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Puget Sound Regional Transportation Study

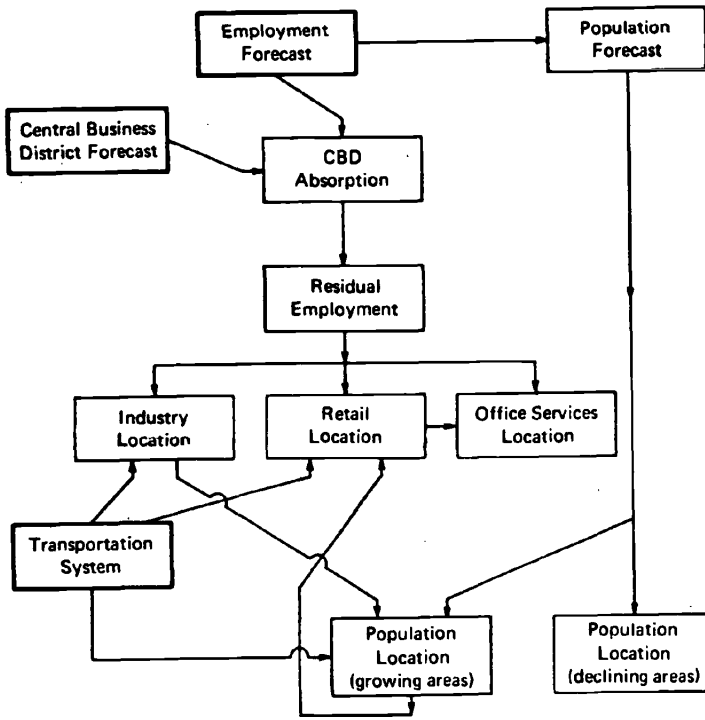
INTRODUCTION

A SCHEMATIC OVERVIEW of the procedure used in the Puget Sound study is shown in Figure 3. The sequence of operations is as follows:

1. Future aggregate levels of employment by industry and of population for the region are specified exogenously with the population forecasts disaggregated to the county level.
2. Regional population and employment forecasts are distributed to zones using a series of allocation models modified by a series of exogenous density constraints.
3. Further transportation requirements are computed for the forecast spatial distribution of households on the basis of their socioeconomic characteristics and the forecast distribution of jobs.
4. Increments to the highway system are then provided to satisfy projected travel demand.

The Puget Sound Regional Transportation Study evaluated two "alternative" land-use plans for 1990. Alternative land-use pattern A is a trend projection. In it a continuation of existing policies is assumed and, thus, a continuation of the changes in land-use characteristics during recent decades. Alternative plan B was chosen by the staff from five plans, each of which departed from existing trends in a different way. These five patterns could be achieved by appropriate zoning, open space, and transportation policies. They were (1) metrotowns—cities in the suburbs, each with a population of 100,000 to 300,000, linked with each other and with central cities by transportation facilities; (2)

Figure 3
Synthesized Flow Diagram for the
Puget Sound Area Land-Use Model



radial corridors—future development concentrated along principal transportation routes radiating from central cities, with the corridors of development separated from each other by wedges of green space; (3) linear corridors—development along the logical north-south transportation channels separated by belts of open space; (4) centralization —concentration of development in central cities, implying a maximum of commuting; (5) satellite towns—new development concentrated in planned suburban towns with populations of about 50,000. The radial corridors pattern was selected for testing as alternative plan B.

Future land-use patterns under plan B were to be achieved by modifying existing public policies. Thus, plan B projections are conditional on modifications in the transportation systems, changes in the zoning laws, and a vigorous program of acquiring open space designed to accomplish the radial pattern of development. In point of fact, the re-

sulting land-use patterns are only marginally different under the two plans (for reasons detailed below).

METHODOLOGY

Aggregate Projections of Employment and Population

A sixteen-sector input-output model (fifteen sectors of manufacturing and one residual) was constructed for the Puget Sound region by the A. D. Little Company. The final demand vector depends on projected national growth in demand for the region's exports and projections of regional consumption, investment, and government spending. This final demand vector is then used to derive projections of the output of each regional industry. The sum of these forecasts of output by industry is the total regional output.

Forecasts of civilian employment by industry are obtained from forecasts of output by industry using existing sales-employee ratios. Forecasts of the total civilian population are obtained by multiplying total civilian employment by the ratio of civilian population to civilian employment. Total population is obtained by adding estimates of the total military population of the region to forecast civilian population.

Population forecasts for each of the four counties comprising the study area are based on analyses of past trends, combined with ad hoc assumptions regarding the manner in which the region will develop. The two most important of these assumptions are the continuation of the trend toward concentration of population growth in the immediate periphery of existing primary urban centers, and the fact that a number of transportation projects already in progress affect the pattern of development in specified ways.

Employment Allocation Models

The techniques used to allocate industry employment for plans A and B are identical. They differ only in the distribution of industrial sites available. Available sites are defined in this model as vacant land zoned for industrial use and inactive industrial parks. The techniques used to allocate industrial employment were designed to allocate employment only in areas outside the Seattle-Tacoma central business districts (CBDs). Independent estimates of CBD employment were constructed for the study by Larry Smith and Company, a Seattle-based consulting firm with considerable experience in real estate market analysis.

Regional employment minus that of the Seattle and Tacoma CBDs, called the employment residual, was allocated to subzones as follows. First, those industries which, in the regional employment forecast, were not projected to grow were assumed to maintain their 1961 locations. Second, employment in those industries projected to decline was reduced proportionally at the base-year locations of the industries. Finally, a two-tiered procedure was used to allocate employment increments in those projected to expand. Existing firms were surveyed about their employment intentions, and the "intended" future increments to employment were allocated to the site locations of the firms. With these totals subtracted from the employment to be allocated outside the CBDs, a second-stage procedure was used to allocate remaining employment increments to subzones. This method involved matching the locational requirements of growing industries with available sites.

Both the new firms and prospective sites were scored in terms of their need or possession of the following characteristics, all defined qualitatively: freeway proximity, water transportation, railroad facilities, and access to the labor force. Available sites were divided further into two classes according to their desirability, and the overflow of firms from a given zone of better sites was then assigned to lesser location sites.

The methods used to allocate retail employment differed for plan A and plan B projections. Under both plans a separate analysis of the future growth of the retail sales in the area's two main shopping districts, the Seattle and Tacoma CBDs, was conducted by the research staff, using methodology designed by Larry Smith and Company. Among the factors considered in the forecasts of CBD retail sales were the presence of suburban growth and competition. Evaluation of these factors relied heavily on marketing forecasts of local firms, the trend in retail sales by location during the period 1958–61, and estimates of the amount of unused capacity in the CBDs. Working against the full utilization of the Tacoma district were the unfinished Seattle-Tacoma Freeway and a faltering downtown urban renewal project.

Retail goods were divided into convenience and comparison goods. Convenience-goods outlets were defined as food and drug stores, eating and drinking places, and gas stations. Comparison-goods outlets included all other retail establishments.

Comparison-goods employment under plan A was allocated first to the CBDs on the basis of the above considerations. The residual was allocated to suburban areas on the basis of judgment. By contrast, con-

venience-goods employees were allocated to zones outside of the CBDs using the following two-stage procedure: (1) Employees were first allocated to analysis zones which received a comparison-goods employment change of 1,000 or more, at the ratio (derived from 1961 data) of one convenience-goods employee to four comparison-goods employees; and (2) the remaining amount of district employment change was prorated to zones which did not receive employment in the first step.

Under plan B the basic assumption was made that comparison-goods retail employment follows population at the large-trade-area level. Existing towns in the plan B radial corridors were considered large trade areas. Total comparison-goods employment change for each town was distributed in proportion to the town's total population change. The employment allocated to each town, less the employment increment to the towns currently planned by retailers, was distributed to those analysis zones in the towns that already had an existing or planned comparison center. These increases in the towns' retail employment, under plan B, took place at the expense of suburban areas.

The shift of convenience-goods employment to the towns in plan B resulted solely from shifts in population. This employment was allocated to tracts within the towns by methods nearly identical to those described for plan A.

In allocating office service employment to zones outside the CBDs multiple regression analysis was used. This analysis related the level of office service employment to the level of retail employment, with about 85 per cent of the variation in office service employment explained. The actual allocation was performed using a two-step procedure: (1) Office employment was distributed to zones exhibiting an increased comparison-goods retail employment in centers of 1,000 or more, at the rate of one office employee to every four employees in retail comparison goods (a rate established from 1961 data); and (2) office service employment not yet allocated within the district was prorated to the other zones in the district, one-half according to their 1961 office employment and one-half according to their projected 1985 comparison-goods employment. This rule was developed by trial and error in an attempt to recognize the nucleating effect of present clusters of office activity.

Under plan B the projected office employment for the CBDs was broken down into categories. The locational requirements of each cate-

gory were then taken into consideration for determining the level of employment for allocation to each CBD. The residual was distributed to subareas on the basis of forecasts of retail trade by subarea.

Population Allocation Models

The spatial allocation of the population residing in large multifamily structures (more than twenty units), hotels, and motels was done on a judgmental basis. The spatial allocation of the population residing in single-family and small multifamily structures (less than twenty units) was obtained by using a series of multiple regression models. The multiple regression models recognized an important complexity of the urban land market—the asymmetrical behavior of older and newer parts of metropolitan areas. To allow for these differences, separate regression models were used in forecasting population change in growing and declining areas.

The forecasting model for growing areas had as its dependent variable the logarithm of the ratio of the actual to the "hypothetical" total population change for a particular zone or subarea. Hypothetical change is that which would result if residential land availability were the only determinant of relative population growth, and the increases in population were allocated in proportion to the amount of land available in the subareas. For example, if a study tract has 10 per cent of the available land in the area, then the hypothetical change would be 10 per cent of the total population change in the entire area. In this population growth model the significant explanatory variables were access to employment, income, and occupation; housing conditions; lot size permitted by zoning; and the size of the land parcel under single control. Employment accessibility was defined as

$$A_i = (S_1/T^x_{i-1}) + (S_2/T^x_{i-2}) + \ldots + (S_n/T^x_{i-n})$$

where A_i is an index of accessibility of zone i to employment in all other zones; S_n is the number of employees in zone n; T_{i-n} is the travel time, including terminal time, between zones i and n; and x is an exponent representing the tripmaker's resistance to distance. The exponent used in the accessibility calculations was 2, based on calibrations made in an earlier study for Washington, D.C.

For analysis zones inside areas that grew between 1950 and 1960, the following steps were taken to distribute future population: (1) Pro-

jected values for the independent variables were determined for each analysis zone. (2) These values were substituted into the equation to give, for each of the population growth zones, the logarithm of the ratio of actual to hypothetical growth. (3) The logarithms were transformed into their antilogs and multiplied by the capacity of the available residential land; this produced a growth index for each zone. (4) The control totals for the 1961 to 1985 population change by county were distributed to analysis zones by prorating them according to the size of the computed growth index. (5) The population distribution for each analysis zone was then checked to assure that it did not exceed the holding capacity of the zone; if the distribution did, in fact, exceed holding capacity, excess population was removed, the filled zones were removed from those available, and the fourth step was repeated.

Distribution between the two types of housing (single-family and small multifamily structures) was made holding the base-year proportions constant across the entire area, although variance among the counties was permitted.

The projection model for declining areas was also based on a multiple regression equation. In this instance the percentage decline in population within census tracts was the dependent variable. It was dependent on the occupations and incomes of the inhabitants and the condition of the housing stock. The independent variables were projected and substituted into the equation. The resulting forecast values were then adjusted judgmentally. The total population decline in these declining tracts is the sum of the forecast decline of individual zones.

The population distribution obtained for plan B differs in only minor respects from that in plan A. In making the plan B forecasts, the coefficients of lot size and land availability variables were both increased in the model for forecasting population change in growing areas. This affected the holding capacities of the areas and a shift took place to more land-intensive residences. The procedure was otherwise identical to that used in forecasting the spatial distribution of population for plan A. Both the forecasts of population and employment by zone were then converted to residential and industrial space requirements, using person-per-type-of-housing-space ratios or existing employee-space ratios.

With the exceptions of the space requirements for miscellaneous government, military, and domestic service employment, the above schema outlines the manner in which the land-use allocation was carried out.

OVERVIEW

The Puget Sound study deserves praise for its innovations in the development of land-use models. However, certain shortcomings are also discernible.

One shortcoming concerns the reasoning underlying the projected location of industry. The spatial distribution model for industry relies heavily on the premise that current locations represent equilibrium locations. This premise is incorporated into the assumption that firms located in the region during the base year will not move over the next twenty-five years. Casual observation argues against this assumption, especially in view of the systematic and numerically large movement of certain industries out of central cities. Another weak point is that changes in the transportation system were not incorporated into the industrial location decision.

There are some questions, also, about the procedure for allocating employment to the CBD. To some extent this occurred because the documentation of the methodology is very limited. For example, it is not clear whether the control totals for the CBD projections are consistent with the control totals used in the land-use model. Further, the procedure of determining CBD employment independent of the other parts of the model is somewhat dubious; for example, CBD retail employment is determined independent of residential location.

In terms of the distribution of population, the model does attempt to place shadow prices on locational costs by including characteristics of housing, such as lot size, housing condition, and size of land parcel under individual control. No allowance is made, however, for increased densities in sections of the study area. Because the dependent variable is the log of the ratio of actual to hypothetical population change in a zone, it is not possible for increases in population to occur in those zones in which there is no vacant land. This excludes the possibility of replacing low-density with higher-density dwellings, either through new construction or filtering. This problem is common to models of the housing market where demolition and filtering are neglected.