# The Nature of Urban Freeway Systems

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●THE OBJECTIVE here is to present information concerning emerging freeway systems in urban areas. At the outset it must be realized that it is hazardous to present data on such a rapidly changing subject. Plans are always subject to alteration, and changes will invariably occur between the times of gathering and the time of presentation of the data. Futhermore, few comprehensive urban freeway networks have been conceived. There is a great variation in the degree of progress in urban highway planning and development from one city to another. Also, no specifics have been established as to the total transportation plant necessary to best serve a city, including freeways, expressways, arterial streets, and transit facilities, and it is unlikely that they will be developed soon.

In order to determine the spatial characteristics and development progress of freeway systems, all of the highway agencies in states with standard metropolitan areas (U.S. Census Definition) were contacted by mail. Information regarding both present and planned freeways was requested. From the returns of this inquiry specific information and special reports were gathered.[1] In addition, 12 cities in various stages of freeway planning were visited. Finally, the highway and urban planning literature was examined for additional information on the conceptual framework underlying urban highway networks.

The terminology of this analysis follows the definitions officially adopted by the American Association of State Highway Officials.[2] Briefly, an expressway is "a divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections." A freeway is "an expressway with full control of access." A radial highway (or radial) is "an arterial highway leading to or from an urban center" (the CBD), and a circumferential (or belt highway) is an "arterial highway for carrying traffic partially or entirely around an urban area or portion thereof." The circumferential, which generally surrounds the CBD core is termed the "inner-distributor loop."

## PATTERNS OF URBAN HIGHWAY SYSTEMS

### General Pattern of the Interstate System

The general purpose of the National System of Interstate Highways (the "Interstate System") is to connect the major metropolitan areas of the United States by a system of freeways (Fig. 1). These freewyas are essentially oriented to intercity highway movement (29), but there can be little doubt that the backbone of most intracity urban highway networks will be the urban segments of the 41,000-mile Interstate System. These urban segments of the Interstate System include at least 1, and as many as 5 or 6, radial freeways to the CBD of most standard metropolitan areas. Interior cities like Indianapolis, Nashville, and Dallas are at the focus of 6 radial segments, whereas cities on the perimeter of the system such as Miami, Charleston, and Duluth have usually only 1 Interstate radial route. These radial freeways are merely replacing older radial arterial routes which have become obsolete because of their lack of access control and outmoded design standards.

[1]Returns were received from the following states: Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, and Utah.
[2]Letter from B.M. French, Regional Engineer, U.S. Bureau of Public Roads, Portland, Oregon, November 18, 1958.


Figure 1. National System of Interstate Highways, 1957.

In addition to the radial freeways, the Interstate System will provide many of the medium-to-large cities with outer bypass circumferential routes. These routes, connecting radials at their outer extremities, provide for the increasing traffic demand between outlying portions of the metropolitan areas occasioned by decentralization, and also allow bypass of the city center.

The Interstate System will also provide an inner-distributor loop, or some portion thereof, in about 20 cities. This loop is one of the major improvements in the central distribution of traffic. Obviously, freeways carrying several thousand automobiles an hour cannot intersect at a point. In the pre-industrial city planned radial routes came together at a plaza, in an open central square, or at a monumental circle. This philosophy of route conjunction characterized the planning of the main roads of the Nation's Capital, Detroit, Madison, and part of Central Philadelphia, to mention only a few cities.

Urban freeway systems, as defined by Interstate routes, are shown graphically, and to the same scale, for 16 cities in Figures 2 and 3. These cities were chosen because the system of radials, circumferentials, and inner-distributor loops will be especially well developed by Interstate routes in these urban areas. With the exception of Cleveland and small sectors of Houston and Dallas, all cities shown have complete outer circumferential routes. Those in Detroit and Chicago can only be semi-circumferential, of course, because of natural barriers. Wherever the circumferential routes deviate significantly from the general circular pattern it is usually because of land acquisition problems caused by rectilinear land platting, as in Detroit, or serious topographical difficulties, as in Cleveland. Columbus, Boston, Detroit, Cleveland, and Los Angeles will have complete inner-distributor loops as parts of the Interstate System. Kansas City, Houston, and Washington, D. C., will have partial loops, while most of the other cities will have only intersecting radial routes near the central business district.

The Interstate System configuration in most urban areas will determine the general structure of the urban freeway network, but the degree to which these systems will accomodate intracity highway traffic needs is a matter of conjecture. As part of the In-

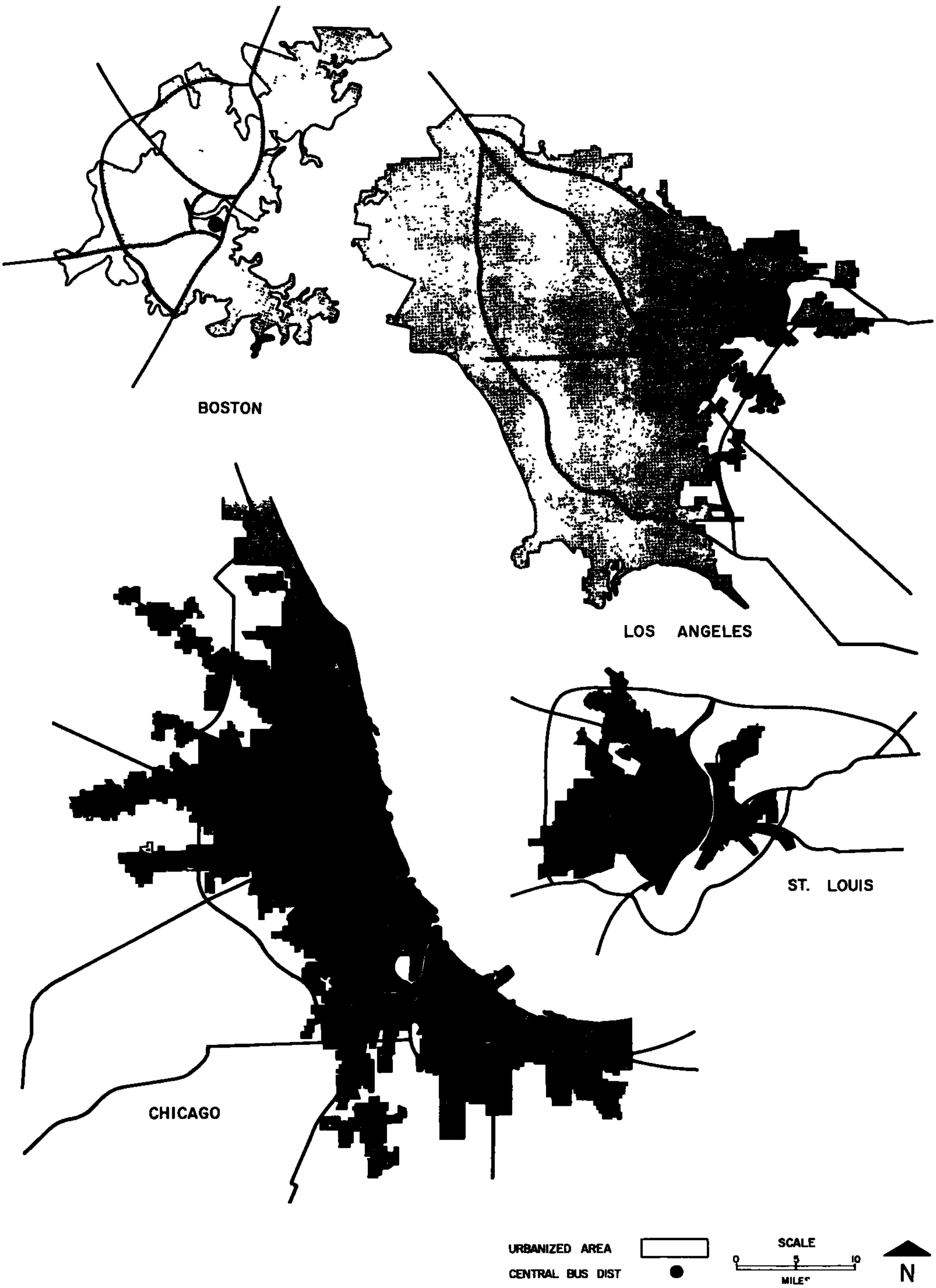



Figure 2. Urban freeway systems as defined by interstate routes (1).

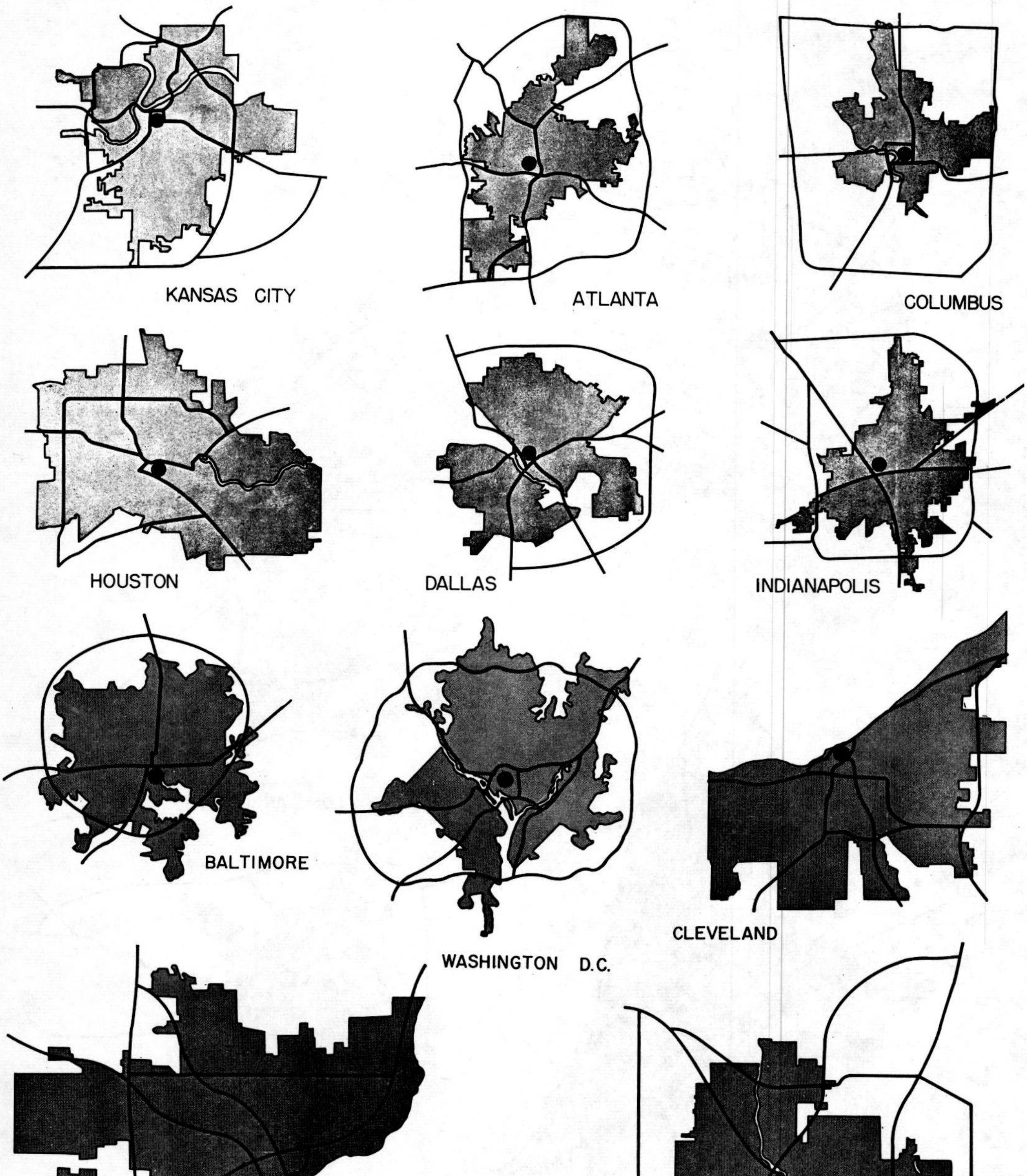



Figure 3. Urban freeway systems as defined by interstate routes (1).

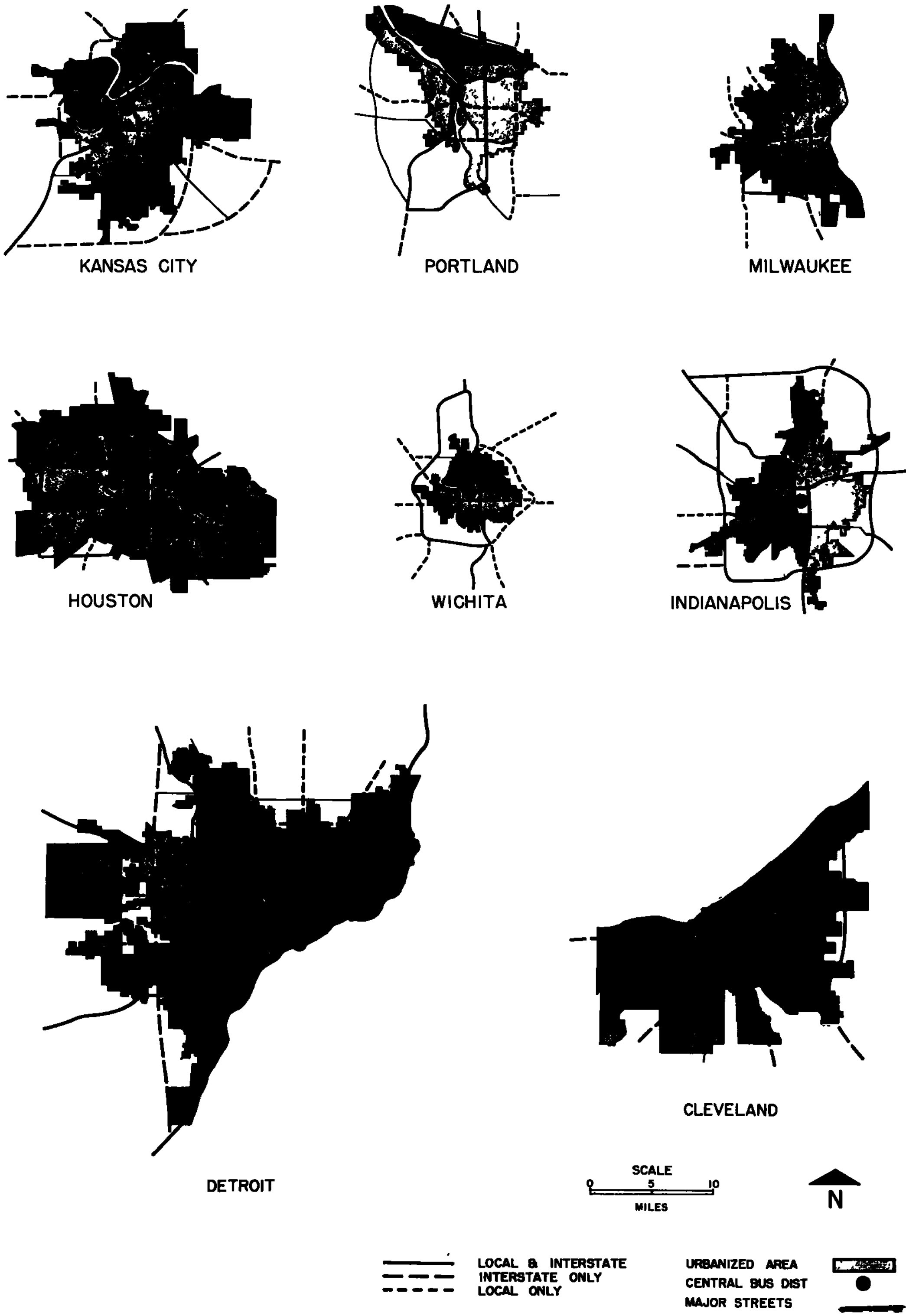



Figure 4. Urban freeway systems as defined by composite plans (1).

TABLE 1

COMPARISON OF TOTAL PERIMETER OF 8 FREEWAY SYSTEMS

| City | Urbanized Area Pop. 1950[1] | Miles of Freeway Within Uniform Distance Bands of CBD (Cumulative) (36) | | | | Freeway Miles per 100,000 Population (urbanized area) |
|---|---|---|---|---|---|---|
| | | 5 mi | 10 mi | 15 mi | 20 mi | |
| Detroit | 2,774,563 | 65.4 | 154 | 211 | 259 | 9.34 |
| Cleveland | 1,406,813 | 40.0 | 119.2 | | | 8.5 |
| Milwaukee | 826,936 | 25.5 | 38.5 | | | 4.7 |
| Houston | 726,214 | 40.2 | 94.2 | | | 13.0 |
| Kansas City | 720,892 | 33.6 | 43.8 | | | 6.1 |
| Portland | 529,902 | 53.4 | 90.6 | 96.2 | | 18.2 |
| Indianapolis | 502,375 | 26.4 | 92.4 | | | 18.4 |
| Wichita | 194,047 | 55.4 | 86.8 | | | 44.7 |

[1]Calculated from Figure 4.

terstate System the radial routes owe their locations primarily to intercity linkages, not local traffic demands. The questions naturally arise as to what degree these radials will serve local needs, and specifically, how many more radials, as well as circumferentials, will be needed to supplement the Interstate System in any given urban area?

State and Local Supplementation of the Interstate System

Another indication of the possible size and shape of the entire urban freeway system in the future may be found by the examination of composite highway plans in various cities. Figure 4 shows some of these systems drawn to a common scale. In addition to freeways, these configurations show locally planned routes of an arterial or expressway nature when needed to complete a composite network. The cities were selected on the basis of the existence and availability of studies dealing with their comprehensive freeway needs. It is cautioned that only the generalized route locations are shown, and some licence has been taken to combine Interstate routes and locally designated ones where it is obvious that only one can fulfill the generalized route location. Insofar as the Interstate locations are extremely generalized, preference has been given to the locally designated routes when only one was selected.

The locally planned freeways for the cities shown in Figure 4 represent varied degrees of planning, engineering, and cooperative effort between jurisdictions. This planning involved the following methods: (1) outside consulting service (Indianapolis); (2) state highway planning and engineering, exclusively (Portland and Houston); (3) city effort exclusively (Wichita); (4) combinations of inter-governmental units (Kansas City and Detroit); and (5) a special purpose governmental district (Milwaukee).

The combination of both Interstate and local routes gives a better indication than the Interstate System of the total freeway resource deemed necessary by freeway planners in the urban areas shown. In some instances routes of a lower type than freeways are noted. These are arterials, expressways, or state highways with some degree of access control. They represent either a compromise design, or show that in some cities full freeway control is deemed unnecessary for all parts of the urban highway system.

The non-Interstate routes in the urban areas shown either add radials to the system, provide radially oriented spurs where the Interstate routes deviate from a radial pattern, or complete the circumferential system. For example, Portland's and Detroit's supplementary plans propose 5 additional radials and Houston's 3. In Kansas City and Milwaukee, short radially oriented spurs are added to the Interstate System. Houston's plan completes the circumferential route with a state highway in the southeast sector of the city, and the Kansas City plan completes the inner-distributor loop on the south side of the CBD. Milwaukee's composite freeway plan is exceptional in this group in that it lacks an outer circumferential.

In addition to the visual comparison in Figure 4, an effort has been made to compare the total miles of freeways in these cities in tabular form (Table 1). Some caution should be exercised in interpreting such a comparison, however, because the total highway network of any particular city includes not only freeways, but expressways, arterials, and sometimes city streets. The proportions of urban highways in these various categories may justifiably vary between different urban areas. It may be noted that the outer circumferentials are located about 10 miles from the CBD. There is no apparent relationship between total miles of freeway and urbanized area population. The degree of planning consistency is seen by comparing the miles of freeway per 100, 000 people in the various urban areas shown. This per capita distance ranges from 4.7 miles per 100,000 people in Milwaukee to an improbable 44.7 miles in Wichita. In terms of the group, Wichita's plan appears much too optimistic, whereas Milwaukee's may be inadequate. It should be observed here that the Wichita study is entirely a product of the city planning agency and has no engineering basis or cost analysis.

## THE INNER-DISTRIBUTOR LOOP

### Physical Characteristics

As has been indicated, the inner-distributor loop is an important innovation in highway development. Insofar as it is also the most expensive element of the urban freeway network, detailed research has been undertaken to show its specific dimensions and its relationships to land use.

Although there are no specific design standards governing the size of an inner-distributor loop, there are certain physical limits based on the conceptual scheme of this type of facility (30). Under optimum conditions the loop would avoid highly valued land and yet be located close enough to the core to provide easy access to parking areas adjacent to the core. Access to and from the loop would be made from the ramp closest to the parking facility, thus keeping through traffic out of the core, thereby minimizing trip conflicts. In other words, a further distance might be traveled on the loop in order to avoid the congestion of city streets.

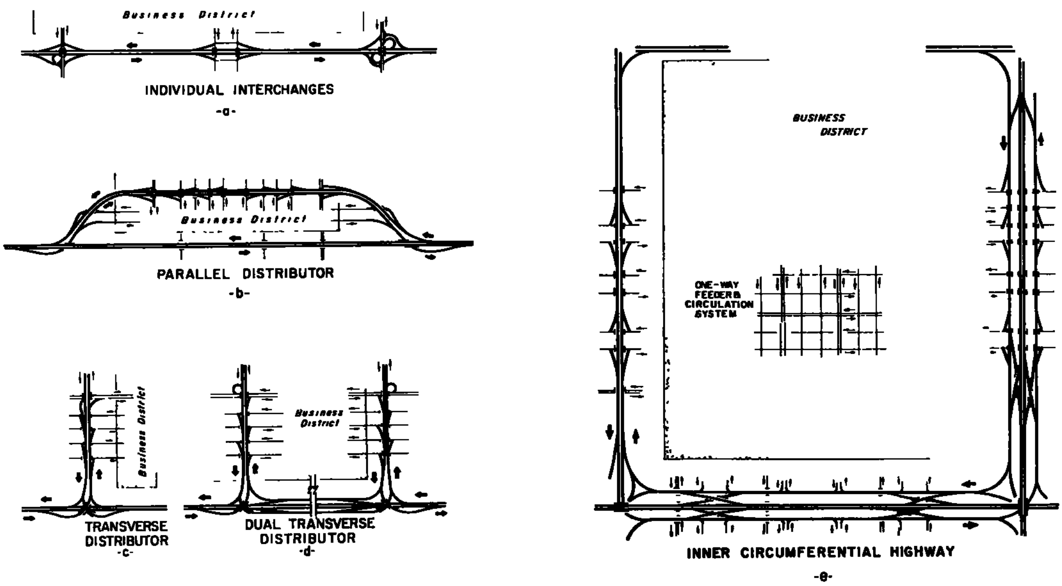



Figure 5. Diagrammatic inner highway distribution systems (1, 2, 3, 4, 5, 6, 7).

The inner loop is designed to supply access to the core throughout its perimeter. The need for complete circulation around the CBD core is partially imposed by the probability that some ramps will be unusable at various times because of accidents or congestion beyond the ramp. Also there are probabilities that some traffic will be unable to weave into the desired lane for off-ramp approach. Under any of these conditions traffic must continue until exit can be made. Therefore, the freeway route should not deviate from a generally circular pattern. Another requirement necessitating the completion of the inner-distributor loop is that inbound traffic will not necessarily enter it at ramps closest to the point of destination, while the reverse of this condition is true for outbound traffic. A complete loop will generally be necessary for the continuous flow of traffic, although some cities have only partial freeway loops planned.[3]

The primary problem with too large a loop is that either long access ramps to the core are required to reach destination points and parking lots, or freeway traffic must disperse on congested city streets for some distance before reaching these locations. Too small a loop cuts down the possible number of access ramps because of the spacing requirements for ramps and thereby limits the amount of traffic which can be deposited in the central area. These individual ramp distributors are major factors in determining the size and shape of the inner-distributor loop. They require from 3 to 8 acres of land each and cannot be closer than about 2,000 ft because of traffic weaving design standards (31). In addition, too small a loop also limits the amount of available parking within it, or cuts into overly expensive land by circumscribing the core too closely.

Additional characteristics of central traffic distribution systems are shown in Figure 5. A quick survey of the systems illustrated immediately points out the significance of a completed inner-distributor loop. Figure 5a shows a single freeway skirting the core on one side. This system is inadequate for all but the smallest cities.

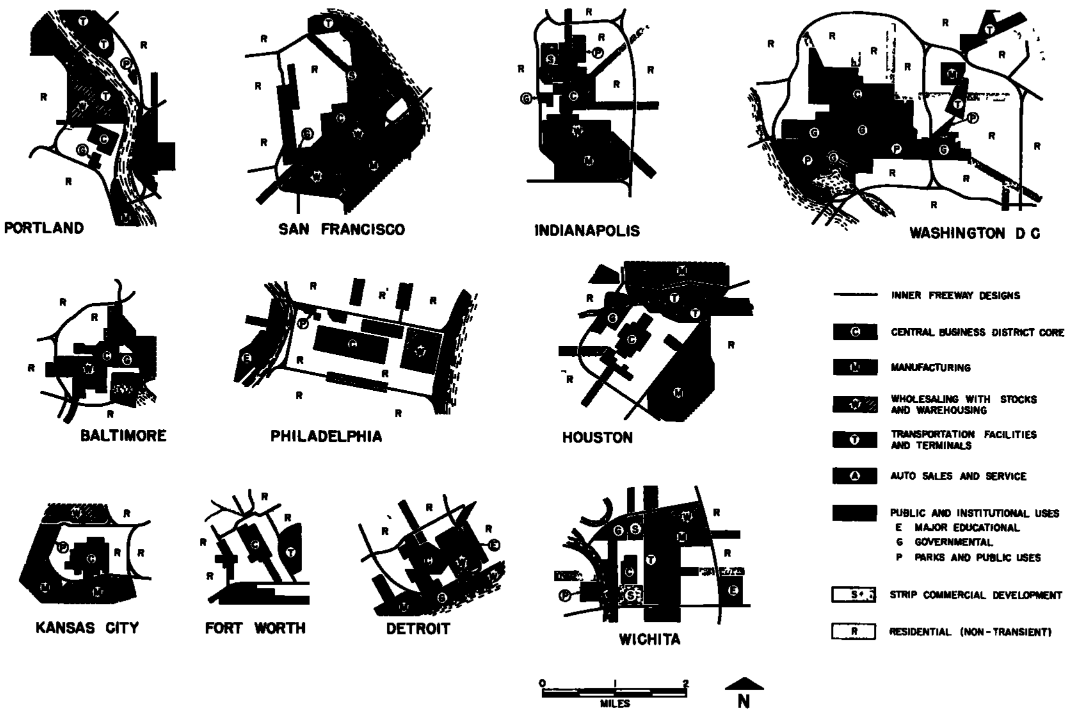



Figure 6. Inner freeway designs and central land use (1, 8, 9).

[3]The north segment of the Planned Cincinnati CBD loop uses city streets. See Cincinnati City Planning Commission, "The Proposed Central Business District Circulation System," pp. 108-119, (1957). Also, the south segment of the Detroit CBD loop is less than full freeway standard (26). The southwest leg of the proposed Houston CBD loop is at present composed of 4 one-way city streets, with a sinchronized plan (4).

Figure 5b shows a parallel distribution system. This system is characteristic of small city highway bypasses. The transverse and dual transverse distributor systems shown in Figures 5c and 5d provide a reasonable perimeter for access to the core but lack the circulatory feature. The complete inner-distributor loop as partially shown in Figure 5e provides the greatest perimeter for access ramps. With 4 sides of 2-way traffic it permits any area inside it to be reached with minimum effort, and allows a bypass of the core from any direction.

Little can be said concerning the adequacy of any inner-distributor loop to serve highway traffic requirements in any particular city unless related to specific data. It is generally realized, however, that no inner loop system yet devised is capable of distributing even the present number of people working in most central business districts if they were to travel by automobile alone. The reason for this is the overlapping of travel on the inner-distributor loop. CBD-bound traffic from origins in opposite segments of the city will jointly occupy the inner loop for a portion of the trip. In view of the relatively limited capacity of all types of inner-distributor systems, continued use of city streets and mass transit for approach to the CBD appears to be absolutely necessary.

The precise size, shape, and location of any specific inner-distributor loop would vary from city to city. Nevertheless, there is considerable similarity in the physical attributes of these loops as demonstrated by Figure 6, which shows planned designs of inner-distributor loops in 11 cities drawn to the same scale. (Note specific legend in Table 2.) These inner loops represent various stages of planning and engineering analysis, and may be substantially changed before being constructed. They reflect also the planning efforts of different agencies in the structure of government, and even a private group, as in the case of Fort Worth.[4]

As to measurable physical characteristics, the inner-distributor loops vary from 8 miles in circumference in Washington, D. C. to slightly over 3 miles in Kansas City and Fort Worth. They are between 1 and 2 miles in diameter. The area encompassed by them varies from 0.7 sq miles in Fort Worth to 4.3 sq miles in Washington, D. C. Most of the loops contain from 4 to 6 major interchanges with radial freeways (Table 3).

TABLE 2

DETAILED LAND USE LEGEND FOR FIGURE 6

| Symbol | Classification | General Use Characteristics |
|---|---|---|
| C | Central business district hard core | As delineated by tall buildings, high pedestrian volumes and high land values Here the majority of space use is devoted to offices, retail trade in department stores and specialty shops, hotels, theaters, and some medical and dental services. It excludes uses below except in small amounts |
| W | Wholesaling with stocks and warehousing | Includes usually commission food dealers, supply houses and warehouses for retail goods. |
| A | Auto sales and services | New and used car sales. Auto specialty repairs, used car sales lots. |
| T | Transportation facilities and terminals | Rail yards and stations, truck terminals, and waterfront activities. |
| M | Manufacturing | The manufacturing of hard products. |
| R | Residential | Housing except for transient accommodations |
| G | Governmental uses | Distinct centers of governmental activity, including city hall, and state and federal office buildings. |
| H | Hospital and medical | Distinct centers of health services |
| E | Major educational institutions | Universities, colleges and large high schools |
| P | Parks and public institutional uses | Relatively large aggregations of space for meeting places, assembly halls, and museums. |
| S | Strip commercial development | Stores and outlets outside the CBD core catering mainly to retail trade and customer services, such as line the old public transit arterials. These commercial strips usually merge into the core of the CBD. |

## Relation to Land Use

Figure 6 also shows the location of the inner-distributor loops in relation to functional areas of land use. It should be cautioned that the functional areas are not directly comparable, or the data completely reliable. Information regarding the functional areas was requested of planning agencies in the particular cities. Each agency was asked to outline areas of similar land use in their CBD according to the classification table furnished (Table 2). Nevertheless, there was still considerable latitude in the interpretations made by the agencies supplying informa-

[4]Based on information from the Fort Worth Planning Agency. The Fort Worth loop does not appear to be developing as originally planned.

tion. For example, the reported core areas of Washington, D. C., and San Francisco are very large when compared with the other cities. This may be because of different interpretations of the core classification, or because of differences in the degree of exactness in mapping it by the various respondents. In other cities vital functions, such as wholesaling, appear to have been unintentionally omitted by reporting agencies. Most of these discrepancies could not be remedied without visiting the cities in question. Nevertheless, there is still a high degree of similarity of functional and spatial structure in the 11 cities, as shown in the following:

1. The CBD core is generally located in a central position within the inner-distributor loop.
2. The core tends to be the smallest major area of functional land use in the CBD.
3. The larger areas of functional land use in the CBD are manufacturing and wholesaling.
4. Railroad and water transportation terminals are always closely tied to wholesaling and manufacturing.
5. Automobile sales and service areas tend to be elongated and arterial oriented, contacting the core at one point.
6. Manufacturing is always located farther from the core than wholesaling.
7. Government buildings are found outside the core, but inside the inner-distributor loop. They are often close to parks.

Once the loop has been constructed, land use on either side may assume different characteristics. Where single functions are split by a loop, as in the case of wholesaling in Detroit, the characteristics of the once single-functional area may become different on either side of the freeway. Another effect of the inner-distributor loop may be to intensify and restrict certain business groupings. Whether uses for permanent residency can long survive within an inner-distributor, except by means of urban renewal or strong public policy support, is questionable. In any event, the chances are great that permanent dwelling units will be relegated to "highrise" structures because of the limited supply of land within the inner-distributor loop.

## LAND SERVICE AREAS OF FREEWAY NETWORKS

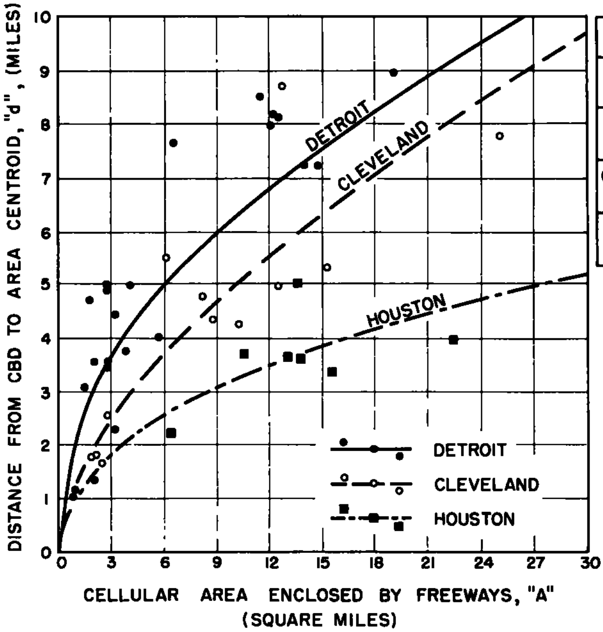
One of the most noticeable features of the urban freeways shown in the foregoing is the relatively similar cellular structure of land units encompassed by them. The ra-

TABLE 3

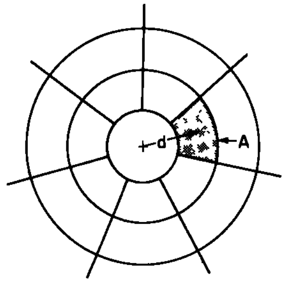
PHYSICAL CHARACTERISTICS OF 11 INNER LOOP DESIGNS

| City | Perimeter (mi) | Length (mi) | Width (mi) | Area Enclosed (sq mi) | Major Interchanges (No.) |
|---|---|---|---|---|---|
| Detroit | 3.9 | 1.3 | 0.9 | 1.03 | 2 |
| Philadelphia | 5.9 | 2.1 | 0.9 | 1.86 | 5 |
| Baltimore | 4.3 | 1.4 | 1.2 | 1.24 | 5 |
| San Francisco | 6.7 | 2.1 | 1.8 | 2.82 | 5 |
| Indianapolis | 6.5 | 2.2 | 1.4 | 2.45 | 4 |
| Portland | 6.0 | 2.5 | 1.0 | 2.13 | 6 |
| Kansas City | 3.3 | 1.3 | 0.8 | 0.75 | 6 |
| Wash., D. C. No. 1[1] | 8.3 | 2.5 | 2.2 | 4.34 | 6 |
| No. 2 | 6.1 | 1.8 | 1.3 | 2.29 | 4 |
| Houston | 5.7 | 2.0 | 1.2 | 1.91 | 3 |
| Fort Worth | 3.8 | 1.1 | 0.8 | 0.67 | 6 |
| Wichita | 5.7 | 1.8 | 1.4 | 2.06 | 4 |

[1]Washington, D. C. has two connecting central distribution loops. The loop containing the core is the No. 1.
Source: Figure 6.




| | DETROIT | CLEVELAND | HOUSTON |
|---|---|---|---|
| MILES OF FREEWAY | 259 | 99 6 | 94 |
| RADIALS | 10 | 6 | 7 |
| CIRCUMFERENTIALS | 2 INTERMED & OUTER | INTERMED & OUTER | OUTER ONLY |
| CELLULAR AREAS | 27 | 12 | 8 |




THEORETICAL DIAGRAM

Figure 7. The cellular structure of urban freeway systems (2, 3, 4, 6, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23).

dial and circumferential elements enclose portions of the urban area within cells with roughly similar shape, but with increasing size outward from the city center.

Insofar as population density decreases with distance from the center of the city, the increasing area of the cellular units with distance outward provides somewhat of a constant population per unit cell. In Detroit, for example, the cells located about 5 miles from the city center have an area of approximately 3 sq miles, a population density of 16,000 to 32,000 people per square mile, and include between 48,000 and 96,000 people. The cells located about 8 miles from the city center are about 12 sq miles in area, have a population density of only 4,000 to 8,000 persons per square mile, but also include between 48,000 and 96,000 people (26).

It is interesting to note that the Detroit freeway plan, a particularly extensive one, develops a cellular structure which encloses areas considerably larger in population than the typical neighborhood and community planning units (32). Neighborhood land planning units usually have 5,000 to 10,000 people each, and community units 15,000 to 30,000 people, except in the older cities. These land planning units are considerably smaller in population than the freeway-defined cells discussed above.

Another way of viewing the extent of a freeway network is by measuring distance between the various highway elements. The interior location of the cellular land units are rarely farther than 2 miles from a freeway, and only 1 mile in cells whose centers are within about 5 miles of the CBD. Even in the Los Angeles freeway network, which has more of a grid than a radial configuration, this observation prevails (33). It appears that a maximum distance of 2 miles from the center of a cell to an encompassing freeway is becoming characteristic of freeway system configurations.

Concerning the freeway network, one school of thought contends that as distance from the center of the city increases, city streets become proportionately less congested, thereby reducing the need for freeways. Under this theory the radial freeways would continue to diverge outward from the core, and circumferentials would also have greater spacing with increasing distance from the city center. Nonetheless, outlying residential density may not diminish with distance from the city center in the future. Under typically developing regional urban complexes, intercity ribbons of land are becoming urbanized without any break in the degree of residential density.

This leads to the notion that many urban freeway networks may develop into a grid system to serve the intercity areas.

The cellular structure of land within the urban freeway network in 3 cities is analyzed in Figure 7. These areas were chosen as representative of cities with moderate, intermediate, and extended freeway systems under development. The cell areas were plotted in relation to distance from the core to their centroids, and lines of best fit were applied to show the general relationships (34). It is immediately notable that the cell areas are considerably larger in Houston, at comparable distances from the core, than in Cleveland or Detroit. In Detroit, for example, the cell areas 4 miles from the core are about 4 sq miles, whereas in Houston at approximately the same distance the cell areas are over 15 sq miles. This is probably because of the lack of an intermediate circumferential in Houston. As a matter of fact, the more extensive the freeway network is, the smaller are the cell areas at given distances from the core. Consequently, cell areas appear to vary from city to city. Even at a distance of 2 miles from the core, the general experience of cellular areas ranges from about 4 sq miles in Houston to 1 sq mile in Detroit.

On a theoretical diagram of a freeway network the area of any particular cell "A" would increase with distance from the core at a rate dependent upon both distance and the number of circumferentials (Fig. 7). The curves of Figure 7 prove this to be generally the case in the 3 cities shown. This analysis is not advanced as a theory of freeway development but as an aid to discussion and analysis of both the total freeway resource and its shape. Actually, cities which are restricted by shorelines from growth in certain sectors may need more radials than cities of similar population size which can spread out in all directions. Detroit and Cleveland may owe their relatively similar characteristics on Figure 7 to this factor.

## RATIONALE BEHIND URBAN FREEWAY SYSTEM DEVELOPMENT

This research, in addition to examining the physical characteristics of urban freeway systems, has attempted to investigate the thinking underlying the shape and extent of these systems. The network studied are characterized more by their similarities than differences. Questions naturally arise as to the principles which were applied to produce this situation. For example, to what extent has a conceptual framework of circulation and a philosophy of system planning influenced freeway planning? Where have economic discipline and design considerations been credited with producing the given configuration? And how has the adequacy of these planned systems been judged?

To find answers to these questions all available freeway planning studies were examined in detail for discussion on the specific reasoning behind the system planning. The results of this inquiry are briefed in Table 4. Although a liberal editorializing was necessary to present the rationale in its barest essentials, considerable effort was made to repeat the key phrases of the text and avoid changing meaning.

TABLE 4

REASONING UNDERLYING FREEWAY SYSTEM PLANS

| City | Rationale |
|---|---|
| Baltimore (24) | To provide a complete system of efficient radial arterials and "ring" streets |
| Boston (25) | To provide a program for the relief of traffic congestion in the area by a network of the latest modern design and capacity expressways |
| Cleveland (9) | To provide a highway plan fully integrated with the land use pattern, with locations selected and to best serve the community within the framework of the principles of good planning, engineering, and economy (The Cleveland freeway plan was also based on studies of the Cleveland Regional Plan Association made in 1944.) |
| Detroit (26) | To develop a complete network of expressways to meet requirements within the Detroit area by 1980, and provide facilities affording the most convenient route from origin to destination |
| Indianapolis (6) | To provide radials, circumferentials, and additional routes to serve the existing circulation needs of the community, plus anticipated needs by 1975. |
| Kansas City (2) | To provide desirable radial and circumferential routes to adequately serve anticipated traffic needs in the Greater Metropolitan Area in 1970, and to provide a freeway loop surrounding the CBD to serve as a distributor and connector for 5 interstate radials and other expressways. |
| Milwaukee (7) | To provide radials to connect with principal highways entering the County, as well as connections between principal concentrations of populations and industry, and to serve 1980 traffic needs. |
| Minneapolis (27) | To provide maximum transportation for residents of the Area and a central distributor system based on estimated 1975 traffic volumes. |
| Omaha (28) | To develop a system of expressways for the Metropolitan Area to serve local and through traffic volumes of 1970. |
| Portland (3) | To accommodate future and existing traffic desires |
| Wichita (5) | To alleviate present traffic congestion and meet 1975 traffic forecasts. |

This particular phase of the research on urban freeways has been disappointing because of the very broad generalizations given as the underlying reasoning for the particular transportation plan. Although many of the reports pay cognizance to the emerging principles of land use planning, such as the inviolability of the various homogenous units of settlement, they offer very little else which relates to the rationale behind the freeway system itself. Strangely enough, some of the reports which reflect the greatest output of work say least on the reasoning behind either specific route locations or the configuration in general. Statements such as, "To accommodate existing and future traffic desires," or "To alleviate present traffic congestion and meet 1975 traffic forecasts," present very little to go on in the evaluation of their particular freeway network.

In several of the reports the development of a freeway system is emphasized as a planning goal, and specific mention is made of the need for radials, circumferentials, and inner distributors. Recognition of system needs, however, does not necessarily give a clue as to the philosophy of spacing the various elements of the system. For instance, how many elements are considered enough? Any traffic desire pattern may be handled by a variety of systems, involving varying degrees of investment and service.

There is no doubt that the urban highway planning studies under consideration here reflect not only various approaches to the subject but different degrees of analytical depth. However, they are all distinguished by their attention to the planning of entire systems, as distinguished from the multitude of single element freeway or expressway studies. In most of the planning reports cited careful attention has been given to the traffic studies basic to them, and the routes have been determined only after a trial series of traffic assignments to the system has been made involving factors of future traffic projection or prediction and the cost-benefit ratios of different systems. The Detroit study undoubtedly reflects the most extensive analysis yet reported and the Cleveland study is also very thorough.

Many of the similarities in the planned configurations shown may be the result of both economic and design determinants. For one thing, the relative uniformity of financial support for these facilities, on a per capita basis, stems from user taxes, which do not differ greatly in scale from one jurisdiction to another. In addition, the relative similarity of urban land development, based on nationwide patterns of residential amenity, may result in similar traffic generating characteristics of land use from one city to another. Before a clear picture of this subject can be obtained, significantly more research will have to be undertaken in appraising the freeway planning goals in the various urban areas of the country.

## SUMMARY AND CONCLUSIONS

The developing freeway systems are composed of 3 distinguishable elements: (1) radials to serve the needs of intercity travel and the centrally oriented intra-urban trip; (2) circumferentials to serve as bypass routes and meet trip desires between outlying centers; and (3) an inner-distributor to collect and distribute traffic to and from radials and to serve as a city center bypass.

The Interstate System will supply varying percentages of total freeway system needs from city to city. In most cases state or local supplementation of the Interstate System will be required to complete the urban freeway network. In at least a dozen major urban areas supplemental freeway routes to the Interstate System have been proposed. These supplemental plans by and large complete the urban freeway network in these cities. The Interstate System provides the framework for the local network. Where comprehensive urban freeway networks have been planned, an average of about 11 miles of freeway per 100,000 urban area population is developing.

The functional efficiency of the entire urban freeway network may depend on the development of a complete inner-distributor loop. Over a dozen cities have them planned or in various stages of development. These loops are relatively similar in their general spatial characteristics, averaging about 5.5 miles in perimeter, 1.9 miles in length, 1.3 miles in width, and enclosing about 1.93 sq miles of area. These loops are generally located within approximately 1,000 ft of the retail and office core of the CBD, and tend to cut into wholesaling, light manufacturing, and old or dilapidated housing. They take up on the average well over 200 acres of central land, which is usually twice as large as the core area referred to above. There are a relatively similar set of functional areas of land use in the vicinity of the inner-distributor loop.

In the freeway systems analyzed, the maximum spacing of routes is such that any point of urban land is rarely farther than two miles from a freeway. Land within 4 or 5 miles of the city center is rarely more than 1 mile from freeway service.

The basic motivation behind freeway conception is providing a transportation facility to serve existing and anticipated traffic demands. No attention is given to the use of freeways as a land use programing tool (35). This no doubt emanates from the fact that the freeway planning agencies have not been given broader urban planning responsibilities, and machinery has not been worked out to effect freeway development and urban planning as one unit.

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## *Discussion*

EDWARD T. TELFORD, Assistant State Highway Engineer, California Department of Public Works, Division of Highways, Los Angeles—As a first step in any discussion of the matters which Horwood, Boyce and Rieg have set forth in their paper, it would appear reasonable to take up the following matters of background concern: (1) objective; (2) relation of the freeway system to the total street and highway system; (3) area occupied; and (4) spacing in a grid system of freeways and its relation to geometric design and traffic capacity.

1. The objective of the freeway program is to develop a freeway system which will be a part of an integrated motor vehicle transportation system, including not only freeways, but major arterials and local or land use roads.
2. There are no destinations on a freeway. The freeway can only serve the motor

vehicle operator effectively if he can proceed between the freeway and the point of the origin or destination of his trip, via adequate conventional street or highway routes properly connected to the freeway system.

3. In a metropolitan area, planning of land use must be on the basis that each acre of land is expected to produce something, whether it be office space, retail business, residence, manufacturing, parking or transportation. The very nature of the forces with lead to the development of a metropolitan area make it necessary to plan for the most effective use of the land. It therefore becomes obvious that only sufficient area to provide for proper balance in total use should be assigned to each of those functions which are a part of metropolitan life, including all types of transportation. If this line of reasoning is accepted, then the area occupied by a freeway becomes an important factor in reaching a conclusion as to the proper spacing of freeways in the total system. As an example the following information is offered:

(a) The Harbor-Santa Monica Interchange will require 87 acres.

(b) The Harbor Freeway between the Santa Monica and San Diego Freeways requires approximately 38.4 acres per mile.

(c) The Harbor-San Diego Freeway Interchange will occupy 86 acres.

4. In the Los Angeles metropolitan area, early studies of the possibility of development of parkway routes led to some radial development, with its origin in the vicinity of Civic Center. With the spread of population over the entire plain of the Los Angeles Basin, the pattern of traffic desire has changed. The resulting pattern is made up of three elements: (a) the northwest-southeast movements roughly parallel to the coastline and connecting with the areas north and south of the metropolitan area; (b) the east-west movement between the coast and the San Bernardino-Riverside area; and (c) superimposed on these, the east-west, north-south grid pattern of traffic movement within the highly developed metropolitan area of the Los Angeles Basin.

In the course of the studies made in 1955-56 the possibility developed that, for much of the area, a grid system of freeways on a spacing of approximately 4 miles would be desirable. There are several factors which lead to this tentative conclusion—among them, the fact that on a well developed street system, a freeway will draw traffic from about 2 miles on either side. Second, it was found that it is desirable to provide for collection and distribution between the freeway and city streets as a separate matter from the interchange between freeways. Considering the desirable geometric features involved in the spacing of ramps entering or departing from the freeway, it appeared that 4-mile spacing of freeway interchanges would offer interesting possibilities. As a matter of interest a study of the freeway traffic which would probably be generated by a 16-mile square area was started and carried to a partial conclusion in 1957-58. This study will be the subject of a paper which may be prepared and offered for consideration at a later date.

The natural development of the freeway study has resulted in a plan for freeways, east-west and north-south, around the central core of the City of Los Angeles at much closer spacing. In fact, the greatest distance from a freeway at any point in the central core is approximately 1 mile. This may be considered by some as an inner-distributor loop, but it is a natural development of the planning of freeway routes to serve the traffic demand in the area.

As to the relationship between the freeway system and the Interstate System, it is probable that the Interstate System will represent somewhere between 25 and 30 percent of the total mileage of freeways in this metropolitan area. While the Interstate System is a vital part of the metropolitan freeway plan, it is not adequate by itself. It appears that the Interstate System has a definite place and may be expected to do certain work in connection with the motor vehicle transportation system, but it would be unwise to attempt to place upon it the burden of serving as a major part of the metropolitan freeway system. It must be remembered that it is an interstate and defense system.