THE LAND USE STRUCTURE OF
FIVE AMERICAN CITIES

by

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B.Arch., Massachusetts Institute of Technology
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(1955)

Signature of Author

Department of City & Regional Planning
May 23, 1955

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Frederick J. Adams, Head
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Dear Professor Adams:

I respectfully submit herewith a thesis entitled "The Land Use Structure of Five American Cities" in partial fulfillment of the requirements for the degree of Master in City Planning.

Sincerely yours:

George Th. Marcou
ACKNOWLEDGEMENTS

I wish to express my gratitude to the faculty and fellow students in the department. They have contributed, each in his own way, to create an atmosphere where companionship and learning go hand in hand.

Special thanks are due to Professor John T. Howard who, as my thesis advisor, gave innumerable helpful suggestions and criticism.

My fiancee, Margaret, has helped in the collection and processing of the data. I wish to express my appreciation for her concern.

Miss Dulcie Jones has graciously undertaken the typing of the thesis.
ABSTRACT OF THESIS

Title: The land use structure of five American cities

Author: Georges Th. Mareou

Submitted to the Department of City and Regional Planning on May 23, 1955, in partial fulfillment of the requirements for the degree of Master in City Planning.

Purpose: This study is an initial attempt at describing the internal as well as the total land use structures of five American cities: Chicago, Detroit, Los Angeles, Philadelphia and San Francisco.

Procedure:

1. To describe the importance of a use in a metropolitan area relative to the other uses, the percentages of these uses to the total developed area were analyzed.

2. To describe the importance of a use in a metropolis relative to the same use in other areas, both percentage of total developed and density for each use were correlated with certain factors that are believed to mold the total structure of a metropolis, such as age, economic base, etc.

3. To describe the internal structure of a metropolis, rings of equal population percentages were drawn around the Central Business District and the land use data derived for each. Then indexes measuring the importance of a use in
a ring relative to the same use in the other rings of a metropolis were derived, compared and analyzed.

4. To measure the importance of a use in a ring relative to the other uses in the same ring, their percentages of the total metropolitan developed area were obtained and their spatial ranking described.

Findings:

1. That the five metropolitan areas are in no respect completely alike.

2. That they presented a certain number of similarities:
   (a) that the uses within them tend to take up a spatial scale of importance similar, in general terms, for all five;
   (b) that some of the variations in their total land structure can be traced back to factors such as age or size;
   (c) that the land use structure for residential and commercial uses, although varying considerably from center to hinterland, offers generally similar progressions for all five areas. That industrial uses are a little more individual in their distribution;
   (d) that within a ring, variations can be found in the predominance of a use relative to the other uses in the ring, but that the general rule rather than the exception
is a ranking in spatial importance similar to that of the whole metropolis, at least for the three uses analyzed: residence, commerce and industry.

Thesis advisor

John T. Howard
Associate Professor
of City Planning
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<td>VALUE OF ACCUMULATED INDEX NUMBERS FOR RESIDENTIAL LAND USES, FOR THE FIVE AREAS</td>
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<td>7</td>
<td>VALUE OF INDEX NUMBERS FOR COMMERCIAL LAND USES, FOR THE FIVE AREAS</td>
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<tr>
<td>10</td>
<td>VALUE OF ACCUMULATED INDEX NUMBERS FOR INDUSTRIAL LAND USES, FOR THE FIVE AREAS</td>
<td>29</td>
</tr>
<tr>
<td>11</td>
<td>PERCENTAGE OF TOTAL DEVELOPED AREA IN USE, IN RING</td>
<td>33</td>
</tr>
</tbody>
</table>
I  INTRODUCTION

The last decades have witnessed a tremendous increase in those activities, in the nation, that are city-oriented. That increase has resulted in an intensified trend towards concentration of population in metropolitan areas. Furthermore, the largest metropolitan areas have become larger, more and more metropolitan areas are getting into the larger brackets. These facts have contributed in focusing the attention of students of the city upon the problems of our larger metropolitan areas.

Yet city-oriented, space-consuming activities do not all locate in equal amounts in all metropolitan areas. Nor do they seem to take up an equal amount of space at all points of an urban area. It is the purpose of this thesis to arrive at certain generalizations concerning the spatial distribution of activities between and within some larger metropolitan areas: Chicago, Illinois; Detroit, Michigan; Los Angeles, California; Philadelphia, Pennsylvania; and San Francisco, California.

Planners have found it expedient, in their work, to obtain facts concerning the land use of cities. What does land use imply? Among other things, four basic qualities. Land implies extent and location, these constitute physical qualities. Use implies type and intensity, human qualities that man superimposes upon land.

Extent of land use involves the quantity of land, whether measured in square feet or acres.
Location of land use necessitates the introduction of some point or axis of reference. It involves a distance for a given point or set of coordinates.

Type of land use implies classifying those activities that are "similar" in nature and grouping them together into one "use".

Finally, intensity of land use measures the quantity of a land use with respect to a unit of population. Depending on the problem at hand, any or all of the above four elements will be analyzed.

There are an infinite number of relationships that might characterize the land use structure of a metropolitan area. Four such were chosen. They are:

1. The spatial importance of a use in a metropolitan area relative to the other uses in the same metropolitan area.

2. The spatial importance of a use relative to the same use in other metropolitan areas.

3. The spatial importance of a use at a certain location within the metropolitan area relative to other locations.

4. Finally, the spatial importance of a use at a certain location relative to the other uses in the same location.

To establish the first set of relationships, use will be made of the area characteristics of metropolitan land uses.

The second set will require studying intensity as well as area characteristics.

The third relationship will be established by the use of area and intensity qualities, in a framework of location.
The last set will make use of location and area characteristics.
II DATA AND LIMITATIONS

There are certain limitations inherent in collecting and grouping together land use surveys conducted by different agencies in different areas.

The land use reports published by these agencies are listed in the bibliography.

The limitations are listed under the four headings: extent of land use, location, type, and intensity.

EXTENT:

The land use surveys did not cover, in all cases, the whole metropolitan area. Only Los Angeles and Philadelphia had complete metropolitan surveys. The other surveys covered up to the city boundaries.

Furthermore, the data was presented in different forms. Detroit had its data collected by census tracts, Los Angeles, Philadelphia and San Francisco by groupings of census tracts. Chicago presented its data on the basis of one mile squares. As the population gets less dense, except in Chicago, the census tracts or their groupings get larger. In offering data on a small unit basis where the streets are most often the boundaries, units of uses find themselves split between census tracts.

Philadelphia's land use survey offered its data in two forms: "net" acreage for the city proper, "gross" acreage for the whole
metropolitan area. "Gross use," to quote the survey report, "is the area predominantly occupied by the specified land use category, including streets, vacant lots and interspersed parcels occupied by other uses." The effect of such a distortion is minimized if the form in which the data is studied is that of a ratio. The "net" acreage data was used in the study of the first two sets of relationships outlined in the introduction, the "gross" acreage figures for the last two.

LOCATION:

As was suggested above, introducing the element of location of a use within a metropolitan area immediately necessitates the choice of a point of reference or a set of coordinates.

Basically there are three ways of grouping the data:

Concentric rings around the Central Business District

Sectors around major transportation lines radiating away from the Central Business District

or A combination of the two above.

These three ways reflect, in part, the three major hypotheses advanced by urban theorists.

The Gradient theory, that the land use pattern continuously changes as distance from the center changes.

The Sector hypothesis, that land uses will reproduce themselves in sectors along transportation lines as one radiates from center.

The Multiple nucleus theory that the land use pattern is a reflection of the tendency of certain sections of the city to specialize
forming nuclei distributed within the city.

Whichever way is chosen will in part reflect the truth contained in each of these hypotheses.

The first way of grouping the data was chosen. The data presented for a ring will then be the average for the land uses within that ring. It should then be kept in mind that any results involving location are a reflection of the way the data was chosen to be gathered.

Considering the form of census tracts or their groupings, absolute distance as a ring determinant was impossible to use. The rings were therefore drawn on the basis of:

Compactness around the Central Business District.

As nearly as possible equal percentages of metropolitan population. These percentages were computed on the basis of the population lying within as well as outside the boundaries of the land use survey area. This applies to those areas whose surveys only covered the central city. The land use data presented for a ring whose population lies partly outside the land use area has then to be considered with caution. Maps LA to LE show, at the same scale, the five areas under consideration. Land use survey area, extent of metropolitan area and ring boundaries are shown. It will be noted that in the case of San Francisco the metropolitan area includes the counties of Marin, San Francisco and San Mateo. Both Marin and San Mateo Counties are thought to be oriented more towards San Francisco rather than the Oakland complex for which data was not available. The results obtained in this study seem to corroborate that assumption.
<table>
<thead>
<tr>
<th></th>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>28,310</td>
<td>11,888</td>
<td>222,212</td>
<td>118,931</td>
<td>133,351</td>
</tr>
<tr>
<td>Metropolitan pop.</td>
<td>487,034</td>
<td>208,938</td>
<td>1,351,610</td>
<td>695,745</td>
<td>129,100</td>
</tr>
<tr>
<td>Accumulated pop.</td>
<td>2,518,616</td>
<td>1,244,013</td>
<td>1,591,315</td>
<td>1,566,793</td>
<td>414,000</td>
</tr>
<tr>
<td>Accumulated pop.</td>
<td>3,061,531</td>
<td>1,671,564</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulated pop.</td>
<td>3,770,833</td>
<td>2,226,210</td>
<td>2,451,022</td>
<td>595,300</td>
<td></td>
</tr>
</tbody>
</table>

Figures in brackets ( ) are for the population within the land use survey only.
The accompanying table 1 lists accumulated populations included in the land use survey for each ring and the summation for each ring of population inside and outside the land use survey area, also accumulated. Included in the table are the accumulated percentages of population in ring relative to the metropolitan area. When we come to study location, these percentages are going to serve as distance characteristics.

**Type**

There were certain differences between the definitions of the land use categories used by the various cities. An attempt has been made to reduce these differences to a minimum. Certain uses were reclassified where the categories were flexible enough to allow it. By taking broad land use categories such as residential or industrial and railroads, the data became more easily comparable between metropolitan areas.

Some land use surveys included categories that grouped two uses together, such as mixed residential and commercial. The data for these categories were split on a basis uniform for all metropolitan areas.

**Intensity**

The land use surveys spanned, for all cities, a number of years. In general, they were started in the 30's, the reports were all published between 1941 and 1946. The population figures used to determine intensity of use as well as the rings of equal percentage of
population are those reported by the 1940 U.S. Census of population.

Four relationships were listed in the introduction that were considered indicative of the land use structure of metropolitan areas.

The four following chapters are dedicated to the analysis of these relationships.
<table>
<thead>
<tr>
<th>Category</th>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Residence</td>
<td>15.9</td>
<td>28.9</td>
<td>36.9</td>
<td>-</td>
<td>24.8</td>
</tr>
<tr>
<td>Multiple Residence</td>
<td>16.2</td>
<td>10.1</td>
<td>2.3</td>
<td>-</td>
<td>12.0</td>
</tr>
<tr>
<td>Total Residence</td>
<td>32.1</td>
<td>39.0</td>
<td>39.2</td>
<td>32.7</td>
<td>36.8</td>
</tr>
<tr>
<td>Commerce</td>
<td>5.8</td>
<td>4.9</td>
<td>3.5</td>
<td>3.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Industry</td>
<td>19.0</td>
<td>10.0</td>
<td>15.3</td>
<td>17.8</td>
<td>9.2</td>
</tr>
<tr>
<td>Recreation</td>
<td>6.1</td>
<td>5.6</td>
<td>5.9</td>
<td>11.9</td>
<td>7.5</td>
</tr>
<tr>
<td>Public &amp; Semi Public</td>
<td>4.5</td>
<td>4.7</td>
<td>4.3</td>
<td>8.1</td>
<td>3.8</td>
</tr>
<tr>
<td>Streets</td>
<td>32.4</td>
<td>35.9</td>
<td>31.7</td>
<td>26.1</td>
<td>37.0</td>
</tr>
</tbody>
</table>

Table 2 - Percentage of land in use to total developed area for the five areas.
<table>
<thead>
<tr>
<th></th>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Residence</td>
<td>4.9</td>
<td>12.3</td>
<td>27.7</td>
<td>.</td>
<td>7.5</td>
</tr>
<tr>
<td>Multiple Residence</td>
<td>5.0</td>
<td>4.3</td>
<td>1.7</td>
<td>.</td>
<td>3.6</td>
</tr>
<tr>
<td>Total Residence</td>
<td>9.9</td>
<td>16.6</td>
<td>29.4</td>
<td>6.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Commerce</td>
<td>1.8</td>
<td>2.1</td>
<td>2.6</td>
<td>.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Industry</td>
<td>5.9</td>
<td>4.2</td>
<td>11.5</td>
<td>5.6</td>
<td>2.8</td>
</tr>
<tr>
<td>Recreation</td>
<td>1.9</td>
<td>2.4</td>
<td>4.4</td>
<td>2.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Public &amp; Semi Public</td>
<td>1.4</td>
<td>2.0</td>
<td>3.2</td>
<td>1.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Streets</td>
<td>10.0</td>
<td>15.3</td>
<td>23.8</td>
<td>5.8</td>
<td>11.2</td>
</tr>
<tr>
<td>Total Developed</td>
<td>30.9</td>
<td>42.6</td>
<td>74.9</td>
<td>22.9</td>
<td>30.3</td>
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</table>

**TABLE 3.** DENSITY OF LAND USE FOR THE FIVE AREAS (acres/1000p)
III THE SPATIAL IMPORTANCE OF A USE
RELATIVE TO OTHER USES IN THE
METROPOLITAN AREA

To examine a use relative to other uses in the same area, the totality of the data in each survey report was considered.

In their totality, the surveys covered the land occupied by the following percentages of metropolitan population:

- For Chicago: 75.5%
- Detroit: 70.7%
- Los Angeles: 100%
- Philadelphia: 66.1%
- San Francisco: 86.9%

Maps 2A to 2E, show in a generalized way the land use pattern for the five areas. The data were nevertheless compiled and grouped as shown on tables 2 and 3. Table 2 lists the land use data in the form of percentage of developed area and table 3 in that of acres per thousand population.

The spatial importance of a use relative to the other uses in the urban area can best be seen by ranking the uses for each area in decreasing order. Whether one chooses percentage of developed areas or acres per thousand population, the results are the same.

Table 4 lists for each urban area, the land use categories in order of decreasing space consumption.

It can be readily seen that the largest percentages of land are
<table>
<thead>
<tr>
<th>City</th>
<th>% of total developed</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streets</td>
<td>32.4</td>
<td>Residence</td>
<td>Residence</td>
<td>Residence</td>
<td>Streets</td>
</tr>
<tr>
<td>Residence</td>
<td>32.1</td>
<td>Streets</td>
<td>Streets</td>
<td>Streets</td>
<td>Residence</td>
</tr>
<tr>
<td>Industry</td>
<td>13.0</td>
<td>Industry</td>
<td>Industry</td>
<td>Industry</td>
<td>Industry</td>
</tr>
<tr>
<td>Recreation</td>
<td>6.1</td>
<td>Recreation</td>
<td>Recreation</td>
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<td>Recreation</td>
</tr>
<tr>
<td>Commerce</td>
<td>5.8</td>
<td>Commerce</td>
<td>Public &amp; S. Public</td>
<td>Public &amp; S. Public</td>
<td></td>
</tr>
<tr>
<td>Public &amp; Semi Public</td>
<td>4.5</td>
<td>Public &amp; S. Public</td>
<td>Commerce</td>
<td>Commerce</td>
<td>Public &amp; S. Public</td>
</tr>
</tbody>
</table>

Table 4: Uses listed in order of decreasing spatial importance, for the five areas.
taken up by either residential or street uses. Each of these uses
takes up from 26.1% for Philadelphia to 39.2% for Los Angeles. Vari-
atations are great.

The differences between the percentages of land taken up by resi-
dential uses and those devote to streets read as follows:

- .3 for Chicago
- .2 for San Francisco
+3.1 for Detroit
+6.6 for Philadelphia
+7.5 for Los Angeles

Chicago makes a more extensive use of the space-consuming grid-iron
street system than any of the other four areas. An examination of the
maps revealed a larger amount of premature subdivision in Chicago.
The percentage of street land, already developed, is out of proportion
with residential land not yet developed.

Industrial and Railroad lands and Recreational land hold the same
rank for all five urban areas. There still are wide variations though:
from 9.2% for San Francisco to 19.0% for Chicago in industrial use,
from 5.6% in Detroit to 11.9% in Philadelphia for Recreational land.

The last two uses - Commercial on one hand and Public and Semi-
Public on the other - change in rank with different metropolitan areas.

Commercial uses vary from a high 5.8% for Chicago and San Francisco
to a low 3.5% for Los Angeles and Philadelphia. Public and Semi-Public
uses take up a low 4.3% in Los Angeles and a high 8.1% in Philadelphia.

The giant space-consumers are then residential or street land uses.
They are followed in spatial importance by industrial and recreational uses. The least important uses are the commercial and the public and semi-public uses.

One can say then, from the above, that a relationship can be established which holds true for all five of the metropolitan areas, in so far as the uses within them, with some variation, have similar spatial importance relatively to one another. There still are variations though of two natures: variations in rank as well as variations within the same rank between urban areas.

An attempt at explaining these variations will be made in the next chapter.


IV  THE SPATIAL IMPORTANCE OF

A USE RELATIVE TO THE SAME

USE IN OTHER METROPOLITAN AREAS

The variations that we can witness in tables 3 and 4 are due partly to data limitations and partly to the nature of each metropolis.

The nature of a metropolis which affects its land use characteristics is the product of a large number of factors. Such factors as age of the metropolis, its economic structure, its regional background, the topography of its land, all contribute to giving a metropolis its land use pattern.

It is proposed, in this section, to match some of these factors that vary from metropolis to metropolis against the land use data. Inferences between the factors and the data might in part explain the variations in the land use characteristics of the five areas.

A word of caution is needed. A correlation between a factor and the data does not necessarily mean that the factor is the sole responsible for the data variation. Furthermore that correlation may be due to a totally different factor. Nevertheless certain reasonable conclusions can be drawn from comparing the factors to the data. Only simple cross-classification is used and the results are discussed only when an inference exists.

The following factors were chosen partly because they were readily available and partly because they are based on a reasonable basis.
AGE: measured by the number of decades that a metropolitan area has had a central city of 50,000 or more. On that basis, the five metropolitan areas take the following order, as of 1940:

- Philadelphia 14 decades
- Chicago 9 "
- San Francisco 9 "
- Detroit 8 "
- Los Angeles 6 "

In percentage of developed area the following inferences can be seen:

- Spatially, residential uses tend to become more important, the younger a city is.

Later residential development has responded to the overall lowering of densities resulting in residential uses taking up a larger proportion of developed land than previously.

The ratio of the percentages of single family to multi-family shows that tendency. Whereas the ratio is almost equal to unity for Chicago, in Los Angeles single family residence (including a negligible amount of two-family housing) takes up 16 times as much land as multiple housing.

- Spatially recreational lands show in a different way the effect of the age of the metropolis upon their percentages of developed land. There is a general tendency for these areas to take up more space in the older metropolitan areas than in the younger ones.

In acres per thousand population, the following inferences can be seen:-
As it is to be expected, the younger metropolitan areas having been able to respond more easily to technological advances in transportation, take up more area of developed land per unit of population than do the older ones.

This tendency is reflected in lower residential densities.

Commercial land per unit of population follows the same rule. Although both Philadelphia and Los Angeles exhibit approximately equal percentages of land in commercial use, the tendency figures reveal wide discrepancies in intensity of use. Philadelphia's low figure of .7 acres per thousand population is a little less than a quarter of Los Angeles'.

In an attempt to relate the difference in ages between cities to the difference in acres per thousand population, the values for age and density were plotted on illustration 3. A strong correlation can be seen which indicates that a decade difference in age means for these five areas from .2 to .3 additional acres per thousand population.

In recreational lands, the acres per thousand population seem to respond to age. Since residential densities in themselves are also, so it seems, affected by the age of the metropolis, the two were matched against one another.

The data show that younger metropolitan areas develop recreational systems at densities much lower than those of the older areas. This, in spite of the low residential densities found in younger areas and in spite of the more extensive park areas found in older urban
areas. The relation is the inverse of what planners might consider
the more "desirable" situation.

- In street areas, the stress on motor transportation which has
made the low densities of younger metropolitan areas possible has
also increased the relative importance of the acres per thousand
population in that use, for the younger areas.

**SIZE:** Population in 1940 as reported by the U.S. Census of 1940
was taken as a measure of size of the metropolis.

When classified in order of decreasing size, the five areas stood
in the following ranking:

- Chicago     4,499,126 population
- Philadelphia 2,898,644 "
- Los Angeles  2,766,569 "
- Detroit      2,295,867 "
- San Francisco 1,419,604 "

In percentage of developed land, the following inferences can be
seen:-

- It appears from the data that the percentage of acres devoted
to industrial uses increases with the population of the different met-
ropolitan areas.

Even when Los Angeles' peculiar type of industry - oil wells and
open oil storage - is not taken into consideration (1.9% of the metro-
politan area) that relationship remains true.

All of our five areas depend at various degrees, as we shall see
later, on industrial activity. It might be that the larger metropolitan areas, because of their size, are able to afford those services that attract more and more industry. It is also possible that a larger population forms enough of a market for the presence of service manufactures, such as ice cream, to mention one.

In acres per thousand population, the tendency seems to be for lower densities of industrial uses as the size of the metropolis decreases.

Los Angeles, if modified for the reasons outlined above, has only 6 acres per thousand population (5.5 acres per thousand population are devoted to oil industries and storage). Even its other major industry, the motion picture industry, is relatively low density industry.

As the city size increases then, more and more land is proportionally devoted to industrial uses at lower and lower densities.

DEGREE OF INDUSTRIALIZATION AND FUNCTION:— The first is measured in terms of the percentage of employed labor force engaged in manufacturing in 1940. The five metropolitan areas fall in this order:

<table>
<thead>
<tr>
<th>City</th>
<th>Percentage of Labor Force in Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detroit</td>
<td>48%</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>36%</td>
</tr>
<tr>
<td>Chicago</td>
<td>35%</td>
</tr>
<tr>
<td>San Francisco</td>
<td>21%</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>19%</td>
</tr>
</tbody>
</table>

Function categories are defined in those terms:
Manufacturing (Mm): employment in manufacturing: 50% or more of aggregate employment in manufacturing, trade and service establishments, employment in retail less than 30%.

Diversified (Mr): employment in manufacturing less than 50% but greater than employment in retail trade.

Diversified (Rm): employment in manufacturing more than 20% but less than 50% of aggregate, employment in retail trade greater than employment in manufacturing.

The five metropolitan areas fell in the following categories:

Detroit : Mm
Philadelphia : Mr
Chicago : Mr
San Francisco : Rm
Los Angeles : Rm

All five metropolitan areas fall, in various degrees, in the category of manufacturing centers. The three highly industrialized are also those which have the highest degree of industrialization.

In percentage of total developed land, these three areas exhibit a decrease in percentage of land devoted to industry. Detroit the most highly industrialized area is also the one with the lowest percentage of land in industry.

In acres per thousand population, the highest densities are found in the most industrialized areas.
We saw above that there seemed to be a relation between size of city and its industrial land use structure.

If we bring the factors of size and degree of industrialization together, we find that the larger the city, the lower its degree of industrialization. A large metropolitan area then seems to get away from strict specialization. Chicago is more diversified than Detroit, for example, yet that very diversification of services and occupations is instrumental in attracting more and more industry.

**REGION:** As defined by the U.S. Census, the five areas fall in the following regions:

- Philadelphia : North-East
- Chicago, Detroit : North-Central
- Los Angeles, San Francisco : West

No inferences were found between regional background and land use structure.

Variations in the land use data can then be traced back, in part at least, to some factors: The spatial importance of residential land uses is relatively higher in the younger cities.

Recreational uses are more spatially important in older cities.

Industrial land uses increase in importance with the size of the metropolitan area; they decrease, however, as its degree of industrialization increases.
These conclusions are based upon the study of the behavior of the percentage of land use relative to the total developed area. Relative to the population, however, lower densities in developed area, residential land, commercial uses, recreational areas and street uses are characteristic of younger metropolitan areas. Industrial land densities seem to decrease as the size of the area increases and as its degree of industrialization decreases.
V THE SPATIAL IMPORTANCE
OF A USE IN A RING RELATIVE TO
THE SAME USE IN OTHER RINGS
OF THE METROPOLITAN AREA

A metropolitan area contains within its boundaries a certain amount of land devoted to a certain use. It also contains a definite amount of population whose activities center within the metropolitan area.

From the above it follows that we can define a "model" that would constitute a basis for comparison between rings within a metropolitan area as well as between the metropolitan areas. In addition, such a model, adjusted, could become a basis for comparing uses to one another. These are the requirements that the model would have to follow.

Such a model would be a metropolitan area in which population and land uses would be evenly distributed. The word "model" here does not mean to indicate a desirable situation. It is merely a tool of comparison.

It follows that any position of that metropolitan area would contain the same percentage of land devoted to, say, commercial uses \((A)\) as it would contain percentage of population \((P)\). Mathematically, \(\frac{A}{\xi A} = \frac{P}{\xi P}\) or \(\frac{A}{\xi A} \div \frac{P}{\xi P} \neq 1\).

An index comparable to the one stated above can be derived for
<table>
<thead>
<tr>
<th></th>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ar/Ar%EP</td>
<td>2.1</td>
<td>5.8</td>
<td>4.7</td>
<td>5.3</td>
<td>6.4</td>
</tr>
<tr>
<td>EP/Ar%EP</td>
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<td>5.3</td>
<td>1.9</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Ar%EP</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
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<td>0.67</td>
<td>0.79</td>
<td>0.32</td>
</tr>
<tr>
<td>Ae%Ar</td>
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<td>5.5</td>
<td>5.5</td>
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<td>5.5</td>
</tr>
<tr>
<td>Ep%Ar</td>
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<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Ae%Ar</td>
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<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Table 5 - VALUES OF INDEX NUMBERS FOR RESIDENTIAL LAND USES FOR THE FIVE AREAS.
<table>
<thead>
<tr>
<th>Approximate equal accumulated percentages of metropolitan population (in % of survey area)</th>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>8</td>
<td>7.0</td>
<td>10.75</td>
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<td>5.5</td>
<td>2.0</td>
<td>2.75</td>
<td></td>
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<tr>
<td>8.6</td>
<td>5.3</td>
<td>1.62</td>
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<td>6.5</td>
<td>6.1</td>
<td>1.07</td>
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<td>7.3</td>
<td>5.8</td>
<td>1.26</td>
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<td>7.6</td>
<td>3.9</td>
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<td>7.8</td>
<td>9.1</td>
<td>.86</td>
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<td></td>
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<td>12.4</td>
<td>14.6</td>
<td>.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.3</td>
<td>14.2</td>
<td>1.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.3</td>
<td>19.6</td>
<td>.78</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7.8</td>
<td>3.3</td>
<td>.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.4</td>
<td>13.4</td>
<td>1.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.4</td>
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<td>.98</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>34.4</td>
<td>44.5</td>
<td>.77</td>
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<td></td>
</tr>
<tr>
<td>17.9</td>
<td>28.3</td>
<td>.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>7.1</td>
<td>.37</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 7 - Values of index numbers for commercial land uses, for the five areas.
<table>
<thead>
<tr>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>.8</td>
<td>5.00</td>
<td>.2</td>
<td>.8</td>
</tr>
<tr>
<td>3.7</td>
<td>5.8</td>
<td>.64</td>
<td>1.9</td>
<td>5.3</td>
</tr>
<tr>
<td>8.1</td>
<td>79</td>
<td>1.03</td>
<td>1.7</td>
<td>.61</td>
</tr>
<tr>
<td>9.7</td>
<td>91</td>
<td>1.07</td>
<td>10.9</td>
<td>13.1</td>
</tr>
<tr>
<td>17.2</td>
<td>16.6</td>
<td>1.04</td>
<td>15.4</td>
<td>19.4</td>
</tr>
<tr>
<td>13.6</td>
<td>14.2</td>
<td>.96</td>
<td>12.3</td>
<td>19.6</td>
</tr>
<tr>
<td>5.1</td>
<td>12.5</td>
<td>.41</td>
<td>20.8</td>
<td>22.7</td>
</tr>
<tr>
<td>26.1</td>
<td>134</td>
<td>1.94</td>
<td>26.1</td>
<td>134</td>
</tr>
</tbody>
</table>

Table 9 - Values of Index Numbers for Industrial Land Uses, for the Five Areas.
each use, for each ring within each metropolitan area. The "spatial importance" of a use can then be measured in terms of "shares" of that use with respect to our model. Tables 5, 7 and 9 show these values for all five areas for three uses: residence, commerce, industry.

By definition, then, a ring will be said to have its share of a use if its index number coincides with that of our model, or if

\[ \frac{A_{x_A}}{P_{x_P}} = 1 \]

A ring will have "more than its share" if that ratio is larger than unity, less if smaller than unity.

For presentation purposes, the index numbers were grouped into eight ranges. Four of these cover use-rich rings, the other four include use-poor rings.

The index numbers obtained as outlined above constitute only one variable. They have to be matched against other variables which characterize distance from the Central Business District. The accumulated percentage of population within each ring was chosen as the distance variable.

Three uses were chosen to be analyzed for all five metropolitan areas. They are residential, commercial and industrial land uses. Each of these is representative of the largest, smallest and medium space-consumers as was found earlier. The index number for each ring for each use was matched against the accumulated percentage of population within the ring boundaries.

The results for each of the three uses are diagramatically shown for each city separately. They are included in their appropriate use classification.
index \( \frac{A_r}{\sum A_r} \div \frac{P}{EP} \)

- under \( .149 \) 
- \( .125 - .249 \) 
- \( .25 - .499 \) 
- \( .5 - .999 \) 
- \( 1.0 - 1.999 \) 
- \( 2.0 - 3.999 \) 
- \( 4.0 - 7.999 \) 
- over \( 8.0 \)

Residential Land Use Structure
DETROIT'S RESIDENTIAL STRUCTURE
SAN FRANCISCO'S
RESIDENTIAL STRUCTURE

accumulated % of metropolitan population
It should be noted that the available land uses data was representative of areas containing up to

84% for Chicago
100% for Philadelphia
100% for Los Angeles
73% for Detroit
87% for San Francisco

of their metropolitan populations.

The index numbers for the areas whose land use data did not cover 100% of the metropolitan population were arrived at by taking both the population percentages shown above and the total land use acreages within their study areas as equivalent to one hundred percent.

Consequently the true index numbers for the different rings are in reality lower than as shown.

A. RESIDENTIAL LAND USES

The attached illustrations, 4A to 4E, show an idealized ring pattern for each metropolitan area. The rings are in proportion to the percentage of the population within them.

The index value for residential uses for each ring is shown by its appropriate range color. These values are shown on table 5.

Under each ring pattern is a sketch of the actual values of the index numbers, for residential land, for each metropolitan area. These values are average for each ring. The values are plotted on
a semi-logarithmic vertical scale, the effect of which is to visually attenuate differences in the higher ranges. The effect of the scale is also to bring out clearly, any general relationships that might exist.

A look at the diagrams reveals that no two cities are exactly alike. But it also shows, as expected, a tendency for rings to become spatially richer in residential uses as the percentage of the metropolitan population increases.

Considering the use-poor rings, we find that the spatial importance of residential uses increases at a relatively constant rate. The use-poor rings cover that part of the metropolitan area which contains about 50 to 60 percent of the population. "Abnormal" situations such as occur in San Francisco, Philadelphia and Los Angeles, will be discussed later.

The spatial importance of residential uses in the use-rich rings, increases at an accelerated rate. This reflects that relatively more land is devoted to residence, the further away from the center. Relatively accelerated rates of decrease of residential densities on the hinterland of metropolitan areas is a widespread urban phenomenon.

The diagrams as constructed are a reflexion of the changes of acres relative to population. They are an indication of residential densities. That such diagrams reflect densities is true only for residential uses. Residential land is accepted as, so to speak, the origin and destination of daily activities. Night-time population, which is basic to our index definition, is strongly related to that land. This is not so
Approximately equal accumulated percentages of metropolitan population (in and out of survey area)

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Land Use</th>
<th>Residential Land Use</th>
<th>Commercial/Industrial Land Use</th>
<th>Agricultural Land Use</th>
<th>Recreational Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Detroit</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
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</tr>
<tr>
<td>Los Angeles</td>
<td>1000</td>
<td>1000</td>
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<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>San Francisco</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table 6: Values of accumulated index numbers for the five areas.
for other uses. People may or may not shop, work, or play within the same ring in which they reside.

It is also obvious that the picture would be truer if floor area ratios could be applied to the land area. At the center of the metropolis, the floor area would be higher than the actual land acres devoted to residence. At the hinterland the amount of residential land is larger than the actual floor area used for residence. The results would tend to shift the index values closer to our model.

When we come to examine individual cities, we have to adjust for the different sizes of rings. One way is to derive a set of index numbers for the accumulated values of the percentages of residential land to the percentages of the population. These values are shown on table 6. Illustration 5 shows these values plotted for all five metropolitan areas against our chosen distance characteristic. Each value is then the average for all residential land and all population within each ring.

The values will tend to equal unity as the metropolitan population approaches 100 percent.

Chicago, the most populous of our metropolitan areas, displays the characteristics that were described above, for the five metropolitan areas as a whole.

The accumulated index diagram shows that its densities are higher than those of Detroit or Los Angeles. It is probable that a combination of factors and not a single one is responsible for Chicago's high densities. Two of these factors might be the age of the city
and its industrial structure.

The order in which the accumulated index values arrange themselves, notably between 10 percent and 90 percent of the metropolitan population in the same as their order when classified by age. The effect of age is therefore not only on the total metropolis but seems to manifest itself in lower residential densities at any concentric area of the metropolis when the average index value is taken for all within that area.

Furthermore, as we shall see later, Chicago's industrial estates keep up in spatial importance with the population, encouraging higher residential densities.

Chicago's ring 4 displays a decrease in spatial importance incompatible with the city's general trend and the overall pattern. In that same ring there is a drop in the percentage of land devoted to residential uses relative to the total developed area. It is the ring containing part or all of Lincoln, Humboldt, Douglas, Burnham parks. There is also a drop of acres/1000 population of the ring, denoting an increase in residential densities, relative to rings 3 and 5.

Philadelphia, the second most populated metropolitan area studied, displays abnormally high densities in its 50 to 60 percent population range. As previously outlined, it is the oldest of all metropolitan areas and does retain its rank as the most dense area. It was felt, however, that its index values were too low. The data for the Philadelphia metropolitan area is compiled on "gross area" basis. "Gross
area is the area predominantly occupied by the specified land use category, including streets, vacant lots and interspersed parcels occupied by other uses." In delimiting residential areas, more land must have been included in the outer rings, less in the inner ones, resulting in too high inner densities.

Los Angeles is the third most populated area studied. Its consistently lower densities are in part a reflection of its age and in part the decentralized character of its major industries, which will be discussed later. The index values at the outer rings are low, depicting the existence on the hinterland of relatively high density areas. The Long Beach area, for example, has the third and fifth highest densities in single and multiple residence respectively, of the study areas used as a basis for the Los Angeles land use survey. It is a beach community with seashore cottages on small lots. The effect of the presence of such communities is to lower the spatial importance of residential uses.

Detroit, the next to the lowest populated area under study, displays no "extraordinary" characteristics.

San Francisco's central area shows densities that are higher than all the others, except Philadelphia. This would hold true whether the total metropolitan population is taken as that of Marin, San Francisco and San Mateo counties (as shown on diagram) or that of the nine bay area counties.

Shortage of land due to the physical shape of the peninsula and poor topography might be cause for these high densities.
Some of the results that flow from comparing our five urban areas to our model metropolis may be obvious. Our intuitive knowledge of metropolitan areas can nevertheless serve as a check to these results.

Following are the results for the commercial land uses.

**COMMERCIAL LAND USES:**

A look at illustrations 6A to 6E, based on table 7, reveals the existence of certain relationships.

As expected, spatially, commercial uses are most important in the Central Business District. Their importance would be even greater if floor areas were used. These high spatial importance values rapidly fall as the percentages of the population increase. At 10 to 30 percent we pass in general from the use-rich rings to the poorer ones.

Most rings in the metropolitan areas fall in the category of use-poor rings. Objectively this does not mean that commercial facilities are not meeting the standards of population. It merely means that on the basis of our model, the downtown commercial areas are more spatially important than the rest. The Central Business District holds the largest percentage of land with the least population.

Individual diagrams indicate relationships between resident population and the commercial area within their ring. Varying floor area ratios, large possible amounts of relation between the resident population of a ring and the commercial area of other rings, and other factors prevent the index values from being equal to unity. By the same token the fact that the values are with some variation close to
index \( \frac{A_{c}}{\sum A_{c}} \div \frac{P}{\sum P} \)

- Under .1249
- .125 - .249
- .25 - .499
- .5 - .999
- 1.0 - 1.999
- 2.0 - 3.999
- 4.0 - 7.999
- Over 8.0

COMMERCIAL LAND USE STRUCTURE
### Table 8: Values of Accumulated Index Numbers for Commercial Land Uses for the Five Areas

<table>
<thead>
<tr>
<th></th>
<th>Chicago</th>
<th>Detroit</th>
<th>Los Angeles</th>
<th>Philadelphia</th>
<th>San Francisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{A_c}{E_c} % / P % EP$</td>
<td>$\frac{A_c}{E_c} % / P % EP$</td>
<td>$\frac{A_c}{E_c} % / P % EP$</td>
<td>$\frac{A_c}{E_c} % / P % EP$</td>
<td>$\frac{A_c}{E_c} % / P % EP$</td>
<td>$\frac{A_c}{E_c} % / P % EP$</td>
</tr>
<tr>
<td>5.0</td>
<td>.8</td>
<td>1.00</td>
<td>8.6</td>
<td>.8</td>
<td>15.7</td>
</tr>
<tr>
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<td>1.95</td>
<td>14.1</td>
<td>2.8</td>
<td>5.0</td>
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<td>20.5</td>
<td>14.5</td>
<td>1.41</td>
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<td>28.3</td>
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<td>100.0</td>
<td>100.0</td>
<td>1.00</td>
</tr>
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<td>1.02</td>
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<td>89.6</td>
<td>1.0</td>
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Approximately equal accumulated percentages of metropolitan population (in & out of survey area)
unity indicates that the percentage of land in commercial use is close to that of the population, in any given ring, except the downtown area. Considering the latter, the difference between its high values and an average for all other rings gives the extent of the percentage of land area which serves the whole metropolitan area. Furthermore the range of population at which the rings pass from the use-rich to the use-poor categories, is a possible boundary for the extent of most of those uses that serve the metropolitan area as a whole. In our cities, that range is between 10 and 30 percent of the metropolitan population, or from 2 to 5 miles from the center of the Central Business District.

The attached table 8 and illustration 7 show the index values for the average commercial area and the average population at different population percentages. It illustrates the effect of the inclusion of more commercial areas relative to population increases. It shows how Chicago has an average density of commercial use, the lowest of any of the cities.

In considering the overall pattern, there appears a periodic movement of ever decreasing amplitude. The higher downtown values keep decreasing to a point between 30 and 50 percent of the population, then pick up again to a maximum located between 50 and 80 percent, to drop again at the hinterland.

This pattern is modified by a high index value which does not occur for all metropolitan areas at the percentage of metropolitan population. These high values seem to be local phenomena. In the case of Chicago, for instance, the high value is due to the inclusion in the
industrial land use structure
CHICAGO'S
INDUSTRIAL STRUCTURE

Accumulated % of metropolitan population
DETROIT'S INDUSTRIAL STRUCTURE

accumulated % of metropolitan population
Los Angeles' Industrial Structure

Accumulated % of Metropolitan Population
SAN FRANCISCO'S INDUSTRIAL STRUCTURE

accumulated % of metropolitan population
commercial area of an extensive commercial amusement park.

Apart from the variations that are mentioned above, Los Angeles displays at the very hinterland of its area an increase due to Pomona, a relatively dense town separated from Los Angeles proper by low density areas.

In the case of San Francisco, the last ring does not keep up in percentage of commercial land with the percentage of the population. Compared to the inner areas, Sunset, Parkside and Merced, which constitute that last ring are not commercially independent but probably have to rely upon commercial facilities outside their ring.

It should be noted that the relationship that exists between percentages of land devoted to commercial uses and percentage of population is partly due to the existence of string-like commercial development along the main transportation lines radiating from the center.

Commercial uses, then, like residential uses, are closely related to the population. But the spatial importance of these two uses is different. Furthermore, the results as obtained through the use of the model are checked by our intuitive knowledge of the metropolis.

Let us apply our model to the industrial structure of the five metropolitan areas.

**INDUSTRIAL LAND USES:**

Illustrations 8A to 8E based upon table 7 show the industrial land structure for all five of the metropolitan areas.

At first, there appears to be no general common characteristic to
<table>
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<th>Approximately equal accumulated percentages of metropolitan population (in/out of survey area)</th>
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Table 10: Values of accumulated index numbers for industrial land uses for the five areas.
the structure of industrial land uses in the five metropolitan areas. There seems to be a scattering of use-rich and use-poor rings. One thing is apparent that the maxima and minima occur at the center of metropolitan areas or at their hinterland.

An accumulated graph, illustration 9 based upon table 10, shows the evolution of the average index numbers as the percentage of the population of the metropolitan area increases.

Nearer the center, the index values go from a maximum in Chicago to a minimum in Los Angeles. The existence of a port and the ensuing industries grouped around it may be the causes for such a pattern. Chicago, San Francisco and Philadelphia have all port facilities at their centers. Detroit and Los Angeles do not.

Following the next segment of the metropolitan population between 20 and 50 percent, we find that values are close to unity. Deviations from the model for Chicago, Detroit and Philadelphia are not excessive. Industrial land/1000 population of the rings, as well as percentages of industrial land to total developed for these rings are relatively constant. In that range, the radiating transportation lines group around them industrial land to the extent that the increase in land is fairly close to that of the population. It does not, here again, necessarily follow that the manufacturing population finds employment within the same ring. Given a more suitable ring formation for San Francisco, the relative importance of ring 2 would have increased close to those of the other cities at the same population percentages.

In the ranges beyond 50 percent we find increases for all four of
the metropolitan areas for which data are available.

Chicago's chiefly heavy industries are located in that area, most of them south of the Central Business District. Some are inland, others such as the Illinois Steel Company chose to locate on the shore of Lake Michigan.

In Philadelphia, the existence of Chester, a heavily industrialized city, boosts the spatial importance of ring 4. Chester is located on the Delaware. That high value is followed by more "normal" values.

Los Angeles has followed a slightly different pattern from the rest. It is the only metropolis whose center is not located by an important transportation water body. Its basic industries have special locational characteristics that have had an effect on its density structure. Motion picture industries do not depend on transportation for their raw materials or finished products as heavily as other industries do. At the same time they have advantages in aggregating and by their nature are relatively high space consumers. Oil extraction occupies extensive areas and has to locate at the oil site, in the plain sand along the coast. Both these two basic industries have, because of their locational and spatial characteristic, put the emphasis on the rings in which they are located, to the detriment of a more evenly spread out industrial structure.

San Francisco's industry, localized as it is mainly in the Portero, Bayview areas has lessened the spatial importance of the outer ring.
It should be kept in mind that throughout all these metropolitan areas are small industries which are scattered throughout the metropolis. Their effect on our presentation is nevertheless overshadowed by that of the large industrial concentrations.

Comparing the industrial structure of the five metropolitan areas to their residential and commercial structures, it is apparent that the latter display a strong tie to the population. In a word, residential land uses increase in spatial importance, as the percentage of the population increases, commercial land uses drop from their high level at the center of the metropolis to a relatively constant level, as that same percentage increases. The industrial structure's relationship to the same basis is highly modified by other factors that distort its relationship to population.
VI  THE SPATIAL IMPORTANCE
OF A USE IN A RING RELATIVE
TO THE OTHER USES IN THE
SAME RING OF THE
METROPOLITAN AREA

The question of the spatial importance of a use in a metropolitan area relative to the other uses in the same area has been dealt with earlier. There, the totality of the metropolitan area was the unit. Here, the same relationship will be studied but with rings as units.

The same three uses that made the subject of the previous section's study will be dealt with again; they are residence, commerce and industry. Referring back to the section dealing with the metropolitan area as a whole, it had been found for all areas, that these three uses when listed in order of decreasing spatial importance read as follows: residence, industry and commerce. Residential uses are among the largest space consumers, commercial uses among the smallest.

If these three uses were evenly distributed in the metropolis then their order of decreasing spatial importance in each ring would be the same as for the metropolis as a whole.

In order to find what their order is for each ring, a frame of reference was chosen that would apply to all five of our areas. The total developed area for the metropolis was selected. The percentage of the land covered by each of these three uses in each ring, relative to the total developed area of the metropolis, was computed. Table 11
<table>
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Table II - Percentage of total developed area in use, in ring.
lists these percentages plotted against our chosen distance characteristic, the accumulated percentages of the metropolitan population within the rings.

From an examination of the data, it is obvious that the ranking of these three uses varies within the metropolis. It is not as clear cut in each ring as for the total metropolis.

If we were to rank the three uses in order of decreasing spatial importance we would find certain similarities.

The residential uses relative to the commercial uses follow a pattern. Industrial uses, particular as they are to each metropolis, rank themselves in different positions, depending on the ring and the metropolis.

In general, then, and this is visible for those areas whose central data are detailed enough, commercial uses are more important than residential uses, right around the downtown area. From then on, residential uses gain predominance, commercial uses very closely following them in importance but on a much lower scale. This close relationship depicts the extent to which commercial uses, except in the downtown areas, are oriented towards the residential lands or rather towards the population living on those lands. Although both residential uses and commercial uses increase, the former increase at a higher rate than the latter. Commercial uses seem then to be directed more toward population rather than the amount of land in residential uses. It is a known fact that the downtown commercial areas do not only serve the little population within them but the rest of the metropolis. The
point at which residential uses gain predominance over commercial uses cannot be determined for all five areas, due to the variety in ring configuration. But judging from the available data, that point is within 3/4 mile of the center of the metropolis.

Industrial uses are very characteristic to each metropolis. Chicago's chiefly light industry is located right in the downtown area. That and the existence of a port as well as the very low amount of residential land have contributed in giving industry in ring 1 as high a percentage of the developed area as commercial uses, placing them high above residential uses. From that point on, industrial uses take up different percentages of the total developed areas, keeping in most cases their rank between residential and commercial uses. It should be noted here that unlike some of the other five cities, Chicago's industry extends deep into its center.

Detroit's rings display a surprising uniformity. Within the first four rings, commercial uses are overtaken by continually increasing residential uses. Industrial uses are at a minimum. In the four other rings, residential, industrial and commercial uses hold their order, the same as for the metropolis as a whole. The absence of large industrial estates in the inner rings has been mentioned before in connection with the lack of a port on the river, at the center of the metropolis. In that respect Detroit differs from Chicago.

Los Angeles' ring structure does not permit to draw any conclusion concerning its center except that at 4.8 percent of its metropolitan population, the residential land has already overtaken the commercial
land in quantity and that in that ring, industrial land is at the lowest. Rings 2 and 3 display the normal ranking. Ring 4 is the only ring in all five areas, outside "downtown" rings in which industrial land overtakes residential land. The main industries in that ring are space-consuming, oil industries. Their relatively low employment per acre has not been the cause for any extensive residential settlements around them. On the hinterland of the metropolis, beyond the point where the data for both Chicago and Detroit stop, Los Angeles displays a general lowering of the three uses. Residential uses still prominent drop and then rise again as they include the quasi-independent town of Pomona. Commercial uses keep their rank. Industrial uses, the lowest, disappear. Philadelphia displays in each ring the general characteristics that were described above.

San Francisco's ring 1 demonstrates the compact nature of its industry. A better ring formation would have shown an increase in the value of industry in ring 2. Ring 4 also shows by its lack of industry the concentration near the center of industrial uses.

In this connection, we have found that out of the five areas, industrial uses in the center are negligible for Detroit and Los Angeles. In the other cases industry has found a way of infiltrating right to the center. Apart from the lack of port facilities at the center mentioned earlier, Detroit and Los Angeles happen to be the youngest of the metropolis studied. In one way or another this fact may have had the effect of minimizing the importance of industry in the center. By deliberate action, in the case of Detroit, the
industrial belt was diverted, mainly by allowing industry to locate on the branch of the M.C. Railroad that bypasses the civic center. In a way this had the effect of creating another center north of the first one.

The similarities in spatial importance between the ring structure of the three uses have been mentioned before. The pattern of residential-commercial uses and how it varies, the industrial use structure and its particular characteristics.

From the examination of the illustrations, it can be seen that the very vast majority of the population for the five urban areas is contained in those rings where residence, industry and commerce are in that order. The same order that applies for the metropolis as a whole. It can be concluded that that order is the rule rather than the exception. That modifications occur at certain points, for all urban areas, such as the predominance of commercial over residential uses in the "downtown" area; these are variations that are consistent with all the areas. They are probably the result of the same forces. Particular variations occur when the extent of these forces varies from metropolis to metropolis. Some of these forces, such as age, economic base, topography, have been mentioned earlier in connection with the study of a use in an area relative to the same use in other areas. There is no reason to doubt that the same forces do not apply locally to distort the internal structure one way or another, and give each metropolis a characteristic internal structure just as they give it a characteristic total structure.
VII CONCLUSIONS

At this point, two major conclusions can be drawn:

- that, although no two cities have shown exactly the same total or internal land use structures, their data, limited as they are, present certain similarities. These have been expressed at the end of each previous section.

- that the variations that occur in the total as well as the internal structures of these areas can be traced back, at least in part, to the play of certain factors, some of which have been previously identified.

This twofold phenomenon suggests a direction for future research.

First, if there are certain similarities inherent in the land use structure of cities, these similarities can be brought out best by the use of a "model". This "model" can be a theoretical one, as the one used in section V, or it can be an average, for all cities in the United States or for a large number of cities within the same population range.

Second, that if variations can be traced back to the play of certain factors, more research would be needed to identify and define these factors. Factors such as the ones used in section IV have to be refined. Although it may not be possible to identify all the factors that go into characterizing a metropolitan area, a large amount of variation will be explained. Developing factors for such items as
topography, transportation potential, population characteristics, even social attitudes, would be a fruitful direction of research.

As we have seen, not all uses are influenced by a certain factor. The degree of response of a use to a factor constitutes another possible aspect for future research.

But before the need for comparing cities which is manifested by planners as well as students of the city comes close to any satisfactory stage, certain basic units have to be established.

This thesis has been a constant battle with inadequate data.

The work that has been carried out by such organizations as the American Institute of Planners to promote a uniform land use classification has not yet borne its fruits. It may be that another system of classification is needed not only more uniform but also more flexible.

Furthermore, the need to investigate units of area other than the census tract is apparent, specially where non-residential uses are concerned. A better unit will also provide chances for testing on a rational basis the truths contained in the three major theories of urban use, as well as possibly drawing attention to new ones.
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