THE landscapes of any American city reflect countless decisions and actions from the time of settlement to the present. The results are apparent not only in differences in land use but in the kaleidoscopic variety of building facades, street patterns, and lot sizes. Early actions precluded or frustrated many later locational decisions. The metropolitan physical plant has accumulated through various historical epochs, and clearly those epochs were distinguished from one another by different ideas and technologies. Increasingly, in proportion to its size and age, the metropolis is becoming a complicated puzzle of heterogeneous and anachronistic features.

The evolutionary nature of the metropolitan anatomy is, of course, widely recognized, and this fact is reflected in a wealth of studies of the historical-geographical development of individual cities and of the anachronistic legacies that make up much of the urban physical plant. Yet research on systems of cities, cities as central places, cities and transportation networks, internal spatial structure of cities, and rank-size distributions has lacked a general historical context.\(^1\) A structured urban history of the country or of its major regions, which would help to bring order to the mixture of historical-locational forces that generate the urban landscape,\(^2\) has not yet appeared. Meanwhile, future populations are projected, and increasingly massive clearance and redevelopment proceed in the old central areas of metropolises without a fully developed theory of metropolitan growth and form.\(^3\) Stages of urban economic growth and social evolution have been postulated. Wilbur Thompson has observed that these are "highly impressionistic generalizations" and "leave much too strong a feeling of the inevitability of growth and

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\(^2\) This is the thesis of a detailed review of the literature of United States urban history by Charles N. Glaab; The Historian and the American City: A Bibliographic Survey, in *The Study of Urbanization* [see footnote 1 above], pp. 53-80.


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Dr. Borchert is professor of geography at the University of Minnesota, Minneapolis.
development.” And he has asked, “What are some of the dampening and restraining forces that surely must exist? We see all about us evidence of local economic stagnation and decay and even demise.”

Central questions relate to the factors that have influenced the location of relative growth and decline, the relationship of anachronistic regions within cities to the evolution of the national pattern of urban growth, the threads that run consistently through the evolutionary process, and the nature of future change as suggested by experience to date. These questions can be illuminated by examining the evolution of the present pattern of standard metropolitan statistical areas through a series of historical epochs, from the first census, in 1790, to the most recent, in 1960.

**Major Innovations and Epochs**

Most American metropolitan areas, throughout much of their history, have functioned chiefly as collectors, processors, and distributors of raw

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materials and goods. Consequently, it might be expected that changes in their growth rates would have been particularly sensitive to changes in (1) the size and resource base of the hinterland and (2) the technology of transport and industrial energy for the processing of primary resources. These two sets of variables are interrelated. The technology partly defines the resource base, and the transportation technology, in particular, strongly affects the size, and therefore the resources, of a city’s hinterland. There is, of course, no implication that the technological changes have been independent variables or basic causes of growth. The presumptions are, rather, that within the given framework of values and institutions they were stimulated by the economic growth and geographical expansion of the nation and that they in turn not only further stimulated growth but also helped to differentiate it geographically.\(^5\)

Among many possibilities, this paper emphasizes three relatively brief periods since the 1790 census in which major innovations appeared in the technology of transport and industrial energy.

THE INNOVATIONS

*Steamboat and “Iron Horse”*

The first of the innovations was the use of the steam engine in water and land transportation. The census year selected is 1830. To be sure, the early steamboats in America preceded that date, but the real buildup of steamboat tonnage on the Ohio-Mississippi-Missouri system began in the 1830’s (Fig. 1),\(^6\) and the main period of increase in the tonnage of general-cargo vessels on the Great Lakes also began in the 1830’s and 1840’s. Rail mileage, likewise, grew rapidly after initial development in 1829. By the end of the decade “the major mechanical features of the American locomotive were established,” boxcars had been introduced, regular mail routes were in operation on the railroads, and the first transatlantic steamer had arrived in New York.\(^7\)

The introduction of steam power created major transportation corridors on the western rivers and the Great Lakes and resulted in enlargement of the hinterlands of ports on both the inland waterways and the Atlantic. It made possible the development of a national transportation system through the integration of these major waterways and regional rail webs. These changes

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favored the growth of ports with relatively large harbors and proximity to important resource concentrations. Simultaneously, however, they hurt the economy of nearby smaller ports.

Steam power was also applied in manufacturing, but its impact was apparently more localized because of the impracticality of long hauls of coal or other bulk commodities with the comparatively light equipment and iron rails of the time. As a result, local waterpower sites continued to influence industrial location. By 1870 waterwheels were still providing roughly half of the inanimate energy for manufacturing, especially in the major manufacturing region. About half of the entire inanimate power for industry was in the five states of Massachusetts, Connecticut, New York, Pennsylvania, and Ohio. Oliver observes that steam "was not universally used in cotton mills until the railroads were sufficiently developed to transport coal cheaply."

That ability came generally in the 1870's.

Steel Rails and Electric Power

The second major innovation was the appearance of abundant, and hence low-priced, steel. The census year chosen for this is 1870. The preceding decade had seen the first commercial output of Bessemer steel in America, and by the mid-1870's American steel products were breaking into the world market (Fig. 1).

A number of related events, each with geographical ramifications of great importance, occurred in dramatic sequence in the decade of the 1870's. Steel rails replaced iron on both newly built and existing lines. Heavier equipment and more powerful locomotives permitted increased speed and the long haul of bulk goods. Rail gauge and freight-car parts were standardized9 (there had been eleven gauges among the northern systems in 1860), so that interline exchange and coast-to-coast shipment were possible. Refrigerated cars made their entry, ushering in a new era of regional specialization in agriculture and centralization of the packing industry at major rail nodes. Other ramifications favored industrial, hence urban, centralization. The practical length

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8 Oliver, op. cit. [see footnote 6 above], p. 160.
9 The urgency of rebuilding existing lines with steel rails at standard gauge in the 1870's is related in Robert J. Casey and W. A. S. Douglas: The Lackawanna Story (New York, 1951), pp. 92-94. The impact of the introduction of the long haul on the geography of an existing system is described in Louis Jackson: A Brief History of the Chicago, Milwaukee, and St. Paul Railway (1900), pp. 6-8. See also Harlan W. Gilmore: Transportation and the Growth of Cities (Glencoe, Ill., 1953), p. 51. For a full account of the beginning of the steel era in the United States and for further references see Oliver, op. cit. [see footnote 6 above], pp. 319-425, especially pp. 416-425.
of coal haul was extended and the cost reduced. The effect was to open vast central Appalachian bituminous deposits and to facilitate the movement of coal to the great ports whose growth had been launched four decades earlier. The greater availability of coal was soon supplemented by the availability of central-station electric power, which followed in the 1880’s.

For the first time massive forces were arrayed favoring market orientation of industry and the metropolitanization of America. At the same time there were negative impacts. The long rail haul spelled the doom of most passenger traffic and cargo movement on the inland waterways, especially the rivers. Small river ports were destined to become virtual museums. It is noteworthy that general-cargo shipping capacity on the western rivers peaked not on the eve of the Civil War but in the 1870’s; thereafter it fell precipitously for half a century (Fig. 1). The easier availability of coal and central-station electricity doomed the small waterpower sites. Most small industrial cities retained their function; many were rail nodes large and important enough to continue to grow with the national economy. But for subsequent decisions the decentralizing factor of many small waterpower sites had yielded to the centralizing force of the metropolitan rail centers, their giant markets, and their superior accessibility.  

Internal-Combustion Engine and Shift to Services

The third major innovation, and probably the least debatable, was the introduction of the internal-combustion engine in transportation and related technology. The census date chosen is 1920. To be sure, the automobile had entered the American scene in the 1890’s, but motor-vehicle registration was insignificant before 1910, and road surfacing and petroleum production began their steep climb in the 1920’s (Fig. 1). The need for a national system of highways was recognized in 1916 with the first federal aid for road construction.

The impact of the internal-combustion engine on the geography of American cities needs little review. But some of the most profound changes affecting the city occurred in agriculture.  

True, the new technology put the farmer in an automobile and thus encouraged the centralization of urban growth at the larger, diversified centers in all the commercial farming regions.

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10 Allan Pred has developed at length the fact that the period from the Civil War to World War I saw the major growth of large cities as industrial centers (op. cit. [see footnote 1 above], pp. 161-162).

But also, by putting the farmer on a tractor, it multiplied the land area he could work alone, initiated a revolution in family farm size, and sped the urbanization of much of rural America. In addition, air passenger transport helped to encourage centralization of the national business management function in a few cities, and the auto stimulated the decentralization of most metropolitan functions. The internal-combustion engine had a profound and happy impact on the growth prospects of cities in the oil fields, but the opposite effect on cities in the coal fields and at railroad division points.

Another change, of overriding importance, coincided with the beginning of the auto-air age. Throughout the nation’s history the primary (agriculture, forests, fisheries, mining) and secondary (manufacturing) sectors of the economy had dominated the employment picture. Their share of total employment had been gradually diminishing, but in 1920 they still accounted for 56 percent. Since 1920, however, the share has been less than half and has been falling rapidly (Fig. 2). The trend is, of course, a reflection of the combined technological advances that have been leading the nation gradually toward an era of automation.

When employment was mainly in resource and processing industries, it was fair to look on cities mainly as assemblers and processors of the nation’s resources. It was appropriate to assume that changes in the technology of transport and industrial energy would be crucial for the growth or decline of cities. In the auto-air age, when primary and secondary employment occupies only a decreasing minority of the labor force, such technological changes are of declining importance in the life and death of cities. Two new factors have come to the fore. One is the increase in service employment. With a fast-growing majority of new jobs since 1920 in the least mechanized and least automated part of our economy—the personal and professional services—the most likely locations for new employment growth have been the places where there were already large concentrations of people to be

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served. Hence in the auto-air age, even more than in the preceding epoch, growth breeds growth. The second factor is the large and growing amount of leisure time available. As Ullman pointed out some years ago, this has led to the great importance of amenities as an urban location factor, both for commuting workers and for retired people.\textsuperscript{13} It has also led to an increase in the time available for, and, presumably, the need of, formal education. Hence educational centers as well as high-amenity locations have been blessed by the fruits of changing technology in this present age.

THE EPOCHS

In short, four epochs in American history can be identified that have been characterized by changes in technology crucial in the location of urban growth and development: (1) Sail-Wagon, 1790–1830; (2) Iron Horse, 1830–1870; (3) Steel Rail, 1870–1920; (4) Auto-Air-Amenity, 1920–.\textsuperscript{14}

Although emphasis here is on factors affecting the differential growth of American cities as entities, these periods are differentiated also by internal features of urban geography and morphology.\textsuperscript{15} The railroad had many impacts on the structure and location of industrial and central business districts, and these districts changed with the entry of steel and the long haul. The coming of steel and electric power made possible the skyscraper and rapid transit. The auto and coincident developments in electronics need no elaboration. Each innovation brought major changes in land-use patterns, densities, lot sizes, nodality of the central business district, and other intraurban variables.

Reservations and qualifications apply, of course, to this fourfold his-


\textsuperscript{14} This differentiation is somewhat related to Eric Lampard’s formulation of three critical periods in the regional economic development of the United States up to 1910: (1) a period of initial resource exploitation in the historic eastern base region, from colonial time through the Civil War; (2) a period of “extension of accessibility” from the eastern base region to the rest of the country associated with an enlargement of the resource hinterland of the eastern base, from the Civil War to World War I; and (3) the era of “nationalization” of the economy, utilizing and improving on a virtually fully developed transportation system since World War I. See Eric E. Lampard: Regional Economic Development, 1870–1950, in Regions, Resources, and Economic Growth (by Harvey S. Perloff, Edgar S. Dunn, Jr., Eric E. Lampard, and Richard F. Muth; Baltimore, 1960), pp. 107–292 (Part 3). See also Constance McLaughlin Green: American Cities in the Growth of the Nation ([New York] 1957), Chap. 10, and the works cited by Sjoberg in connection with his discussion of the Technological School (Gideon Sjo-berg: Theory and Research in Urban Sociology, in The Study of Urbanization [see footnote 1 above], pp. 157–189; reference on pp. 170–171).

\textsuperscript{15} For an extensive discussion of urban evolution in relation to transportation technology and development in specific metropolitan areas see James E. Vance, Jr.: Labor-shed, Employment Field, and Dynamic Analysis in Urban Geography, \textit{Econ. Geogr.}, Vol. 36, 1960, pp. 189–220, and his “Geography and Urban Evolution in the San Francisco Bay Area” (Berkeley, 1964).
The periods are not homogeneous. Even if they should stand up as useful divisions for the description and study of American metropolitan evolution, they contain many subdivisions, which vary from one region to another.

Furthermore, the boundaries between the epochs, although characterized by the near simultaneity of important innovations, are nevertheless complex transition periods. Some of the features of transition constitute little epochs of their own; examples might be the canal epoch (ca. 1810's to 1840's) and the electric interurban railway epoch (ca. 1900's to 1930's). Oliver\textsuperscript{16} observes, "The canal was at best a temporary and an inadequate answer to the need for inland transportation." In a sense, it represented an attempt to adapt the technology of water transportation to the quickly growing need for tapping inland resources as the frontier advanced. Likewise, the rash of interurban electric rail lines that appeared about the turn of the present century may be viewed as a "temporary and inadequate" attempt to adapt rail-transport technology to the growing need for a flexible, rapid linkage between farm, small town, and city as the populations of large regions became commercialized and urban-orientated.\textsuperscript{17}

Finally, throughout virtually all the first three epochs the settled area of the United States was expanding westward. The rate, timing, and direction of advance of the settlement frontier were in many ways quite independent of the major technological innovations that opened each of these epochs. On the other hand, the westward expansion helped to press the need for these innovations. More important from the viewpoint of this paper, cities were needed and built as new lands were opened. Hence the land pioneered during each of these epochs constitutes a region within which all city sites were chosen, and subsequent investments made, under a particular sequence of technological considerations.

**Metropolitan Size Classes**

In order to compare sizes and growth rates during the four historical epochs postulated here, American cities were divided into five population size categories. First, the 212 standard metropolitan statistical areas of the 1960 census were reduced to 178 by combining some and dropping those under 80,000 population. The 178 were then ordered by size. A smoothed curve joining them in rank-size distribution is shown in Figure 3. A change in


slope is noticeable at four points—at populations of about 250,000, 820,000, 3,000,000, and 8,000,000. Above each of these critical points lies a group of cities whose growth at some period in their history has been accelerated as compared with the places below the critical point. These division points break the 1960 SMSA’s into five groups, which may be labeled as follows: first order, more than 8,000,000 (New York); second order, 2,300,000 to 8,000,000; third order, 820,000 to 2,300,000; fourth order, 250,000 to 820,000; and fifth order, less than 250,000. Although the divisions are somewhat arbitrary, they seem to identify significantly different groups of cities. The New York metropolis is, of course, in a class by itself no matter how the SMSA’s are divided. The second and third groups appear as clusters on the
graph that portrays Jerome Pickard's population and functional size orders (Fig. 4). The fifth group seems to match the primary wholesale-retail category identified, by the analysis of business functions, at the top level below Minneapolis-St. Paul in a regional hierarchy of trade centers in the northern Midwest and Great Plains.

Table I—Limits of Size Orders for SMSA's in 1960 and Corresponding Areas in Earlier Years*

<table>
<thead>
<tr>
<th>Size Order</th>
<th>Population Threshold (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1790</td>
</tr>
<tr>
<td>First</td>
<td>180</td>
</tr>
<tr>
<td>Second</td>
<td>90</td>
</tr>
<tr>
<td>Third</td>
<td>40</td>
</tr>
<tr>
<td>Fourth</td>
<td>15</td>
</tr>
<tr>
<td>Fifth</td>
<td>5</td>
</tr>
<tr>
<td>Central-city minimum</td>
<td>1.1</td>
</tr>
</tbody>
</table>

* The fifth order is truncated by the lower size limits for an SMSA; a number of urban areas not large enough to be defined as SMSA's are fifth-order centers.

For the earlier census years two definitions had to be formulated before the procedure could be applied. First, it was necessary to define "SMSA" for those years. In the 1960 census an SMSA by definition had to contain, in effect, a central city of at least 50,000 population. For the present study the minimum size of the central city was reduced to be commensurate with the smaller total population of the United States in the earlier census years. Hence the minimum-sized central city for an "emerging SMSA" in 1920 was 29,500; in 1870, 11,100; in 1830, 3600; and in 1790, 1100. The population of the county was used at each point in the time series. Where a county was split during the series, appropriate adjustments were made. But each SMSA or emerging SMSA that appears at any point in the time series is always defined by the same county or counties. To be sure, this is only one way of achieving a measure of consistency in dealing with a problem for which there is no entirely satisfactory solution at present. Few of these counties in the early epochs were "metropolitan" in any modern sense. But they included the forty to fifty largest places in 1790 and 1830; and the definition identified, then as now, the nation's principal population clusters.

18 Jerome P. Pickard: Metropolitanization of the United States, Urban Land Inst. Research Monograph 2, Washington, D. C., 1959, Fig. 21 (p. 67).
19 John R. Borchert and Russell B. Adams: Trade Centers and Trade Areas of the Upper Midwest, Upper Midwest Economic Study Urban Rept. No. 3, Minneapolis, 1963, pp. 36-39 and Figs. 1 (p. 4), 8 (p. 25), and 9 (p. 27).
Second, it was necessary to define for the earlier census years the limits of the five size orders defined above for 1960. Again, each of the size-order limits was reduced to be commensurate with the smaller national population in the earlier years. These values, however, were then adjusted upward to account for the smaller proportion of a given “metropolitan” county covered by the smaller central city of earlier times. The result was the set of limits shown in Table I.

Thus five size orders and four historical epochs were established. By comparing the numbers of newcomers, dropouts, and shifts in size order through the series of epochs it is possible to observe the evolution of the modern array of metropolitan areas. It is also possible to observe the impact of several major changes in technology and the expansion of resource base and metropolitan hinterlands that accompanied the westward movement. Figure 5 shows all the places included in these five size orders during at least one of the four historical epochs.

**Evolution of the Pattern**

*Sail-Wagon Epoch, 1790–1830*

At the time of the 1790 census almost all the major urban population clusters were ports on Atlantic bays or estuaries, or on the navigable reaches

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21 For the years before 1960 each size-order threshold, \( T_y \), was first defined by the relationship \( T_y = T_o (P_y/P_o) \), where \( T_o \) is the threshold population in 1960, \( P_o \) is the United States population in 1960, and \( P_y \) is the United States population in the earlier year. For thresholds under 100,000 “SMSA” population a further adjustment was made, using the relationship \( T_r = T_y (F_y/F_o) \), where \( T_y \) is the threshold defined for the earlier year by the initial adjustment, \( T_r \) is the readjusted value, \( F_y \) is the percentage of United States population that was rural in 1960, and \( F_o \) is the percentage of United States population that was rural in the earlier year. Where the county population exceeded 100,000, it was assumed that rural (especially farm) population within the “SMSA” was negligible, and no second adjustment was made.

The net effect of this definition and procedure is to overstate the populations of urban areas in the earlier periods, especially before 1920 and especially in areas with populations under 100,000. Because of the second adjustment of threshold values, the size orders are roughly comparable throughout the series. Lukermann (op. cit. [see footnote 1 above]) approximated urban-area populations for the eastern and central United States 1790–1890. Comparison of his rank sizes and geographical patterns with those in this paper shows no significant discrepancies resulting from the different definitions.

22 This section is an attempt not to write history but to interpret briefly Figures 6 through 11 in the light of readily accessible secondary materials and historical census data. The regional framework and regional economic changes discussed are elaborated in Perloff and others [see footnote 14 above]; in Ralph H. Brown: Historical Geography of the United States (New York, 1948); and in several standard regional geographies, notably J. Russell Smith: North America (New York, 1925); George J. Miller and Almon E. Parkins: Geography of North America (New York and London, 1928); and Harold Hull McCarty: The Geographic Basis of American Economic Life (New York and London, 1940). On the other hand, the detailed history and geography of specific cities within these regions, over time, are dispersed through myriad local studies. Important references appear in Harold M. Mayer: Urban Geography, in *American Geography: Inventory & Prospect* (edited by Preston E. James and Clarence F. Jones; Syracuse, N. Y., 1954), pp. 142–166; and in Glaab, *op. cit.* [see footnote 2 above], pp. 73–80.
Fig 5—Places in the five size orders of SMSA's or "emerging metropolitan areas" in one or more of the census years 1790, 1830, 1870, 1920, or 1960. Names of the central cities are indicated by initials. Open circles represent the areas that were not SMSA's in 1960.
Fig. 6—Distribution of major towns and neighboring county populations by size order, 1790. Source of the population data for Figures 5–8, "A Compendium of the Ninth Census" (1872). Population-density isopleths generalized from Clifford L. Lord and Elizabeth H. Lord; Historical Atlas of the United States (New York 1953), p. 46. Base map in Figures 6–9 is A. K. Lobeck's "Physiographic Diagram of the United States" (courtesy C. S. Hammond & Co.).
of the Connecticut, Hudson, Delaware, and Savannah Rivers, or on the Chesapeake Bay system (Fig. 6). Among the centers of third or high order, only Worcester, Massachusetts, was not a port, and only Worcester and Pittsburgh were not on the Atlantic waterway. Lower-order centers also were mainly Atlantic ports, though they included inland centers of agricultural trade and local industry. There was no primate city or national metropolis; the Boston, New York, and Philadelphia areas were of about equal size. Lukermann has observed that the entire family of Atlantic ports was characterized by small hinterlands and a primary orientation toward the sea and Europe and could in fact be considered part of the West European urban system.\(^{23}\)

Change was modest during the epoch (Fig. 7). Virtually all places that rose in size order—that is, grew faster than the national growth rate—were in areas of westward expansion and accompanying development of new resources: the drift-filled valleys and drift-capped plateaus of western New York, the Ontario plain, the Great Valley, the Bluegrass, and the Nashville Basin. Other important resources lay within these new agricultural regions or adjacent to them—notably waterpower, the timber of the northern Appalachians and the Adirondacks, and the anthracite of northeastern Pennsylvania. The “boom” cities, those which rose two or more ranks, were mainly along the inland waterways that penetrated the new western lands—the Erie Canal, the lower Great Lakes, and the Ohio River system. Exceptions were the Great Valley cities near the anthracite fields.

As agricultural settlement expanded in western New York there was a relative decline in growth rate, and a drop in size order, at a number of small ports and inland centers serving agricultural areas in eastern New York and New England. Meanwhile, although the struggle for deeper hinterlands had begun, the absence of any major change in the technology of land transport permitted most Atlantic ports to retain essentially the same functions through most of the epoch and to register neither relative increase nor relative decrease in size order up to 1830.

**Iron Horse Epoch, 1830–1870**

At the beginning of this epoch all emerging metropolitan areas of third or higher order except Pittsburgh were east of the Appalachians or in western New York. The area of continuous settlement was spreading westward toward the Mississippi. But commercialization of the newly exploited land

\(^{23}\) Lukermann, *op. cit.* [see footnote 1 above].
resources still awaited an effective network of transportation lines and cities.

The coming of the railroad brought drastic changes. A series of regional rail networks developed. The larger networks converged at critical port locations on the inland waterways that penetrated the vast agricultural land resource of the Interior Plains. Small networks or individual lines focused on the smaller ports. The emergence of these “great ports” of the Midwest accounted for most of the boom cities of the epoch (Fig. 8) and laid the metropolitan base for an important part of the market-oriented industrial growth of the Steel-Rail Epoch. Limitations of technology made the rail networks generally tributary to the water-transport system; they were built outward from major ports or to those ports from principal neighboring concentrations of farmland, mineral, or timber resources. In their initial effect they were therefore complementary to the waterways as long-haul general-freight carriers.

In the older settled areas of the North other important changes in the urban pattern emerged. Boom centers appeared in the anthracite fields, and Pittsburgh advanced to second order, where it would remain until the end of the Steel-Rail Epoch. These changes reflected the accelerated demand for coal that came with the development of the railroad, the wider industrial application of steam, and accompanying changes in the iron industry. On the Atlantic seaboard New York became a first-order center; it had been about the same size as Philadelphia at the beginning of the epoch, it was twice as large at the close.

Thus the urban pattern of the United States was revolutionized by the

### Table II—Number of Centers and Total Population in Each Size Order

<table>
<thead>
<tr>
<th>SIZE ORDER</th>
<th>1790</th>
<th>1830</th>
<th>1870</th>
<th>1920</th>
<th>1960</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUMBER OF CENTERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Second</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Third</td>
<td>8</td>
<td>8</td>
<td>14</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Fourth</td>
<td>20</td>
<td>29</td>
<td>33</td>
<td>51</td>
<td>70</td>
</tr>
<tr>
<td>Fifth</td>
<td>8</td>
<td>12</td>
<td>37</td>
<td>75</td>
<td>82</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>39</td>
<td>52</td>
<td>91</td>
<td>147</td>
<td>178</td>
</tr>
<tr>
<td><strong>TOTAL POPULATION (thousands)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First</td>
<td>—</td>
<td>—</td>
<td>2,471</td>
<td>8,490</td>
<td>14,760</td>
</tr>
<tr>
<td>Second</td>
<td>514</td>
<td>1,120</td>
<td>3,301</td>
<td>10,364</td>
<td>28,826</td>
</tr>
<tr>
<td>Third</td>
<td>499</td>
<td>784</td>
<td>3,627</td>
<td>13,918</td>
<td>26,493</td>
</tr>
<tr>
<td>Fourth</td>
<td>530</td>
<td>1,812</td>
<td>2,533</td>
<td>12,829</td>
<td>30,473</td>
</tr>
<tr>
<td>Fifth</td>
<td>95</td>
<td>300</td>
<td>1,826</td>
<td>6,972</td>
<td>12,647</td>
</tr>
<tr>
<td>“SMSA” total</td>
<td>1,638</td>
<td>4,016</td>
<td>13,458</td>
<td>52,573</td>
<td>113,199</td>
</tr>
<tr>
<td>U.S. total</td>
<td>3,929</td>
<td>12,866</td>
<td>39,818</td>
<td>105,711</td>
<td>179,323</td>
</tr>
</tbody>
</table>
Fig. 7—Changes in size order, major towns and neighboring counties, 1790–1830. Population-density isopleths generalized from Lord and Lord, op. cit. [see Fig. 6], pp. 46 and 49.
Fig. 8—Changes in size order, major towns and neighboring counties, 1830–1870. Population-density isopleths generalized from Lord and Lord, op. cit., pp. 49 and 104.
Fig. 9—Emerging metropolitan areas in the Steel-Rail Epoch. Changes in size order of major cities, including neighboring county populations, 1870-1920. Population-density isopleths generalized from Lord and Lord, op. cit., pp. 104 and 107-108. Sources of population data: "A Compendium of the Ninth Census" (1872) and "Abstract of the Fifteenth Census of the United States" (1933).
development of a national system of transportation, albeit a crude one. The
epoch saw not only the emergence of a first-order center but also the greatest
increase, both relative and absolute, in the number of second- and third-order
centers in the nation's history (Table II).

The map for this epoch (Fig. 8) also reflects the aftermath of the Civil War
and, probably more important, the slow rate of investment in urban, indus-
trial, and transportation facilities in the South in the preceding decades.
New Orleans was an exception. It was a critical point in the national transpor-
tation system that comprised the northern regional rail networks and the
inland waterways. Before the Civil War it had risen to third order and largest
city in the South. Meanwhile Charleston, despite pioneer railroad building
into its comparatively static agricultural hinterland, dropped to fourth order
and began a prolonged relative decline.

Steel–Rail Epoch, 1870–1920

By 1870 major urban areas had arisen as far west as the Missouri River
frontier, and one (Little Rock, Arkansas) had appeared west of the Mississippi
in the South. Many resource concentrations remained unexploited pending
further improvement of the land transportation system and creation of a
network of urban centers in the West and South. By the beginning of the
following epoch all these regions had been knit together by a standardized,
nationwide system of rail lines, and the modern pattern of major urban centers
was beginning to emerge (Fig. 9).

New urban centers reflected the opening or commercialization of the
remaining important agricultural land resources of the West—the Texas and
Oklahoma prairies, the Colorado piedmont, the Wasatch piedmont, the
Central Valley and Southern California, the Puget Sound–Willamette low-
land, and the Palouse. They also reflected the exploitation of thitherto isolated
major mineral deposits, such as Butte copper, southwest Missouri lead and
zinc, and Lake Superior iron ore, and of mineral and timber resources in the
mountains adjoining the agricultural oases and valleys. Finally, they reflected
the advance of the agriculture-timber-mineral frontier into Florida.

In the older settled areas the boom cities were associated mainly with the
upward leap in the importance of coal—especially high-grade bituminous—
that accompanied the growth of the modern iron and steel industry. A
cluster of boom cities emerged on the western Pennsylvania coalfields and
in the area between Pittsburgh and Lake Erie; and metropolitan Birmingham
appeared on the map in the South. Other, but less spectacular, advances in
rank occurred along the Norfolk–Toledo axis as long-haul technology opened
the rich bituminous deposits of West Virginia and eastern Kentucky. Still others resulted from industrial growth based on the forest resources along the northern frontier of the agricultural Midwest and on the resources readily available for the hydroelectricity-based industrial development on the Piedmont in the South. Meantime, nearly all the great metropolitan commercial centers of the Midwest and Northeast, while establishing themselves as major industrial cities, retained their positions or advanced one level in the hierarchy.

Two groups of metropolitan areas accounted for most of the declines in size order in this epoch. The largest group comprised the towns along the Ohio-Mississippi-Missouri and principal tributaries. Smaller centers such as Dubuque and Quincy (Illinois) dropped out of the “metropolitan” ranks; St. Louis, Louisville, and Wheeling fell in the hierarchy, never to recover the relative positions they had held during the epoch of the steam packet and the iron horse. A second group consisted of a number of important industrial cities at historic waterpower sites along the Mohawk, the Merrimack, and the Blackstone and minor ports on the Hudson and the New England coast. None of these places was to regain the level it had held before the epoch of the steel rail and central-station electric power.

The main shifts during the epoch are summarized in Table II. The new centralization of industry in major metropolitan areas was reflected in the growth of the five largest “SMSA’s.” That group increased its share of the national population faster than in any other epoch. The number of third- or higher-order centers, which had increased greatly in the Iron Horse Epoch, was stabilized, but their share of the nation’s people rose sharply. The extension of national accessibility to isolated parts of the South and West augmented the number of lower-order metropolitan centers. The total number of fourth- and fifth-order cities registered its greatest growth in this epoch.

**Auto-Air-Amenity Epoch, 1920–**

By 1920 the present pattern of settled areas had been established, and subsequent metropolitan changes have taken place within that pattern. Nevertheless, new resources and locations have been exploited and old ones abandoned (Figs. 10 and 11).

The much smaller labor force required per unit of production in the extractive industries is reflected on the map in the relative decline of Butte and Joplin and, along with the shift from steam to internal combustion, in the decline of coal and railroad centers in the Appalachians and across the Midwest. The shift to internal combustion is, of course, largely behind the out-
break of new or higher-order metropolitan areas in the oil fields from central Kansas to western Texas and the western Gulf Coast and in the concentration of growth in the SMSA’s of southern Michigan.

Regional and metropolitan dispersal, inherent in the shift to auto and truck and in the development of a dense highway network, is reflected on Figures 10 and 11 in two principal ways. One is the entry into the metropolitan ranks of numerous “satellite” cities on the fringes of the historic Manufacturing Belt and within 100 to 150 miles of great metropolitan industrial centers. The other is the effect of suburban dispersal on the definition of a metropolitan area. In the Appalachians, for example, half a dozen “SMSA’s” have dropped out because their central cities failed to maintain a population equal to, or larger than, that of other metropolitan centers. In these cases it is typical to find a central city crowded on a valley floor, blighted by obsolescent buildings, air pollution, narrow streets, and rusty rail lines, and exposed to flood risk. Population and commercial growth have dispersed to the uplands to exploit the resources of open space, a dense rural road net, panoramic views, and relatively clean air. The result is that the metropolitan area has grown and ceased to be “metropolitan” by definition, and the central city has declined and ceased to be “central” in fact.

This diffusion of metropolitan structure is also evidence of the increasing importance of amenities in determining the growth pattern of individual cities and regions. The location of the boom centers is further evidence of the force of amenity on a national scale. All are in Florida, the desert Southwest, and Southern California. The migration to the Southwest and Florida in the Auto-Air-Amenity Epoch has been as massive as any in the earlier westward movement. There was a net migration of 11.4 million persons to California, Arizona, and Florida from other regions between 1920 and 1960. This equaled the total population gain—and was probably double the immigration—for the twelve North Central States during the Iron Horse Epoch, 1830–1870.24

At the regional scale the increase in importance of educational centers, related in part to the growing importance of amenity, is illustrated by two pairs of Midwestern cities. The coal-rail center of Danville, Illinois, dropped out of the “metropolitan area” group, and the nearby university center of Champaign-Urbana entered it. Among the urban centers of the old eastern

Fig. 11—Geographic distribution of SMSA's by size order, 1960. Population-density isopleths have been generalized from "Goode's World Atlas," 12th ed., 1964, p. 58.
Indiana gas belt, the industrial city of Anderson dropped out, and neighboring Muncie, with both industrial and university functions, entered.

**Effects of Technological Change**

Throughout the evolution of the present pattern of American metropolitan areas two factors, great migrations and major changes in technology, have particularly influenced the location of relative growth and decline. Both factors have repeatedly been given specific geographical expression through their relationship to resource patterns. Major changes in technology have resulted in critically important changes in the evaluation or definition of particular resources on which the growth of certain urban regions had previously been based. Great migrations have sought to exploit resources—ranging from climate or coal to water or zinc—that were either newly appreciated or newly accessible within the national market. Usually, of course, the new appreciation or accessibility had come about, in turn, through some major technological innovation.

Nor can one see the end of these changes in locational advantage due to technological change and migration. Speculate, for instance, on the possible outcome of three changes, quite conceivable within the next half-century, whose seeds may well be lying in our midst at present. Assume the automation of, say, 80 percent of the office work heavily concentrated in the downtown skyscrapers of major metropolitan centers. Or assume the production of low-cost, mass-produced, single-family dwellings varied in style and superior in structure and maintenance to those now in use. Or assume the introduction and success of a lightweight family vehicle that requires neither steel to build nor oil to power. Clearly, the process of urban growth in an open system is open-ended. To be sure, the rate of change from any point in time is constrained by the existing physical plant and institutions. But there is unlikely to be any “end product” of the process. Each epoch will simply be succeeded by another.

**Varying Predictability of Metropolitan Growth**

If metropolitan growth tends to be epochal and open-ended this suggests two probable characteristics of its predictability.

On the one hand, during any given epoch, similar conditions of paramount importance are likely to govern the rate and direction of growth over wide regions or types of location. Of course, countless short-term random effects are superimposed on the long-term trend. One might therefore ex-
pect the growth trend for a given metropolis during a given epoch to be regressive. That is, short-term spurts or declines will expectably be offset by succeeding short-term trends in the opposite direction. A regression line, fitted to the points representing these frequent ups and downs, describes the long-term trend. Thus the Upper Midwest Economic Study’s urban re-

![Graph showing population growth over time](image)

**Fig. 12**—Population of the two counties comprising the Johnstown, Pa., SMSA (1960), by decades, 1830–1960. The depression of the 1930’s, with its temporary decrease in mobility of a substantial economically "stranded" population, appears as a relatively short-term, low-amplitude event in the growth history in comparison with either the rise of the steel industry and dominance of steam-powered rail transportation or the advent of the internal-combustion engine.

search disclosed that past growth trends (during the automobile epoch) provided by far the most significant independent variable in a multiple regression equation to project 1950–1960 population growth rates of urban areas in its study region.25

On the other hand, when some basic component of the nation’s society or economy or technology “turns a corner” and a new epoch opens, a new set of

Fig. 13—The varied historical layering of American SMSA's in 1960.
overriding and “long-term” forces goes into effect. Thereafter, one might expect past growth to cease to be a good predictor. At the least, its validity would have to be reestablished for a new set of conditions. The old regression line for a given metropolitan area would not necessarily represent the long-term growth trend in the new epoch. Short-term fluctuations would be less likely to regress toward the same line as in the preceding epoch (Fig. 12).

As the new epoch unfolds, a new pattern of “initial advantage” also emerges; for certain advantages are created that could not have existed before. Business and civic institutions must reorganize to meet new challenges. This seems to have been done most effectively in the places least tied to natural-resource exploitation or secondary production, and with the largest and most diversified hinterlands, hence the most important centers of circulation and management. Even some of the high-order centers have had to make massive adjustments from one epoch to the next; St. Louis and Pittsburgh are probably the outstanding cases so far.

INTERNAL DIFFERENTIATION OF METROPOLITAN AREAS

During each epoch a new increment of physical development has been added to each metropolitan area. Each increment is eventually differentiated from the adjoining ones not only by the age of its structures but also by their scale, design, use, degree of obsolescence, and, often, site or location. The successive increments form distinctive regions in the internal geography of any metropolitan area, and the regions have certain characteristics in common wherever they appear across the country.

But historically different increments tend to differentiate American cities at least as much as they tend to standardize them (Fig. 13), because cities differ profoundly in their epoch of initial settlement and in their periods of boom or decline. For example, it is possible that a Chicago or a Los Angeles metropolitan area will someday be as populous as the present metropolitan area of New York. But both are most unlikely to have a physical structure similar to New York’s, even aside from the differences among the natural settings.

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26 This suggests a modification of Allan Pred’s model of self-generating urban growth during a period of rapid industrialization (Pred, op. cit. [see footnote 1 above]). Innovation in a particular industry, because of its impact on the evaluation of a particular resource, may result in new or expanded industry at a place other than the one at which the innovation occurred. In that case, the flow of benefits may be diverted to a new location. The observed evolution also suggests that technological change may be considered an integral part of the basic process that generates an urban hierarchy. Although this was recognized by Walter Christaller in the section on “Dynamic Processes” in his “Central Places in Southern Germany” (translated by Carlisle W. Baskin; Englewood Cliffs, N. J., 1966, pp. 84–132), technological change has generally been handled as a secondary “modifier” of the basic model.
Chicago’s growth so far belongs 47 percent to the Steel-Rail Epoch and 45 percent to the Auto-Air-Amenity Epoch; corresponding percentages for Los Angeles are 15 and 85 (Table III). Hence their historical increments have been markedly different, and their future increments will belong to a different technology from that which has built present-day New York.

If the system is indeed evolving and open-ended, it is patently incorrect to consider either Los Angeles or Chicago illustrative of a stage en route to the development of another New York or, for that matter, to consider any American city to be at any stage in any rigid model of development.

**EXPLOITATION OF LAND**

America’s metropolitan centers grew initially on land whose sites and locations were regarded as advantageous, given the contemporary technology and migration pattern. Improvement and use of the land made redevelopment or restoration much more costly, if not impossible. At first the land was “improved”; but as the improvements aged and grew obsolete the land appeared instead to have been “despoiled.” New technologies hastened obsolescence and transferred the locational and site advantages to other land. Men moved to this new land and began again the sequence of improvement and abandonment: they abandoned the obsolete buildings, locations, or cities to those who remained behind to adapt and abandon in their turn.

This sequence of land selection in the light of existing technology, development, use, despoliation, and abandonment has characterized in varying degree the past utilization of timber, soil, water, and mineral resources. It appears also to have characterized the use of land for urban purposes. The process can be visualized at three different scales on the accompanying maps. At the metropolitan scale it is illustrated by the partial abandonment of the central city for outlying areas during successive technological epochs; at the regional scale, by the shift of new development from mining towns to university towns, from railroad centers to recreational centers; at the national scale, by the shift from older cities in the Northeast to newer cities in the Southwest or Florida. It could be argued that, at any scale, the basic attitude toward the potential urban land resource has been exploitive. There is no general provision for “recycling” the resource of developed land when the initial development has become obsolete.

The result is a gigantic, national “filter down” process with important geographical and historical dimensions. The nation’s new construction has been concentrated, in any given epoch, not only in new neighborhoods and
new suburbs but also in what have been, for all practical purposes, new cities (Table III). The residue of obsolescent physical plant has also become concentrated, not only in certain districts of most cities but in virtually the entire area of some. Vast big-city cores and nearly the whole of some smaller metropolitan areas are approaching the condition of inhabited ruins, and the residue of old structures continues to expand, thanks to the lagging national rate of replacement. Analysis of available historical housing data indicates that the construction of new dwelling units over the first sixty years of the twentieth century was enough to replace, on the average, only 4 percent of the units standing at the end of each decade.27 For later generations the legacy

<table>
<thead>
<tr>
<th>SIZE ORDER</th>
<th>SMSA</th>
<th>WAGON-SAIL</th>
<th>IRON HORSE</th>
<th>STEEL RAIL</th>
<th>AUTO-AIR-AMENITY</th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>PRE-1830</td>
<td>1830-1870</td>
<td>1870-1920</td>
<td>1920-1960</td>
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<tr>
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<td>3</td>
<td>11</td>
<td>44</td>
<td>42</td>
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<tr>
<td>Second</td>
<td>Philadelphia</td>
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<td>15</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td></td>
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<td>8</td>
<td>47</td>
<td>45</td>
</tr>
<tr>
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<td>0</td>
<td>6</td>
<td>29</td>
<td>65</td>
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<tr>
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<td>27</td>
<td>66</td>
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<td>Los Angeles</td>
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<td>0+</td>
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<td>85</td>
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<tr>
<td>Third</td>
<td>Washington</td>
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<td>5</td>
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<td>71</td>
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<td>56</td>
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<tr>
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<td>New Orleans</td>
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<td>67</td>
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<td></td>
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<td>0</td>
<td>4</td>
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<td>23</td>
<td>25</td>
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<tr>
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<tr>
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<td>Scranton and Wilkes-Barre-Hazelton</td>
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<td>63</td>
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</tr>
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<td>1</td>
<td>47</td>
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<td>40</td>
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<td>Corpus Christi</td>
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<td>2</td>
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<td>93</td>
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<td></td>
<td>Las Vegas</td>
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<td>4</td>
<td>96</td>
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</table>

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of buildings, like the earlier "natural" endowment, has become an exploitable physical resource.

On the one hand, the traditional exploitive development of the land resource for urban purposes is understandable in view of the abundance of undeveloped land, the high costs of acquiring and clearing used land, and the high replacement costs under prevailing conditions. On the other hand, the growing accumulation and low level of maintenance of obsolescent districts and cities suggest the inadequacy of the present approach.

**ADAPTABILITY AND CONTROL**

Two major problems seem to result from the nature of metropolitan evolution. First, long-term changes in size and physical character are highly uncertain. Second, the exploitation of new land and accompanying abandonment of old in successive periods lead to a gigantic accumulation of residual structures. This residue is a drag on both the improvement of the general health and welfare and the market for new, low-cost buildings.

It appears unlikely that the tendencies inherent in this evolutionary process will change significantly. To be sure, the fraction of the total number of metropolitan areas that changed size order diminished during the Steel-Rail and Auto-Air-Amenity Epochs. Also, there have been fewer booms (Table IV). This increasing stabilization was to be expected as the national trans-

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Table IV—Number of SMSA’s and Emerging SMSA’s Experiencing Shifts in Size Order

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Up one rank</td>
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<td>37</td>
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<td>65</td>
</tr>
<tr>
<td>Up two ranks</td>
<td>11</td>
<td>16</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Up three ranks</td>
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<td>4</td>
<td>3</td>
<td>1</td>
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<td>Down one rank</td>
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<tr>
<td>Down two ranks</td>
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<td>2</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Steady</td>
<td>26</td>
<td>24</td>
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<td>New entries</td>
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<td>17</td>
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<tr>
<td>Net increase</td>
<td>13</td>
<td>39</td>
<td>56</td>
<td>31</td>
</tr>
</tbody>
</table>

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28 Louis F. Winnick (Housing and Urban Development: The Private Foundation’s Role [The Ford Foundation, New York, 1965], p. 3) makes the following observations: "No other important consumer good has been as inflation-prone as housing. Over the past seventy years the cost of a unit of housing space has risen twice as fast as other costs." Also, Chauncy D. Harris has pointed out the very small fraction of the land resource required by cities (The Pressure of Residential-Industrial Land Use, in Man’s Role in Changing the Face of the Earth [edited by William L. Thomas, Jr.; Chicago, 1956], pp. 881–895; reference on p. 889.
portation network was completed and improved and nearly every part of the country raised its level of participation in the national economy. Nevertheless, metropolitan areas continue to grow at differential rates. There has been virtually no decrease over the past two epochs in the number of places that advanced one rank in the size order, and only a slight decrease in the number that declined one rank. At the beginning of each epoch a major change in technology registered its impact on the values of existing metropolitan locations and on the pattern of migration; and some new cities were also established. As long as America remains an open society, there will surely be unforeseen major changes affecting old cities and new alike—new rounds of initial advantage, reorganization, and adaptation, new reasons to exploit new land and abandon old.

Given the two problems of uncertainty and migration-abandonment, pressure is mounting to make the metropolitan settlement pattern more adaptable to change. For this purpose two types of development appear to be of great potential importance. One is the production, for the full range of urban functions, of soundly engineered and attractively designed structures that can be emplaced or removed at much lower costs than in the past. The other is the improvement of information-education systems to increase the extent, accuracy, and currency of knowledge of the changing metropolis. An important consequence of this might be the development of a degree of public objectivity that would permit more rapid adaptation of institutions, notably local government.

On the other hand, one might expect mounting pressure to create new institutions and shift values in order to retard the rate of change and thereby reduce the need for rapid and massive adaptation. For example, in some cases truly comprehensive, long-range planning could lower the permissible rate of

29 Lukermann, op. cit. [see footnote 1 above].
technological change throughout an urban or regional system to that of the least tractable, slowest-changing component of the system, in the interest of preserving orderly development.

The mounting pressures for greater adaptability and greater control may often conflict. Where and how to compromise them seems likely to be an important and recurring issue in the future course of American metropolitan evolution. Furthermore, the issue is likely to be debated and resolved on many different grounds, since no one city is the evolutionary prototype for all others.