# Attraction of Interstate Radial Freeway Corridors for New Office Sites

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The impact of Interstate radial freeway corridors on the location of new office developments in seven U.S. cities between 1970 and 1976 is discussed. Data indicate that in each of the seven cities greater growth of this type occurred outside the downtown core than in it. Growth of office sites compared with previous development ranged from 12 to 110 percent and averaged 24 percent in the core and ranged from 106 to 307 percent and averaged 207 percent in noncore areas. Growth expressed in gross square meters showed a similar pattern. Of the office development that took place from 1970 to 1976, the greatest proportion of new sites occurred in Interstate radial corridors (average of 34 percent). When gross square meters of new office development was analyzed, growth on Interstate radial freeways exceeded growth in all noncore transportation corridors but not in the core itself. An analysis of other factors theoretically associated with these patterns suggests that accessibility to the residences of white-collar workers, especially those who make decisions on office location, was most important. Other factors examined—including accessibility to the city core, metropolitan tax differentials, and the cost and availability of land—were found to be unrelated or much less significant.

Completion of the Interstate highway network in American metropolitan areas has opened a wide variety of locational options for urban land use. New office sites have been prominent among these developments. The purpose of this study is to compare Interstate radial freeway corridors with other locations in seven metropolitan areas to determine their relative attraction for new office sites in the period between 1970 and 1976. The seven metropolitan areas studied are Atlanta, Dallas, Denver, Louisville, Minneapolis-St. Paul, Omaha, and San Jose.

## DEFINITIONS

In this study, an office site is one in which the prime functions of the units that occupy it are the creation, storage, and dissemination of information on services performed, goods held or transferred, and personnel employed. A site may comprise a single office building, an office park of several buildings, or a complex of buildings built by the same developer in a limited time period. A service may be performed at the same location—e.g., physicians see patients and insurance agents sell policies—but rarely is the good for which the records are surrogates present at the office location. No steel ingots, for example, are found in the headquarters building of U.S. Steel.

The study includes office sites that are both renter-occupied and owner-occupied. It excludes all office sites that are wholly occupied by federal, state, and local government agencies whether these buildings are leased from the private sector or not because it is assumed that decisions on the location of government offices are usually made under a set of constraints different from those in the private sector. The study also excludes corporate headquarters located at the site of production facilities. Buildings with less than 2324 $m^2$ (25 000 $ft^2$) of gross floor area are excluded from the study. This allows the establishment of a manageable universe of sites within the metropolitan area of each city. It also permits the study to make maximum use of some existing public and private agency inventories that provide relevant data only on office sites in their cities that contain at least 2324 $m^2$ of gross floor area.

An Interstate radial is defined as a federally funded Interstate highway anchored at or near the central business district (CBD) of that metropolitan area. It extends outward from the CBD like a spoke of a wheel and, in most cases, intersects the Interstate circumferential highway. A non-Interstate radial has the same geographic pattern as the Interstate radial but is not necessarily a limited-access route. A radial corridor is defined as that area that lies within 1.6 km (1 mile) on either side of a radial highway and extends from the CBD to a point 6.4 km (4 miles) beyond the Interstate circumferential. A corridor 3.2 km (2 miles) wide is also developed along the Interstate circumferential in each metropolitan area. In some of the metropolitan areas, the circumferential is not composed entirely of Interstate routes. The short segments of state routes used to close the circumferential are in this study included as part of the Interstate circumferential.

Each of the metropolitan areas studied contains a cluster of downtown office sites that coincides roughly with the CBD. In no case, however, does this cluster extend linearly more than 2.2 km (1.4 miles), and in most it is less than 1.6 km (1 mile). Consequently, it is possible to enclose the downtown cluster in every metropolitan area in a circle whose radius is 1.1 km (0.7 mile). The CBD as defined in the Census of Retail Trade might be used as the base for some metropolitan areas, but in others it is not spatially coincident with the cluster of downtown office sites. In this study, the term "core" rather than CBD is used to designate the downtown office area.

The noncorridor area comprises all space inside a line 6.4 km (4 miles) from the Interstate circumferential, space that is not included in one of the types of spatial units described above. The number and types of the spatial units described above and the square kilometers they contain in each metropolitan area are given in Table 1. They also appear individually on the maps shown in Figures 1 through 7 (distance scales on these maps are given in U.S. customary units).

The period from 1970 to 1976 was selected for study because for most of the metropolitan areas it marks both the completion of the Interstate system and a sharp increase in development of office sites (Table 1).

## SELECTION OF METROPOLITAN AREAS

The 7 metropolitan areas studied were selected from among 60 standard metropolitan statistical areas (SMSAs) that met the following criteria: (a) a central city population of at least 100 000 but fewer than 1 million inhabitants, (b) a central city with at least one core-anchored Interstate radial that was toll-free and that contained at least three interchanges between the

**Table 1. Number and area of five types of development locations in the seven metropolitan areas studied.**

| | Atlanta | | Dallas | | Denver | | Louisville | | Minneapolis-St. Paul | | Omaha | | San Jose | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Number | Area ($km^2$) | Number | Area ($km^2$) | Number | Area ($km^2$) | Number | Area ($km^2$) | Number | Area ($km^2$) | Number | Area ($km^2$) | Number | Area ($km^2$) | Number | Area ($km^2$) |
| Interstate corridors | 5 | 311.8 | 4 | 255.1 | 4 | 228.7 | 2 | 100.0 | 5 | 288.8 | 1 | 47.9 | 2 | 62.4 | 23 | 1294.7 |
| Non-Interstate corridors | 4 | 207.2 | 4 | 225.3 | 3 | 138.6 | 2 | 98.4 | 5 | 293.7 | 1 | 49.5 | 4 | 162.4 | 23 | 1175.1 |
| Interstate circumferentials | 1 | 207.2 | 1 | 227.9 | 1 | 50.5 | 1 | 55.7 | 1 | 295.2 | 1 | 76.1 | 0 | 0 | 6 | 912.6 |
| Core and core extensions | 1 | 11.7 | 1 | 7.0 | 1 | 7.0 | 1 | 3.9 | 2 | 7.8 | 1 | 3.9 | 1 | 3.9 | 8 | 45.2 |
| Noncorridor areas | | 658.1 | | 805.0 | | 731.9 | | 133.1 | | 1031.1 | | 166.0 | | 171.5 | | 3696.7 |
| Total | | 1396.0 | | 1520.3 | | 1156.7 | | 391.1 | | 1916.6 | | 343.4 | | 400.2 | | 7124.3 |

Note: 1 $km^2$ = 0.386 $mile^2$.

**Figure 1. Office sites initiated in Atlanta metropolitan area between 1970 and 1976.**

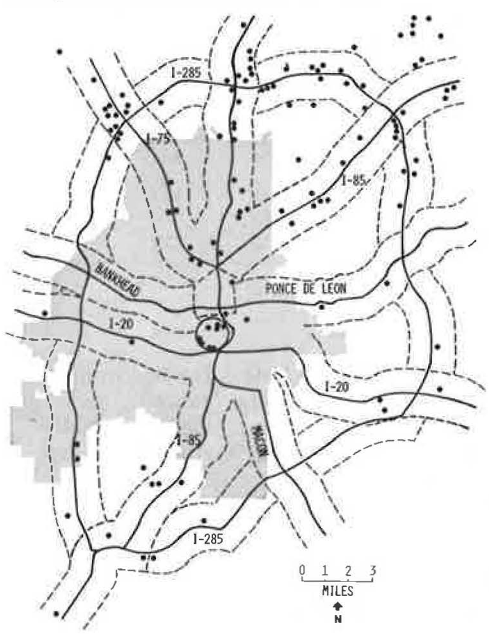



**Figure 2. Office sites initiated in Dallas metropolitan area between 1970 and 1976.**

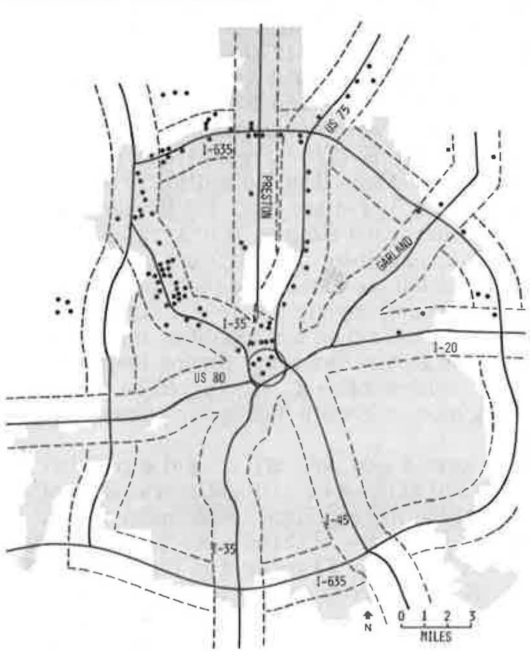



**Figure 3. Office sites initiated in Denver metropolitan area between 1970 and 1976.**

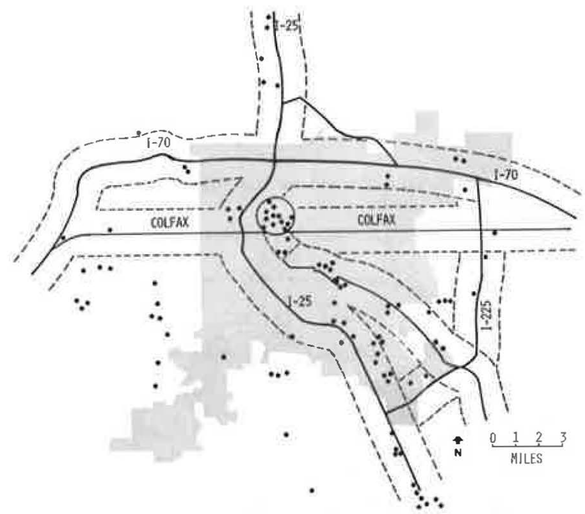
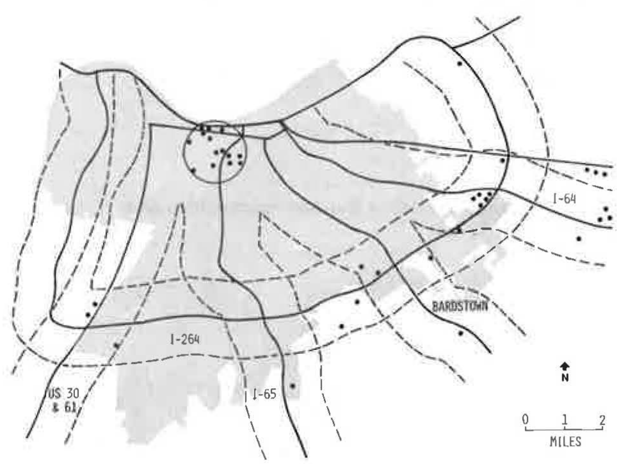



**Figure 4. Office sites initiated in Louisville metropolitan area between 1970 and 1976.**




core and the circumferential, and (c) the existence of a comprehensive and accurate inventory of office sites.

An attempt was made to provide as good a regional distribution as possible of metropolitan areas to be studied. Selecting them from diverse geographical areas allowed for the inclusion of metropolitan areas of different ages with different regional functions and ties. Their distribution represents most of the large regions of the United States: San Jose represents the

Figure 5. Office sites initiated in Minneapolis-St. Paul metropolitan area between 1970 and 1976.

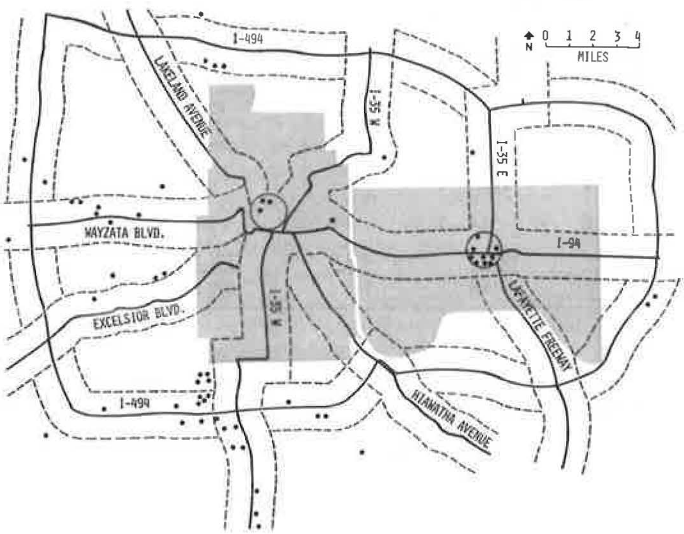



Figure 6. Office sites initiated in Omaha metropolitan area between 1970 and 1976.

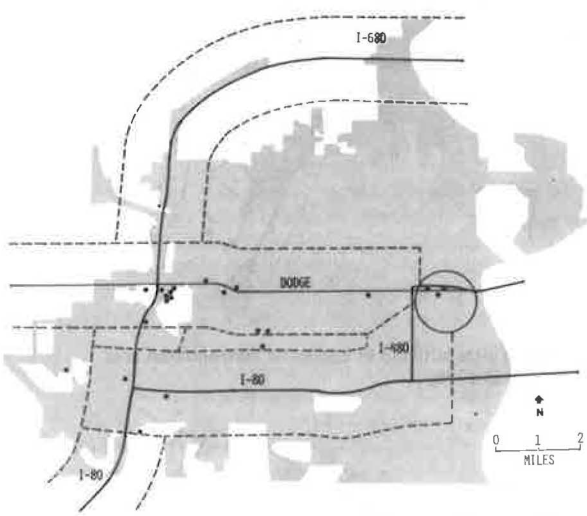



Figure 7. Office sites initiated in San Jose metropolitan area between 1970 and 1976.

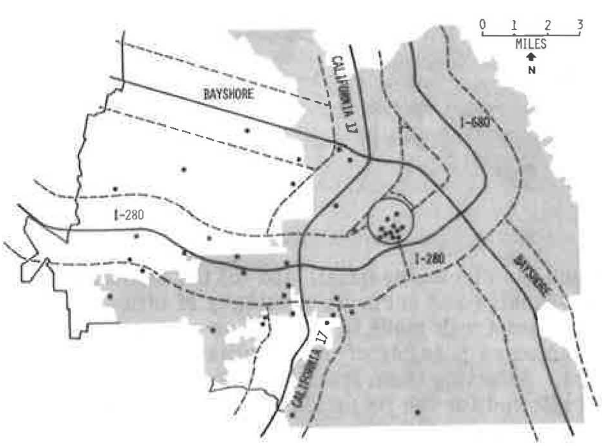



Table 2. Historical growth of office sites.

| Metropolitan Area | Number of Sites: Pre-1970 | 1970-1976 | 1976 Total | 1970-1976 Growth as Percentage of Pre-1970 Sites |
|---|---|---|---|---|
| Atlanta | 119 | 118 | 237 | 99.2 |
| Dallas | 120 | 102 | 222 | 85.0 |
| Denver | 68 | 98 | 166 | 144.1 |
| Louisville | 33 | 39 | 72 | 118.8 |
| Minneapolis-St. Paul | 120 | 60 | 180 | 50.0 |
| Omaha | 44 | 22 | 66 | 50.0 |
| San Jose | 24 | 41 | 65 | 170.8 |
| Total | 528 | 480 | 1008 | 90.9 |

Table 3. Historical growth of gross square meters of office development.

| Metropolitan Area | Gross Square Meters (000s): Pre-1970 | 1970-1976 | 1976 Total | 1970-1976 Growth as Percentage of Pre-1970 Gross Square Meters |
|---|---|---|---|---|
| Atlanta | 1791 | 1623 | 3 414 | 90.6 |
| Dallas | 1908 | 1611 | 3 519 | 84.4 |
| Denver | 541 | 1023 | 1 564 | 189.1 |
| Louisville | 269 | 409 | 677 | 152.1 |
| Minneapolis-St. Paul | 1674 | 721 | 2 395 | 43.1 |
| Omaha | 496 | 163 | 659 | 32.8 |
| San Jose | 139 | 265 | 404 | 189.9 |
| Total | 6818 | 5815 | 12 632 | 85.3 |

Note: 1 $m^2$ = 10.76 $ft^2$.

West Coast, Denver the West, Dallas the Southwest, Omaha and Minneapolis-St. Paul the Midwest, and Louisville and Atlanta the Southeast. Only the traditionally industrial and commercial Northeast—where most of the cities are old and well built up and there is little space for office site development between the core and the circumferential—is not represented.

## INCREASE AND CENTRIFUGAL MOVEMENT OF OFFICE SITES AND GROSS AREA

The 1976 pattern of office sites in the seven metropolitan areas is a product of 7 years of growth that might well be referred to as an office "boom" in some areas. The 480 sites developed during the 1970 to 1976 period represent a more than 90 percent increase over the number of sites developed before 1970 (pre-1970 sites include only those that were developed before 1970 and that were still in place in 1976) (Figures 1 through 7 and Tables 2 and 3). More than 5.8 million gross $m^2$ (62.5 million gross $ft^2$) of space were put in place in this period; this increased the pre-1970 area by 85 percent. By 1976, San Jose, Denver, and Louisville had more than doubled the number of their pre-1970 office sites, and Atlanta nearly did so. A similar pattern held across the seven metropolitan areas for increases in gross square meters. Among the seven, only Omaha and Minneapolis-St. Paul could be described as showing only modest growth during the period from 1970 to 1976.

This 7-year period saw not only a rapid expansion but also an outward shift—a centrifugal movement—of office sites in all the metropolitan areas under study. In the aggregate, the cores of these metropolitan areas showed a modest growth of 23 percent in the number of sites and 40 percent in gross square meters (Table 4). The noncore areas, on the other hand, experienced growth rates of over 200 percent in the number of sites

**Table 4. Growth in number and area of office sites in core and noncore areas between 1970 and 1976.**

| Metropolitan Area | Sites: Core Number | Sites: Core Increase (%) | Sites: Noncore Number | Sites: Noncore Increase (%) | Gross Square Meters: Core Number (000s) | Gross Square Meters: Core Increase (%) | Gross Square Meters: Noncore Number (000s) | Gross Square Meters: Noncore Increase (%) |
|---|---|---|---|---|---|---|---|---|
| Atlanta | 10 | 13.6 | 108 | 234.8 | 436 | 41.1 | 1188 | 162.4 |
| Dallas | 11 | 17.8 | 91 | 193.6 | 407 | 29.2 | 1204 | 233.6 |
| Denver | 15 | 36.5 | 83 | 307.4 | 335 | 84.6 | 689 | 472.0 |
| Louisville | 14 | 53.8 | 25 | 280.0 | 224 | 103.3 | 184 | 280.7 |
| Minneapolis-St. Paul | 12 | 14.3 | 48 | 133.3 | 262 | 23.9 | 459 | 79.3 |
| Omaha | 3 | 11.5 | 19 | 105.6 | 43 | 15.2 | 120 | 56.4 |
| San Jose | 11 | 110.0 | 30 | 214.3 | 94 | 150.0 | 170 | 222.5 |
| Total | 76 | 23.6 | 404 | 207.2 | 1801 | 40.0 | 4014 | 173.5 |

Note: $1\ m^2 = 10.76\ ft^2$.

**Table 5. Increase in number of office sites in each type of location as percentage of total growth in metropolitan area from 1970 to 1976.**

| Metropolitan Area | Interstate Radials Number | Interstate Radials Percent | Non-Interstate Radials Number | Non-Interstate Radials Percent | Circumferentials Number | Circumferentials Percent | Cores and Core Extensions Number | Cores and Core Extensions Percent | Noncorridor Areas Number | Noncorridor Areas Percent | Total Number |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | 47 | 39.8 | 23 | 19.5 | 25 | 21.2 | 10 | 8.5 | 13 | 11.0 | 118 |
| Dallas | 42 | 41.2 | 26 | 25.5 | 15 | 14.7 | 11 | 10.8 | 8 | 7.8 | 102 |
| Denver | 39 | 39.8 | 15 | 15.3 | 4 | 4.1 | 15 | 15.3 | 25 | 25.5 | 98 |
| Louisville | 12 | 30.8 | 7 | 17.9 | 3 | 7.7 | 14 | 35.9 | 3 | 7.7 | 39 |
| Minneapolis-St. Paul | 11 | 18.3 | 11 | 18.3 | 18 | 30.0 | 12 | 20.0 | 8 | 13.3 | 60 |
| Omaha | 3 | 13.6 | 14 | 63.6 | 0 | 0 | 3 | 13.6 | 2 | 9.2 | 22 |
| San Jose | 10 | 24.4 | 9 | 22.0 | - | - | 11 | 26.8 | 11 | 26.8 | 41 |
| Total | 164 | 34.2 | 105 | 21.9 | 65 | 13.5 | 76 | 15.8 | 70 | 14.6 | 480 |

**Table 6. Increase in gross square meters of office development in each type of location as percentage of total growth in metropolitan area from 1970 to 1976.**

| Metropolitan Area | Interstate Radials Gross Square Meters (000s) | Interstate Radials Percent | Non-Interstate Radials Gross Square Meters (000s) | Non-Interstate Radials Percent | Circumferentials Gross Square Meters (000s) | Circumferentials Percent | Cores and Core Extensions Gross Square Meters (000s) | Cores and Core Extensions Percent | Noncorridor Areas Gross Square Meters (000s) | Noncorridor Areas Percent | Total Gross Square Meters (000s) | Total Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | 455 | 28.1 | 223 | 13.7 | 411 | 25.3 | 436 | 26.9 | 98 | 6.0 | 1623 | 27.9 |
| Dallas | 504 | 31.3 | 482 | 29.9 | 154 | 9.6 | 407 | 25.3 | 63 | 3.9 | 1610 | 27.7 |
| Denver | 387 | 37.8 | 124 | 12.1 | 28 | 2.7 | 335 | 32.7 | 150 | 14.7 | 1024 | 17.6 |
| Louisville | 105 | 25.7 | 24 | 6.0 | 29 | 7.0 | 224 | 54.8 | 26 | 6.5 | 408 | 7.0 |
| Minneapolis-St. Paul | 97 | 13.4 | 95 | 13.3 | 178 | 24.6 | 262 | 36.3 | 90 | 12.4 | 722 | 12.4 |
| Omaha | 23 | 14.0 | 77 | 47.1 | 0 | 0 | 43 | 26.6 | 20 | 12.3 | 163 | 2.8 |
| San Jose | 69 | 26.1 | 54 | 20.4 | - | - | 94 | 35.6 | 47 | 17.9 | 264 | 4.6 |
| Total | 1640 | 28.2 | 1079 | 18.6 | 800 | 13.7 | 1801 | 31.0 | 494 | 8.5 | 5814 | 100.0 |

Note: $1\ m^2 = 10.76\ ft^2$.

and more than 170 percent in gross square meters. The difference in growth rate between number of sites and gross square meters results from the fact that noncore sites tend to be smaller than those in the cores. Two areas with strong and active urban redevelopment programs—San Jose and Louisville—both more than doubled their pre-1970 square meters of office development during the 1970 to 1976 period. Nevertheless, noncore growth even in these two areas exceeded 200 percent. In every metropolitan area, the number of sites in the noncore area more than doubled in the period. This is the single most important growth rate in the metropolitan area for, regardless of the square meters involved, these new sites represent an aggregate of individualized location decisions.

## CHANNELING OF CENTRIFUGAL MOVEMENT

Office site growth outside the cores was not, however, evenly distributed over the noncore areas. The largest proportion of growth in the seven metropolitan areas in the period from 1970 to 1976 occurred in Interstate radial freeway corridors (Table 5). In Atlanta, Dallas, Denver, and Louisville, Interstate radial corridors ranked first among all noncore spatial units in growth of office sites. In San Jose, the Interstate radials ranked second but the proportions of the metropolitan increase were unusually well distributed among the three noncore spatial units. This was not the situation in Omaha where the non-Interstate radial (Dodge Street) absorbed the bulk of the increase and the Interstate radial corridor was thus a distant second. Nor was it the case in Minneapolis-St. Paul where the Interstate circumferential ranked first in noncore growth and the Interstate radial corridors second.

On the basis of the increase in gross square meters, Interstate radial corridors in Atlanta, Dallas, Denver, and Louisville recapitulate the site rankings and lead all noncore spatial units in these metropolitan areas

(Table 6). The larger size of office sites in the San Jose Interstate radial corridors contributed to raising these spatial units to first ranking. Interstate radial corridors in Omaha and Minneapolis continued to lag behind the non-Interstate radial corridors and the Interstate circumferential respectively in their proportion of the total metropolitan growth in gross square meters in the 1970 to 1976 period.

ROLE OF ACCESSIBILITY FACTORS

The role of the Interstate freeway as a force that attracts office development to locate nearby can be traced through several variables usually found in industrial location theory. Primary among these is accessibility. The concept of accessibility, however, is most useful in explaining the impact of an Interstate freeway or any other link in the transportation network when it is differentiated rather than generalized into a single measure

At a minimum, the accessibility of a site can be viewed from several different levels. Macroaccessibility relates the office development site to other important activity nodes within the metropolitan area. These nodes should be differentiated. Accessibility to the CBD or core—the traditional center of office and government functions—must be considered. Accessibility of the site to potential employees (i.e., white-collar workers) should also be examined, especially since labor supply is a prominent variable in industrial location models. The realities of office location decision making also require an examination of the relation between the site selected and the residences of the decision makers and other executives. Accessibility to clients (or markets) is another standard factor in industrial location models. But it should be noted that offices are not an undifferentiated mass and that the location of clients may be of no concern to the purely administrative (or headquarters) office but of considerable importance to offices oriented toward a local market because of "sales" activities (e.g., real estate, law, and insurance) (1).

A second level of accessibility is mesoaccessibility, which refers to the relation between the office development site and the freeway. The speed and ease of entry to and exit from the freeway system can be an important factor. Development is much more likely at freeway intersections than between exits, and the data presented earlier in this paper indicate that office development is generally more likely to occur within 1.6 km (1 mile) of a freeway than farther away. An example of the effect of mesoaccessibility is the attractiveness of Interstate freeways for office development in Dallas, which is strongly influenced by the extensive use of frontage or service roads that parallel the freeway. A negative example may be cited in San Jose where an office building adjacent to the freeway but with limited access to freeway drivers because a nearby exit is provided only for eastbound traffic has had a high rate of vacancy for several years.

The third level of accessibility is microaccessibility, which refers to the ease of entry to and exit from the office development and includes such factors as the number and location of driveways and parking facilities. This factor is almost totally controllable by the developer of the site and is unrelated to the location of freeways or other major links in the transportation network. But it may be involved in the decision making of a potential renter or user of office space and therefore may contribute to the attractiveness of the specific development. This in turn may contribute to the broad pattern of office development location because the speed at which a development is occupied influences other investors and developers who may not adequately assess the reasons for success or failure.

Accessibility to White-Collar Workers

Accessibility to the residences of white-collar office workers is highly related to the attractiveness of a freeway corridor for office development. In general, office development occurs in the direction of the predominant concentration of white-collar workers. For instance, the largest concentrations of white-collar workers in the metropolitan Louisville area occur in the eastern portions near I-64E; this freeway is also marked by a large proportion of recent office development. Similarly, in the Dallas area, the white-collar population is concentrated north of the CBD and recent population trends suggest a continuation of this trend; not unexpectedly, therefore, all of the office development since 1970 has been north of, or inside, the CBD. The result is that I-35E north of the CBD exhibits large growth in this decade while the continuation of this freeway south of the CBD shows no attraction for new development (and relatively little development before 1970).

The pattern is repeated in San Jose where the highest white-collar accessibility occurs in the western portion of the study area served by I-280, which in turn is highly attractive to office developments. In contrast, the continuation of I-280 east of the CBD, designated as I-680, does not serve white-collar workers and does not have any large office developments. Atlanta's concentration of white-collar workers is north of the CBD as is most of its office development.

Accessibility to Executives

Even more important than accessibility for secretaries and clerks is accessibility for their bosses, who are the decision makers on office location. The importance of accessibility of office developments to the residences of location decision makers has been noted by analysts and practitioners alike. For instance, Quante (2, p. 104) has concluded that

> The most important consideration in headquarter relocation is usually an interest in reducing the commuting burden of senior executives. Indeed, this factor is so important that many headquarters choose locations close to the residences of top management.

Location theories stress the economic rationality of maximizing profit and minimizing costs and may exclude this factor as subjective and exogenous. But Quante argues that corporations that place a high value on the well-being of their senior executives are making a rational economic decision.

Manners (3, p. 96) has observed that

> The reasons for the growth of suburban office activities are not difficult to find. Above all else, it is the transportation convenience of suburban locations which has been the most influential with office managers and developers alike. A shorter journey to work for at least the key executives, the ability to use automobiles with free or low-cost parking at the office . . . are all decisive in the locational trend.

A Dallas leasing agent, expounding on an "intercept theory," explained, "This theory is nothing more than the idea that if you can put a building close to where the decision makers live, you will lease your space" (4, p. 31). Dallas provides some additional data to support this contention. Although northeast Dallas and neighboring Garland have some large concentrations of white-collar workers, corporate managers are more likely to live northwest of the CBD, and this is where new office development has been concentrated.

This factor becomes especially important for office location decisions because traditional industrial location theory, with its emphasis on labor, raw materials, and marketing costs, is not applicable to offices. Their "main products—decisions—are intangible, and most of their inputs are unquantifiable" (2, p. 4).

In summary, accessibility of office sites to white-collar workers, especially top executives, is an important factor in determining the location of recent office developments. The freeway, therefore, contributed to the suburbanization of office space by first contributing to the suburbanization of residences; once the executive lived in the suburbs and commuted to the CBD, he or she began to think of suburbanizing the place of work as well.

### Accessibility to the Core

The traditional site for office buildings and government centers and auxiliary services has been the CBD or core of a city. This has been declining in recent years for a number of reasons. Certainly, one of these reasons is that developments away from the core may still enjoy excellent access to it because of improvements in the transportation network. The completion (or near completion) of the freeway system, with radials that extend from the core and link into a circumferential freeway, has given outlying areas excellent access to the business and cultural attractions that remain in the core. The decline of the core can also be traced to the physical decline of the area and the physical and social decline of surrounding neighborhoods. Another factor that contributes to the relative decline of the core as a site for offices has been an improvement of the communications system that has resulted in a decreased need for face-to-face communication. In addition, the increasing size and complexity of modern businesses have resulted in corporations increasingly relying on their own staffs for financial, legal, and other services rather than purchasing them from nearby firms.

More firms therefore find that they do not need the amenities of the city core and so are willing to move farther from it. In fact, in Dallas in 1974 a concentric zone 6.4 to 8 km (4 to 5 miles) from the core contained 13 percent of the office buildings and 12 percent of the gross floor area, but the zone only 1.6 to 3.2 km (1 to 2 miles) from the core had only 7 percent of the buildings and 3 percent of the office space. A zone still farther from the CBD [8 to 16 km (5 to 10 miles) from the center] contained more than one-fourth (28 percent) of all office buildings and almost one-fifth (19 percent) of the gross floor area in Dallas County (5).

In Louisville, no office site on the I-64 radial is closer than 11.3 km (7 miles) to the core, and there is only one office development between the core and the core side of the 3.2-km (2-mile) circumferential freeway corridor. Office developments 16 km (10 miles) east of this core but near the radial freeway have been successful, and local developers expect still more development 4.8 km (3 miles) farther out when a new outer circumferential freeway intersects with the radial.

Similarly, in Minneapolis-St. Paul the nearest new office developments not in the cores are 13 km (8 miles) out, and I-94, which links the two cores, has not had any office development during the 1970s. The next office boom is expected to occur 26 km (16 miles) south of the Minneapolis core where I-35E and I-35W will merge.

The circumferential freeways—or, more accurately, portions of them—are often more attractive to new office developments than the radials that extend into the core (the heaviest concentration usually occurs near the intersections of a radial freeway and the circumferential freeway).

In summary, distance from the core is of virtually no importance in the location of office development. Access to the core, however, is still important; office developers and rental agents still boast "only minutes from downtown" by the freeway. But the additional 5 to 10 min spent as a result of a location farther away is easily tolerated, especially as these trips to the core become rarer.

## COSTS

The second broad category of variables that is potentially useful in explaining the location patterns of office development is dollar costs, some of which are translatable from the accessibility measures just noted. Several types of costs are theoretically relevant for the office-location decision maker. For the developer, the price of land and construction may be crucial, and these costs are in turn passed on to the user of the office space. Taxes are another cost factor frequently relied on as an explanation for differentials in the rate of economic growth. Labor cost is the final theoretical cost category; its usefulness in explaining intrametropolitan location decisions is quite limited, however, since wage rates do not vary appreciably within a metropolitan labor market.

### Tax Differentials

Theoretically, any cost differential should act as a factor that attracts development to the less expensive site. Some business people point to higher tax rates to explain why they leave one area for another. But these tax differentials are generally relatively small. For instance, in Dallas a \$1 000 000 office building would pay \$10 463 in real property taxes to the city; in University Park, an enclave surrounded by Dallas, the same building would pay \$5720 in city real property taxes. This \$4743 difference may seem large but, when it is proportioned over the typical size for a \$1 000 000 building, the difference is approximately \$1.08/m$^2$ (\$0.10/ft$^2$) of floor area per year. This is less than the \$0.50 variation in cleaning service costs experienced by various managers of office buildings in the Dallas area [according to data supplied by the Dallas Association of Building Owners and Managers in September 1976, the variation in cleaning service costs was more than \$5.38/m$^2$ (\$0.50/ft$^2$) even when the most extreme rate at each end of the cost range was ignored]. This differential is only a small proportion of the average annual rental rate of \$69.06/m$^2$ (\$6.42/ft$^2$) and an even smaller proportion of the total costs of operating an office when labor costs, which can be as high as \$430 to \$645/year/m$^2$ (\$40 to \$60/year/ft$^2$) and represent approximately 85 percent of total expenses (3, p. 98), are included.

Not only is the difference in tax rate between cities usually small but it may also be less significant than intercity variations in assessment practice. [Although tax differentials are usually relatively small, two of the metropolitan areas studied in this report (Minneapolis-St. Paul and Atlanta) had tax rates two to three times higher in the central city than in some of the outlying suburbs. Developers in Minneapolis-St. Paul were especially strong in their claims that higher taxes in the two central cities were an important factor in the suburbanization of office space in that metropolitan area despite the provision of the Metropolitan Development Act of 1971, which redistributes a small portion of commercial property taxes to all cities in the metropolitan area.] A Denver developer added that differences in the "sophistication" of cities in the development process may be more important; a city such as Denver may be better prepared than some of the satellite communities to aid a developer by cutting time delays in granting permits and thus reducing the developer's front-end costs.

It should also be noted in any evaluation of the impact of tax (or other cost) differentials on office development patterns that office occupancy rates are more sensitive to quality considerations than to cost considerations (3, p. 98). Buildings with low rental rates are often those with high vacancy rates because the building is not considered prime space.

Price of Land

The relation of the price of land to its attractiveness for office development is not a simple one. At a minimum, as the land becomes more attractive (e.g., its accessibility is improved through improvements to the transportation network), its price increases.

The price of land may not be a critical factor in development because the higher price of a land parcel can be compensated for through more intensive development. Thus, the core in the study cities where land costs are as high as \$269 to \$807/$m^2$ (\$25 to \$75/$ft^2$) is still a viable site for office development if high-rise development is substituted for garden-type development.

But the lower price for land farther away from the core enables the development of larger parcels that can provide ample space for free parking. This is an important inducement for firms currently located in the CBD. One observer sees it as the equivalent of a \$30/month salary increase (4, pp. 31-32).

The use of larger parcels of land also permits the use of garden development or low-rise construction, which is cheaper. Cheaper land and cheaper construction combine to contribute to cheaper office space than can be found in comparably aged buildings in the core.

In summary, if all other factors are equal, cheaper land will attract office development. But all other factors are rarely equal. Therefore, one must conclude that, within limits, the price of land is not a determinant of where offices are developed.

Availability of Land

Another variable that may be considered a necessary condition before development can occur is a supply of available land. An analysis of the impact of freeways on the location of office development should examine this variable.

Freeways play an important role in making land available for development by providing access to it for potential users in the metropolitan area. An analysis of the location patterns of new office development must consider the role of available land in shaping those patterns. It is possible, for instance, for one freeway to pass through vacant land that, when combined with improved accessibility, attracts new development to the area while another freeway is routed through an already-developed area that may serve to inhibit new development despite the added accessibility. This is one explanation offered for the extensive office development along I-35W and the southwestern portion of I-494 in Minneapolis and the virtual lack of new development along I-94 linking Minneapolis and St. Paul.

An examination of vacant land in the seven cities studied leads to the conclusion that available land may be a necessary condition but is not sufficient to attract development. For example, there are large tracts of vacant land along the southern terminus of I-35 in Dallas, and yet the new development is along the portion of I-35 north of the CBD (Stemmons Freeway). Similarly, there is more vacant land near the southern leg of the I-635 circumferential than near its northern leg, and yet the latter is considered the "hot" area for development in the Dallas metropolitan area.

But even the conclusion that available land is a necessary condition for office development must be tempered by raising the question of what constitutes available land. The concept cannot be limited to vacant lots or larger parcels because much of the new development in suburban areas occurs on land converted from agricultural use (e.g., much of the office development in San Jose is in former fruit orchards). If land is devoted to another land use—whether it be agricultural, residential, or commercial—it may still be considered available for office development if the cost of purchasing and clearing it is no higher than the price of vacant land elsewhere and if zoning and other land-use restrictions permit it.

The availability of land is therefore a function of price and zoning and not of current land use. This is not to say that adjacent land use is unimportant. The lack of development along much of I-80 in Omaha is attributable to the attraction of industrial and warehousing land uses to this area because of the Union Pacific railroad tracks that are adjacent to and parallel with the freeway. Similarly, the pattern of office development locations shown in Figures 1 through 7 indicates some agglomeration of similar units since it is rare for an office site to be isolated from other office developments. The availability of land may also be a function of the size of the parcel; outlying land is more likely to be available in large parcels whereas already-developed land may be divided into smaller parcels spread over broader ownership, which makes the aggregation of a sufficiently large land package a difficult process.

It should be noted that the importance of zoning and other land-use restrictions (e.g., building height or setbacks) will vary with the ease with which they may be amended in any city. Increased concern for the environment and increased citizen participation have made variances more difficult to acquire, especially if residential land is affected.

## CONCLUSIONS

The data for the seven cities studied indicated that greater growth of office developments occurred outside the downtown core than in it. The greatest proportion of office sites developed in the 1970 to 1976 period occurred in Interstate radial corridors. Among the most significant factors that influenced the pattern of new office sites was the accessibility of the office location to residences of white-collar workers, especially those of the decision makers who determine office location. Other factors—distance to the downtown core, metropolitan tax differentials, and availability and price of land—were much less significant.

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# Neighborhood Quality-of-Life Indicator Model for Highway Impact Assessment

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**Research was undertaken to evaluate and test the relevance and usefulness of a quality-of-life indicator model for evaluating the effect of highway construction on a neighborhood. The model was tested by using data collected for six study areas (and for approximately the same number of control areas) in each of four selected metropolitan areas (Indianapolis, Kansas City, Omaha, and St. Louis) between 1960 and 1970. The quality-of-life production model, which essentially consists of two production functions that express the changes in the quality of life of study and control areas respectively in response to the changes in the component indicators as a result of highway construction and other exogenous changes, did reveal promising results from field survey data. Neighborhood quality of life was about 3 to 6 percent better in the study areas with highway construction than in the control areas without highway construction. The changes or improvements resulting from highway construction are statistically significant and are different from zero.**

Interest in the problems of evaluating impacts on urban neighborhoods of transportation development in general and highway construction in particular has been growing considerably. Recently, as pointed out by Wachs (1), the issues related to the impact of transportation systems have become more compelling than issues related simply to the balance between supply of and demand for transportation services. Americans are becoming more concerned about so-called "concomitant outputs," such as the tangible and intangible effects of the system on society and the environment (e.g., air pollution, noise, land use, urban sprawl, community life-style, and neighborhood cohesion), than about "performance outputs," such as changes in travel times, volume, costs, and other objectives of the transportation system.

How can the relations between the amount and distribution of travel and the social, economic, political, and environmental impacts of transportation facilities and systems be identified, measured, and evaluated? What specific changes can be recommended so that the performance outputs can be maximized and the adverse concomitant outputs minimized? What research is needed that would contribute to efficient and optimal decisions regarding the provision of transportation facilities and services in both the short and long run in urban and rural areas? Answers to these questions are of critical importance because any intelligent transportation decision requires not only a comprehensive plan with detailed construction engineering and architectural design but also a variety of assessments of the potential impacts of the transportation project on socioeconomic, environmental, and ecological receptors.

In 1962, Congress passed legislation that requires that all future freeways constructed in urban areas be based on "comprehensive planning for the entire metropolitan area." Such plans were to include consideration of the total transportation needs of the area and were to be based on anticipated long-range land-use plans for the region. Thus, concerns other than just transportation issues were introduced into the decision-making process (2). For example, one additional question regarding freeway construction that has been raised is whether the benefits derived from the particular freeway are greater than the costs—direct or indirect, tangible or intangible, social or private—associated with the construction of that freeway.

Generally, the demand for highway construction is based on the need for upgrading transportation services, which are actually joint products that combine safety, capacity, accessibility, and quality of service. The most immediate and direct effects of the construction are the most measurable, and probably the most predictable, changes brought about by the investment in road building. These are called direct or first-order impacts and are characterized as changes in input, performance outputs, and concomitant outputs.

The indirect or second-order impacts arise when the direct impacts are viewed in concert with the environment within which they take place. For instance, as a consequence of highway construction, people adjust their travel habits and activity patterns to benefit from the performance outputs of the newly constructed highway. Mobility may be improved and travel time decreased. Land and property values may increase because of proximity and better access to the highway or may decrease because of a high level of pollution, noise, and community disturbance.

Tertiary or third-order impacts are further repercussions entirely within the physical and institutional environments of the constructed highway that result