OFFICE SPACE DEMAND MODEL

INPUTS:
- Community Population
- Market Population
- Region Population
- Description of Characteristics
- Ranking of Characteristics
- Weights of Characteristics
- Space per Employee
- Other Constants

CALCULATIONS:
- Calculate Scores of Attractiveness
- Calculate Employment Share in Office Buildings
- Calculate Total Office Employment

OUTPUTS:
- Scores of Attractiveness
- Adjusted Scores
- Office Space Demand For:
  a) Local Market
  b) Middle Market
  c) Regional Market

EXHIBIT F
### DATA INPUTS

#### DEMAND SIDE
- Base year household size
- Base year population
- Distribution of household income
- Consumer expenditure factors

#### SUPPLY SIDE
- Location of existing and planned retail establishments
- Total footage of retail centers in market area
- Total footage of retail centers in new community

### OUTPUT

- Projected turnover rates for new community and market area facilities
- Expected capture rates for new community and market area facilities
- Projected purchasing potential

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**RETAIL DEMAND MODEL LOGIC FLOW**

**EXHIBIT G**
In this simplified formulation, the expected sales turnovers and capture rates for shoppers' goods are computed primarily as a function of competing net physical sales floor areas within the market area.

For convenience merchandise lines, the expected sales turnover and capture rates are estimated strictly as a function of comparative transit times to competing retail centers.

RESIDENTIAL SCORING MODEL

The Residential Scoring Model develops a residential attractiveness score based on five key sets of factors which substantially influence residential location preference and choice.

The elements of this Residential Scoring system are listed below:

Characteristics of the Location

1. Access to job (time, distance).
2. Availability of public transportation.
3. Distance from CBD.
4. Availability of major shopping facilities.
5. Access to metropolitan highway network.
6. Access to recreational and cultural amenities.

Characteristics of Community Planning and Development

1. Perceived Prestige of new community.
2. Quality of Schools.
3. Availability of suitable.
4. Perceived personal safety.
7. Property and other local taxes.
8. Special community wide facilities and services.
Characteristics of the Neighborhood

1. Walking distance to schools
2. Walking distance to parks and recreational facilities
3. Neighborhood appearance -- aesthetics
4. Neighborhood homogeneity
5. Proximity to neighborhood shopping facilities
6. Proximity to religious and cultural institutions.

Characteristics of the Housing (relative to other available housing options)

1. Size of unit
2. Interior and exterior design
3. Interior amenities and special features
4. Parking
5. Value
6. Privacy
7. Open space
8. Quality of construction

Characteristics of the Competition

1. Vacancy rate in for sale housing
2. Vacancy rate in rental housing
3. Number of housing units under construction
4. Quality of competing subdivisions

The scores are developed for each of three socio-economic groups -- low, average and high. The classification of households into socio-economic groups is accomplished on the basis of the education, income and occupation characteristics of the household.

MARKET STUDY APPROACHES

The advantages of computer-based techniques for economic and demand projection, such as NUCOMS, are obvious: (1) speed and reliability of computations, (2) great power of sensitivity analysis ("what if" scenarios), (3) data storage retrieval, and (4) incorporation into a model with an enormous number of variables and intricate interrelationships.
EXHIBIT H
RESIDENTIAL SCORING MODEL

Input Data
Family Composition Values

Compute Proportion of Households Represented by Each Family Type

Evaluation of Major Attributes of New Community

Evaluation Standards

Ranking of Each Attribute

Factor Values for Each Attribute

High Average
Low Socio-Econ Group
Scores for Each Characteristic for Each Family Type

Compute Weighted Scores for Each Socio-Economic Group

Option

Print-Out Option
Matrix of Factor Values
Relative Importance of Factors

Weighted Scores for Each Socio-Economic Group, Plus Optional Output
The general approach for projecting community demand (residential, retail, office, industrial and institutional) for new towns often utilized by economists, planners and market analysts is simpler. (Exhibit I delineates the general framework.) This section provides a delineation of some analytic techniques which have been utilized by analysts in practice.

The hierarchial approach is similar to NUCOMS; however, there are some fundamental differences. First, except for the retail demand analysis, community demand projections are generally directly linked to the regional projections. The assumption which is implied here is that the region as a whole serves as the market area for the new community; there is no attempt to disaggregate the region for analytic purposes. Generally there are two major components in the regional analysis; population projection and the employment growth projection. In most cases, the regional projections are usually available in state or local planning agencies; the analyst will often accept these with minor modifications. The community retail demand projections is based on "trade areas" identified by census boundaries with readily available population projections. Second, the components of the community demand are assumed not to be interrelated; i.e., growth in one component, such as industrial or office, does not directly affect residential demand and vice versa. Generally speaking, this is somewhat simplistic. (There are, however, cases which seem to support this assumption. Shenandoah New Town, in Georgia, has experienced large industrial land absorption without concomitant growth in residential growth). Third, in assessing the attractiveness of the various components of the community, objective "scoring" analysis is usually bypassed. In most cases, attractiveness, or community "capture" potential, is based on subjective assessment.
PROJECTION TECHNIQUE
SATELLITE NEW TOWNS

REGIONAL ECONOMIC MODEL

POPULATION GROWTH MODEL (REGIONAL)

POPULATION GROWTH MODEL (SECTOR)

RESIDENTIAL DEMAND MODEL

RETAIL DEMAND MODEL

OFFICE DEMAND MODEL

INDUSTRIAL DEMAND MODEL

COMMUNITY DEMAND MODEL

FINANCIAL MODEL

EXHIBIT I
The "subjective" component is perhaps the most important distinguishing element in market studies, vis-a-vis an automated computer based projection model such as NUCOMS. In market demand projection studies, the analyst's knowledge of the new town, its location, regional socio-economic structure, and the interrelationships of all the unquantifiable variables, is really the "bottom line" in providing accurate development projections.

It is also important to note that in community demand projection techniques, the focus is on the "demand side" of the equation; the developer affects the actual character of economic development in the new community, through the number, type, and price of residential, industrial, and commercial space. The analyst will generally make rational assumptions about the developer's behavior; (1) the developer will provide competitively priced and designed products; (2) the developer will provide an adequate supply of products in advance of demand; (3) planned community amenities will be provided; (4) sound overall management of the project will take place in the development of the community.

HOUSING DEMANDS

The estimate of housing demand in the community is extremely important in both physical planning and financial feasibility analysis of a new town. Unlike the NUCOMS model, the analyst will analyze the demand potential directly from the population growth projection of the market region, independent of other community components (industrial, office, retail, institutional). As noted above, this is a simplifying assumption.
A typical algorithm for projecting housing demand within the community is provided in Exhibit J. First, the regional market demand, \( d_1 \), is computed from household populations. (Households population is population exclusive of population in group and institutional housing; group housing population is generally not significant, except in areas where such groups as the military or a university may be significant in size). Regional household population at various time intervals, \( p_1 - G_i \), can then be translated to regional household levels, \( h_1 \), by dividing by the average household formation size, \( h_i \). The estimation of the average household formation at future time intervals is an extremely important variable: in the United States, a constantly decreasing trend has been experienced, and this trend is expected to continue. Due to this phenomena, market areas with even decreasing population trends have actually experience increasing new housing demand. This variable is also a "sensitive" variable which greatly affects demand projections with small variations. Nevertheless, estimates of household formation in a given region have been fairly successful. Upon computation of the shifts in the number of households, \( D_1 \), the regional housing demand is calculated by adding the estimated vacancy level, \( W_1 \), and the housing demolition level, \( V_1 \), anticipated in the future time periods. Vacancy and demolition level in the regional setting remain or shift in an relatively predictable manner. At this point, the analyst attempts to determine the "capture rate" of the community to the expected regional housing demand. Unlike the computation for regional housing demand, the determination of the capture rate, \( c_i \), is not rigorously determined. An examination is made of the present and historical market variables: competitive developments and their capture rate trends, urbanization paths, socio-economic shifts, etc. In addition, trend analyses of building
RESIDENTIAL DEMAND MODEL
Satellite New Towns

\[ T_i = c_i D_i \]
\[ D_i = (d_i + (V_i + W_i)) \]
\[ d_i = H_i - H_{i-1} \]
\[ H_i = \frac{(P_i - G_i)}{h_i} \]
\[ H_{i-1} = \frac{(P_{i-1} - G_{i-1})}{h_{i-1}} \]

and

\[ T_i = S_i + M_i \]
\[ S_i = s_i T_i \]
\[ M_i = m_i T_i \]
\[ s_i + m_i = 1 \]

\[ T_i = \text{Project housing demand at time } i. \quad (t=i). \]
\[ c_i = \text{Project capture rate of regional market at } t=i. \]
\[ D_i = \text{Regional market demand at } t=i. \]
\[ V_i = \text{Regional housing demolition level at } t=1. \]
\[ W_i = \text{Regional housing vacancy level at } t=1. \]
\[ d_i = \text{Regional increase of households from } t_{i-1} \text{ to } t_i. \]
\[ H_i = \text{Regional household level at } t=i. \]
\[ P_i = \text{Regional population at } t=i. \]
\[ G_i = \text{Regional group/institutional households at } t=i. \]
\[ h_i = \text{Average household formation size at } t=i. \]
\[ s_i = \text{Ownership housing ratio at } t=i. \]
\[ m_i = \text{Rental housing ratio at } t=i. \]
\[ S_i = \text{Project ownership housing demand at } t=i. \]
\[ M_i = \text{Project rental housing demand at } t=i. \]
## EXHIBIT K

### HOUSEHOLD TRENDS IN THE HOUSTON SMSA

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Population</th>
<th>Population in Group Quarters</th>
<th>Population in Households</th>
<th>Persons Per Household</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>1,430,394</td>
<td>20,275</td>
<td>1,410,119</td>
<td>3.37</td>
<td>418,650</td>
</tr>
<tr>
<td>1970</td>
<td>1,999,314</td>
<td>28,116</td>
<td>1,971,198</td>
<td>3.19</td>
<td>617,492</td>
</tr>
<tr>
<td>1975</td>
<td>2,444,000</td>
<td>34,000</td>
<td>2,410,000</td>
<td>3.10</td>
<td>777,400</td>
</tr>
<tr>
<td>1980</td>
<td>2,911,000</td>
<td>41,000</td>
<td>2,870,000</td>
<td>3.00</td>
<td>956,700</td>
</tr>
<tr>
<td>1985</td>
<td>3,245,000</td>
<td>45,000</td>
<td>3,200,000</td>
<td>2.90</td>
<td>1,103,400</td>
</tr>
<tr>
<td>1990</td>
<td>3,565,000</td>
<td>50,000</td>
<td>3,515,000</td>
<td>2.80</td>
<td>1,255,400</td>
</tr>
<tr>
<td>1995</td>
<td>3,957,000</td>
<td>55,000</td>
<td>3,902,000</td>
<td>2.70</td>
<td>1,445,200</td>
</tr>
<tr>
<td>2000</td>
<td>4,342,000</td>
<td>61,000</td>
<td>4,281,000</td>
<td>2.60</td>
<td>1,646,500</td>
</tr>
</tbody>
</table>
### EXHIBIT L

#### ESTIMATED HOUSING DEMAND IN THE HOUSTON SMSA

**1960-2000**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in Number of Households</td>
<td>198,842</td>
<td>159,900</td>
<td>179,300</td>
<td>146,700</td>
<td>152,000</td>
<td>189,800</td>
<td>201,300</td>
<td>869,100</td>
</tr>
<tr>
<td>Plus: Demolitions</td>
<td>12,000</td>
<td>6,000</td>
<td>6,000</td>
<td>6,000</td>
<td>6,000</td>
<td>6,000</td>
<td>6,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Plus: 5% Absolute Vacancy</td>
<td>10,500</td>
<td>8,300</td>
<td>9,300</td>
<td>7,600</td>
<td>7,900</td>
<td>9,800</td>
<td>10,400</td>
<td>45,000</td>
</tr>
<tr>
<td>Total Demand</td>
<td>221,342</td>
<td>174,200</td>
<td>194,600</td>
<td>160,300</td>
<td>165,900</td>
<td>205,600</td>
<td>217,700</td>
<td>944,100</td>
</tr>
<tr>
<td>Average Annual Demand</td>
<td>22,134</td>
<td>34,800</td>
<td>38,900</td>
<td>32,100</td>
<td>33,200</td>
<td>41,100</td>
<td>43,500</td>
<td>37,800</td>
</tr>
</tbody>
</table>
utilizing a functional area of service concept, e.g., local office market, sectoral or regional office market, or regional and headquarters market (regional, national or international). More directly, however, the office space demand is projected by analyzing the employment growth projections of the region. An examination of the office related employment categories (SIC, Standard Industrial Classification), such as Finance, Insurance, Real Estate, Medical and Professional Services, and Government, and their projections on a regional level are readily available from state and regional planning agencies.

A typical set of equations for the community office space demand is outlined in Exhibit M. The regional office space demand at any time interval (in sq. ft.), J₁, is determined by multiplying the projected growth in office related employment during time intervals i and i-1, Eᵱᵢ, to the factor representing the proportion of office related employment requiring new office space, rᵱᵢ; the results of these are then multiplied to the space per employee ratio (sq. ft/employee), qᵱᵢ. Both qᵱᵢ and rᵱᵢ are variables which are functions of time. The values of these variables can be assessed through a trend or a regression analysis. In the past, the values for these variables have shifted in a relatively predictable manner; the accuracy of these variables can be enhanced by analyzing the coefficients of each office-related SIC instead of utilizing an aggregated value. The results of the regional office space demand projections form the basis of the community demand projections. A capture rate, kᵱᵢ for each of future time interval is multiplied by the projected regional demand.
Similar to the capture rate of housing demand, and unlike the NUCOMS model, the capture rate for office demand is not generally determined quantitatively or through a scoring model. An extensive assessment of historical office space market variables is made; community locational advantages and disadvantages, socio-economic trends of location, community considerations (land costs, physical amenities, utilities, labor availability, prestige), competition, vacancy rates, office space stock condition, etc. All these variables, in conjunction with the analyst's intimate knowledge of the market, are utilized in determining the capture rates. The community's track record, if it exists, is obviously an important component of the overall analysis.

This approach assumes that residential, retail, and industrial growth in the community will not directly affect the office demand and vice versa. Moreover, it assumes that the types of office space demand in the community are represented by the office space type distribution in the region.

INDUSTRIAL SPACE DEMAND

Similar to the office space demand projection technique described above, market demand studies often assume that community industrial demand is directly linked to the regional market growth. Interrelationships between industrial growth and residential, office and retail growth are often bypassed. This simplifying assumption is far more serious for industrial demand than others. There are strong direct linkages between industrial growth and other components of the community; however, accurately establishing the linkages is extremely difficult and tenuous. Thus, analysts will often directly link industrial
space demand in the community with the industrial space demand in the region. Industrial demand in the region is a direct function of the growth of industry-related employment (categorized by SIC's), i.e., Construction, Transportation, Communication/Utilities, Wholesale Trade, Manufacturing and Business Services. This approach implies that the types of industry demand in the community are represented by the industry type distribution in the region; there are generally three types of industrial activity—production, storage and distribution, and research and development.

An Example of a computational routine for industrial space demand is outlined in Exhibit M. The regional industrial land demand at any time interval, \( N_i \), is calculated by multiplying the projected growth in industrial land related employment during time intervals \( i \) and \( i-1 \), \( F_i - F_{i-1} \), by a factor representing the proportion of industrial land related employment requiring new industrial land, \( p_i \). The results are divided by the employees per acre ratio (land absorption coefficients). The variables \( p_i \) and \( b_i \), both of which are functions of time, are usually analyzed through trend or regression analysis. The accuracy of these variables can be enhanced by analyzing the coefficients of each industry-related SIC category instead of utilizing aggregated values. Both of these variables shift, if at all, in a relatively predictable manner. After determining regional industrial space demand, capture rates for the community, \( l_i \), are multiplied by the regional demand to find the demand level in the community. Similar to the techniques in office and residential demand, the capture rate is determined through a non-rigorous methodology. A careful and thorough
OFFICE DEMAND MODEL

$O_i = k_i J_i$

$J_i = (e_i r_i q_i)$

$e_i = E_i - E_{i-1}$

$A_i = O_i / f_i$

$O_i$ = Project office space demand (sq.ft.) at $t=i$.  
k_i = Project capture rate of regional market at $t=i$.  
$J_i$ = Regional office space demand (sq.ft.) at $t=i$.  
$e_i$ = Regional office related employment growth at $t=i$ to $t=i-1$.  
$E_i$ = Regional office related employment at $t=i$.  
$r_i$ = Proportion of office related employment requiring new office space.  
$q_i$ = Space (sq.ft.) per employee ratio.  
$f_i$ = Space (sq.ft.) per acre ratio.  
$A_i$ = Project office land demand (acre) at $t=i$.  

INDUSTRIAL DEMAND MODEL

$I_i = l_i N_i$

$N_i = (u_i p_i) / b_i$

$u_i = F_i - F_{i-1}$

$I_i$ = Project industrial land demand at $t=i$.  
$l_i$ = Project capture rate of regional market at $t=i$.  
$N_i$ = Regional industrial land demand at $t=i$.  
$u_i$ = Regional industrial related employment growth at $t=i$ to $t=i-1$.  
$p_i$ = Proportion of industrial related employment requiring new industrial land.  
$b_i$ = Employees per acre ratio.  
$F_i$ = Regional industrial related employment at $t=i$.  

EXHIBIT M
assessment of industrial land market variables is made which includes locational advantages and disadvantages; labor costs and availability, accessibility, land costs and availability, utility costs and availability, public service costs, quality of environment, industrial land stock in the market, etc. Past performance of the community in its ability to attract industry is also carefully analyzed. All of these variables are incorporated in determining the capture rates for the community. An example of a “work sheet” which follows the above routine is shown in Exhibit N.

RETAIL SPACE DEMAND
The demand for retail space in the community can be categorized into different and distinct types: (1) convenience center (30,000 to 100,000 sq. ft. of GLA) which provide sales of convenience goods (food, drugs, and sundries) and specialty shops which provide personal services for day to day needs of an immediate neighborhood (5,000 to 40,000 population), (2) a community center (100,000 to 300,000 sq. ft. GLA) which is built around a junior department store or a variety store as the major tenant in addition to a supermarket (serving a population of 40,000 to 150,000), and (3) a regional center (300,000 to 1,000,000 sq. ft. GLA) which provides general merchandise, apparel, furniture, and home furnishings in full depth and variety (serving at least 150,000 population). Basic to the concept of retail demand projection techniques is the definition of the "trade" or "market" area. The analyst usually defines these areas along such convenient