed.

Other Employment

Service activities, such as dry cleaning outlets, hairdressers, banks, etc., have followed a pattern similar to that of retail establishments. They have moved to the suburbs to be closer to the people and industries they serve. Certain types of activities, however, still find the downtown area very attractive. These are organizations that depend on accessibility to a large labor pool or specialize in certain lines. For example, in Baltimore the Commercial Industrial Trust located in the downtown area mainly because it needed a large pool of office workers. On the other hand, some of the more or less standardized office operations which do not require large labor forces will locate in the suburbs.

Governmental

In studying the location choice pattern for many governmental activities in the Washington area, it was clear that a strictly personal decision by the head of the agency was generally involved. However, different influencing factors were noted. First of all, accessibility to the labor force is rather important. Thirty percent of the governmental expansion between 1948 and 1957 occurred in the downtown area.

Certain governmental activities seem to concentrate in outlying suburban zones where other governmental activities have already been located. Nine zones in the suburban area received more than their share of the growth, on the basis of the analysis made in the study.

Besides increase in the number of Federal employees, there was an increase in employment by local governments. Most of this growth followed changes in population, because a large portion of it was aimed at serving the new population.

Broadly, the study has shown that a great many of the changes in employment patterns have followed population adjustments. Almost all retail and service employment has shifted with population. Many governmental and office activities have moved out to be closer to the people they serve. In effect, about two-thirds of the employment follows the migrating people.

The most important conclusion to be drawn from these studies is that transportation is not the key factor in shaping cities today. With the universal use of the automobile and the development of metropolitan area street systems, the urban dweller has been given almost unlimited latitude in where to live or locate his business. Because of this, he gives considerable attention to factors other than transportation in making a final decision.

At first glance, this conclusion seems to be at odds with other recent research. For example, the Bone and Wohl study (8) of the industrial expansion along Route 128 outside Boston has indicated that transportation was a very important factor in this growth. These results were based largely on attitudes expressed by industrialists who have located along this freeway.

However, a further look at the replies of these industrialists reveals that they also were giving a great deal of weight to other factors. A large number of them stated that the attractiveness of the area as well as its advertising value was important. Though many of them did say that "commercial access" was very important to them, the fact remains that they could have obtained practically the same commercial access if they located one or two miles away from the expressway. A few minutes of travel would not have made that much difference.

Certainly the fact that Cabot, Cabot and Forbes were promoting the area along Route 128 increased its growth potential. In fact, the area along the route was not developing until this firm was able to convince one industrialist to locate along the route. This single relocation brought with it the wave of development now evident. The fact that industrialists follow fads just as people do was observed in most of the cities studied.

This would also hold with regard to the accessibility to the labor force. Perhaps if over-all employment patterns in the Boston area were analyzed, the findings would be similar to those found in the ten cities.

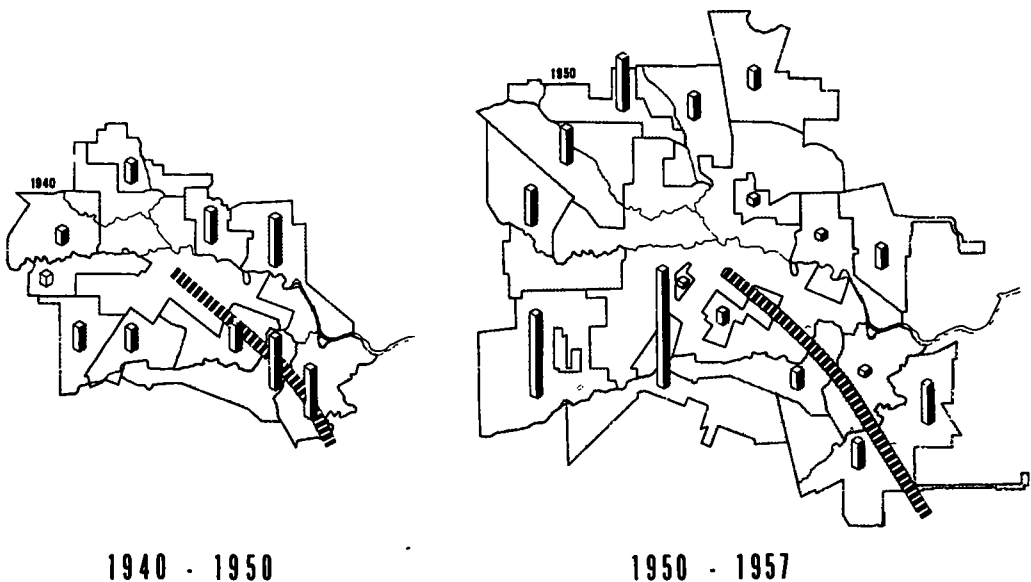


Figure 3. Houston population increases, 1940-1957. (Source: Houston Planning Commission)

Also often cited when discussing the influence of freeways on urban development, is the great expansion of residential development that occurred near the Gulf Freeway in the southeast section of Houston (9). It is true that when this facility was first opened there was a tremendous growth in its vicinity for a period of about five years (Fig. 3). However, recent growth trends in the Houston area have swung to the southwest portion of the city, which is generally considered the prestige area. What is more, a new freeway has been built which serves a rather run-down section of Houston. This has had no apparent influence on the growth patterns.

Such illustrations of the dynamics of urban growth show that all the factors related to expansion must be considered together. Any time a change in transportation facilities is introduced, it may modify the influence of the other factors. Greater accessibility, particularly at the beginning of a new development, if combined with other favorable factors, may stimulate a great deal of growth. But, as in Houston, the other factors like prestige may become dominant and changes in accessibility are not enough to modify growth patterns.

All of this tends to emphasize the basic point brought out at the beginning of this paper—namely, that urban growth depends not only on many individual decisions, but also on the alternatives offered at the time the decisions are made. If the expansion of large electronic activities in the Boston area had occurred before Route 128 was developed, these industries would have located in some other place. If Route 128 were being built today, it might not attract anywhere near the number of firms it attracted there, because the industries might not see the site advantages in the same light today as a few years ago.

The object lesson of these observations is that urban growth is sensitive to many factors that are modified by time.

In conclusion, these two points should be strongly emphasized:

1. It is obvious from the analysis of growth patterns in these ten American cities that the standard of living is becoming a major factor in development patterns. The individual, whether home owner or industrialist, is becoming more and more concerned with other factors besides transportation. This change must be recognized in urban plans.
2. The techniques used in these growth trend analyses, being admittedly in the pilot stage, are subject to improvement and refinement. However, they already have provided valuable new insights into urban growth which will be useful in planning for community facilities. Additional research in this field is sure to make an increasingly important contribution in the years ahead.

REFERENCES

1. Hansen, W. G., "How Accessibility Shapes Land Use." *Journal of the American Institute of Planners*, pp. 73-77 (May 1959).
2. Barnes, C. F., "Integrating Land Use and Traffic Forecasting." *HRB Bull.* 297 (1961).
3. Herbert, J. D. and Stevens, B., "A Model for the Distribution for Residential Activities in Urban Areas." To be published by Penn-Jersey Transportation Study.
4. Garrison, W. L., "Notes on the Simulation of Urban Growth and Development." *Univ. of Washington, Discussion Paper Number 34.*
5. Wingo, L., "Transportation and the Utilization of Urban Land." *Resources for the Future, Inc.*
6. Wiant, R. H., "A Simplified Method For Forecasting Urban Traffic." *HRB Bull.* 297 (1961).
7. "Standard Industrial Classification Manual." *Executive Office of the President, Bureau of the Budget (1957).*
8. Bone, A. J. and Wohl, M., "Massachusetts Route 128 Impact Study." *HRB Bull.* 227 (1959).
9. "Economic Evaluation of the Gulf Freeway." *City of Houston, Department of Traffic and Transportation (July 1949).*