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AIRLINE PASSENGER TRAFFIC PATTERN WITHIN THE UNITED STATES

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THE density and flow of airline passengers between pairs of communities is only one of the several related research projects which the Civil Aeronautics Administration has completed that deal with a community's characteristics and its demand for air transportation. In these research projects, the statistical indicators of air transportation activity, such as aircraft ownership and aircraft operations, have been correlated with the basic economic factors which create and control them. This article sets forth the factors determining the airline passenger traffic pattern within the continental United States. Traffic density and flow are stated in terms of airline passenger traffic for September 1948, as this is the last September for which complete data are available from the CAB Airline Traffic Surveys.

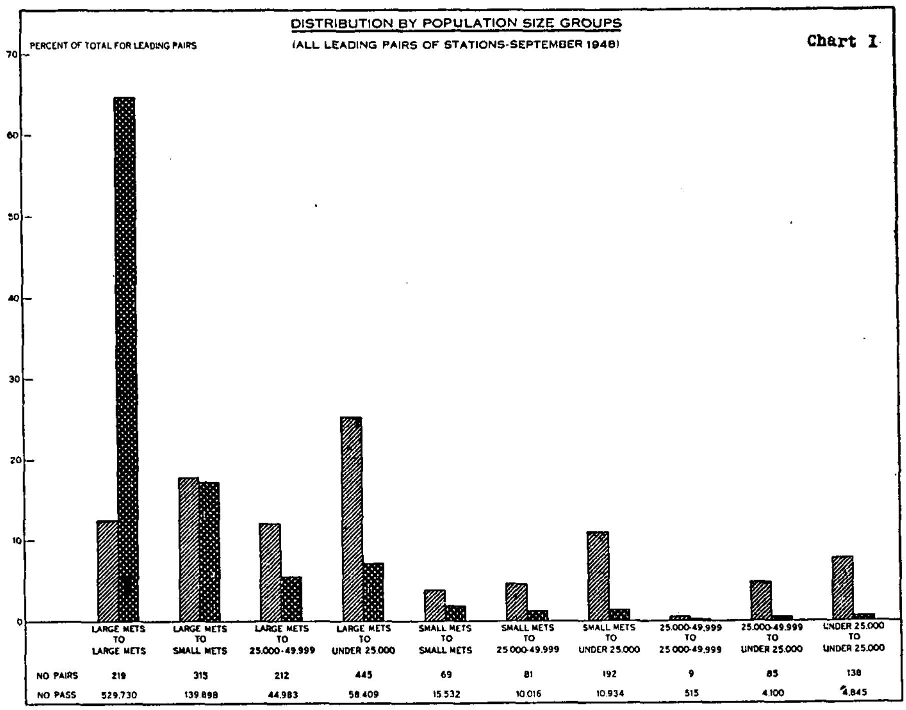
Primary Factors Affecting Traffic Flow

Prior to any discussion of the factors affecting the airline passenger traffic pattern is the recognition that traffic flow is the movement of passengers between two communities. The volume of traffic is controlled, therefore, by factors affecting both of the communities in the pair, rather than factors affecting only one of the places. It follows, therefore, that the primary factors must be ones which are representative of both communities and are a measurement of the combined effect of both communities on the volume of airline passenger traffic.

The very definition of air transportation establishes the *population* of the communities in a pair as one of the primary factors. The combined effect of the population could be stated either as the sum or the product of the populations of the two communities. Population product, rather than the sum, is the correct measurement of the combined effect of the population of the two communities in a pair for it takes into account the relative size of both places.

The population product for a pair of communities is obtained by the multiplication of the population of the two communities in the pair; the population product of New York-Chicago in 1950 was more than 70 trillion, while the one for two communities of 10,000 each amounted to only 100 million. When other factors are held constant, any community will have its maximum passenger volume with the largest place to which it has adequate airline service and, conversely, its smallest traffic with the smallest city. As a rule, therefore, the volume of passenger traffic between pairs of communities tends to vary directly with the difference in the size of their population products.

In September 1948 a substantial volume of traffic between a pair of communities required that one or both communities in the pair be a large metropolitan area (1950 population of 300,000 or more) while a significant traffic density had the requirement that both communities be a large metropolitan area. Chart 1 illustrates the dominating force of large metropolitan areas in the airline passenger traffic pattern and it also shows that substantial airline passenger traffic only occurs between a pair of communities having a large population product. By definition, a large population product requires that at least one community in any pair be a large metropolitan area.



Consider these figures: In September 1948, 64.7% of all passengers were found in pairs of communities where both were large metropolitan areas and an additional 29.7% were in pairs where one of the communities was a large metropolitan area. The remaining 5.6% accounts for all pairs generating traffic in which neither community was a large metropolitan area.

The *distance* between communities in a pair is the second primary factor. Airline passenger traffic, like surface transportation, has the bulk of its activities concentrated within the shorter distances. The number of airline passengers, other things being equal, will vary inversely with the distance between the communities. In September 1948 most of the airline passengers traveled less than 400 miles. As shown in Table 1, only pairs of communities with large population products had sufficient "force" to generate any significant volume of traffic beyond 400 miles. However, the concentration of traffic for pairs of communities in which both were large metropolitan areas occurred in the short distance brackets.

TABLE 1

% of September 1948 Passenger Traffic

Mileage Brackets	*Both Large Met. Areas*	*One Community A Large Met. Area*	*Neither Community A Large Met. Area*
Under 100	2.2	11.0	16.2
100-199	26.2	29.0	52.1
200-299	21.5	26.0	22.0
300-399	14.0	12.0	6.2
Sub-Total	63.9	78.0	96.5
400-799	21.0	17.0	3.5
800-1199	8.1	4.0	0.0
1200 and over	7.0	1.0	0.0
Total	100.0	100.0	100.0

This distance principle is valid in all forms of transportation. However, in air transportation, three qualifications must be made. The first one has to do with a basic attribute of air transportation and will always be a qualification of the distance concept. The other two are qualifications which can possibly be removed, since they relate to the vehicle and management. These three distance qualifications are:

I. *Effect of Differences in Air-Surface Distance Ratio*
Air transportation usually has an advantage of shorter distance over surface transportation, normally about 15%. When the air distance is much shorter than the ground distance, cities benefiting from this condition tend to divert greater proportions of their total traffic to transportation by air. As an example, Milwaukee is almost equi-distant by air from Madison and Muskegon. Madison is the larger of the two cities and is an Institutional with very high purchasing power, while Muskegon is an Industrial with average purchasing power. However, the air distance between Madison and Milwaukee is approximately the same as the ground distance between them, while the air distance between Muskegon and Milwaukee is less than 30% of the ground distance between them. Muskegon and Madison are thus in totally different situations with respect to airline passenger traffic with Milwaukee in terms of time saved over ground transportation. Moreover, they are in different situations with respect to relative costs of air and rail travel. The Madison traveler to Milwaukee pays $4.40 (plus tax) to go by airplane but only $2.84 by rail, while the Muskegon traveler *pays less to go by air than by rail.* The result in differences of air passengers between each of these cities and Milwaukee is startling. During the month of September 1948, the number of passengers by air

between Madison and Milwaukee was only 92, while the number between Muskegon and Milwaukee was 1,361.

II. *Minimum Distance for Airline Passenger Travel*

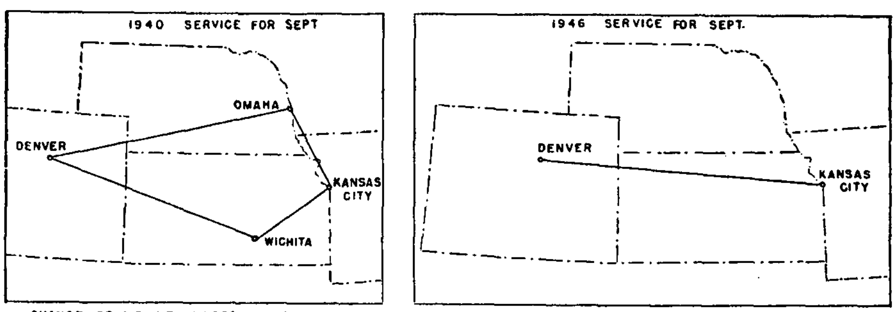
Under present conditions, air transportation is often not a paying proposition to a customer for very short distances. Experience has demonstrated that the minimum competitive distance for airline passenger transportation lies somewhere around 100 miles unless there are counter-balancing barriers to surface transportation. This void of airline passenger traffic in the shorter distances is particularly noteworthy in view of the fact that the bulk of surface-carried passengers travel less than 100 miles. Over 98% of all automobile passengers and over 44% of all rail passengers travel less than 100 miles. By contrast, only 5.7% of all scheduled airline passengers travel within this mileage bracket. This fact points up the absence of airports and aircraft types geared for the mass travel market at short distances.

III. *Management Factors Affecting Airline Passenger Travel*

There are a number of management factors which are not susceptible to mathematical measurement but are of obvious importance in evaluating community air passenger generation and distribution, particularly the time-distance relationships. Examples are: direct versus indirect connections, number of schedules, time of schedules, service standards and other human factors. While such factors cannot be measured precisely, their effect on community air passenger traffic is obvious. Chart 2 shows that when air connections between Denver and Kansas City were indirect, Kansas City contributed only slightly over 1% to Denver's total air traffic and

Chart 2. Direct vs. Indirect Connections

PASSENGERS BETWEEN DENVER AND KANSAS CITY



CHANGE OF AIRLINE NECESSARY AT EITHER WICHITA OR OMAHA

DIRECT ROUTE

PASSENGERS BETWEEN PAIR	29	PASSENGERS BETWEEN PAIR	1484
% OF TOTAL DENVER'S TRAFFIC	1.20	% OF TOTAL DENVER'S TAFFIC	5.70
% OF TOTAL KANSAS CITY'S TRAFFIC	0.21	% OF TOTAL KANSAS CITY'S TRAFFIC	4.63

Denver contributed only 1/5 of 1% to Kansas City's total. When direct connections were established between these two centers, however, the two cities exchanged about 5% of their air passengers with each other.

SECONDARY FACTORS AFFECTING TRAFFIC FLOW

The *economic character* of each community in a pair is the most important secondary factor which influences the volume of inter-city airline passenger traffic. The traffic between any pair of communities varies in accordance with the traffic-generating power of *each* of the communities. The average Marketing Center will generally generate more passengers than the average Industrial city of the same size, because the residents of the Marketing Center have more need for and ability to buy air transportation than do the residents of an Industrial community.

Moreover, the factors of geographic location and of economic character often coincide to swell the community volume of passengers and passenger-miles. Marketing Centers, being central distribution points with vast hinterlands, are relatively far away from other cities of comparable size, while Industrial centers can perform their productive functions best in close proximity to other cities. Institutionals, which derive a major portion of economic support from resort and related activities, similarly often have a greater air transportation community-of-interest with remoter population centers than with those closer at hand. Thus, Miami's largest traffic is with New York City, 1,090 air miles away, and its second largest traffic is with Chicago, 1,190 air miles away. Balanced cities, being by definition about average in purchasing power and air potential, are also around average in passenger flight miles.

The density of communities within a geographic area is the other secondary factor affecting passenger traffic volume between pairs of communities. Where many cities are within an area, the traffic between any pair is minimum because the traffic for each community in the pair is distributed among many. On the other hand, where cities are few in an area, the traffic between a pair is maximum as the traffic for each community in the pair is concentrated with the other.

The heavily populated Northeast is an example of community density. In New England, Hartford, Boston, Bridgeport, Lowell, Providence, Springfield and Worcester are all within 125 miles of each other. New York State has Albany, Buffalo, Rochester and Syracuse close to each other and to the New England large metropolitan areas and to Philadelphia, Baltimore and Washington nearby. A similar situation exists in the industrial belt in and around Ohio. By contrast, Denver's nearest large metropolitan area neighbor, Omaha, is 485 miles away; Miami's nearest large neighbor, Atlanta, is 614 miles away; and San Francisco's nearest large neighbor, Los Angeles, is 327 miles away.

INTER-CITY PASSENGER VOLUME FORMULA

Of the principles discussed, the first two relating to population product and inter-city distance can be measured somewhat precisely. Their mathematical expression is stated below. The traffic between Community X and any other city, with economic character and area density held constant, will be roughly proportionate to the product of the populations of communities divided by the distance between them:

$$\frac{\text{Population} \times \text{Population}}{\text{Distance}} \qquad \frac{(\text{P} \times \text{P})}{(\text{D})} = \text{Traffic Ratios}$$

Like all economic formulae, this one is a guide and an indicator. Its application requires a fundamental knowledge of economic geography and air transportation.

Chart 3 demonstrates the use of this formula to calculate the relative air traffic between Chicago and 11 other communities in the same size and economic character group. The left side of the chart shows that Chicago should theoretically have its largest air passenger traffic with St. Louis, its second largest with Cleveland, etc., and its smallest

Chart 3. PERCENT OF CHICAGO'S PASSENGERS WITH OTHER BALANCED LARGE METS.

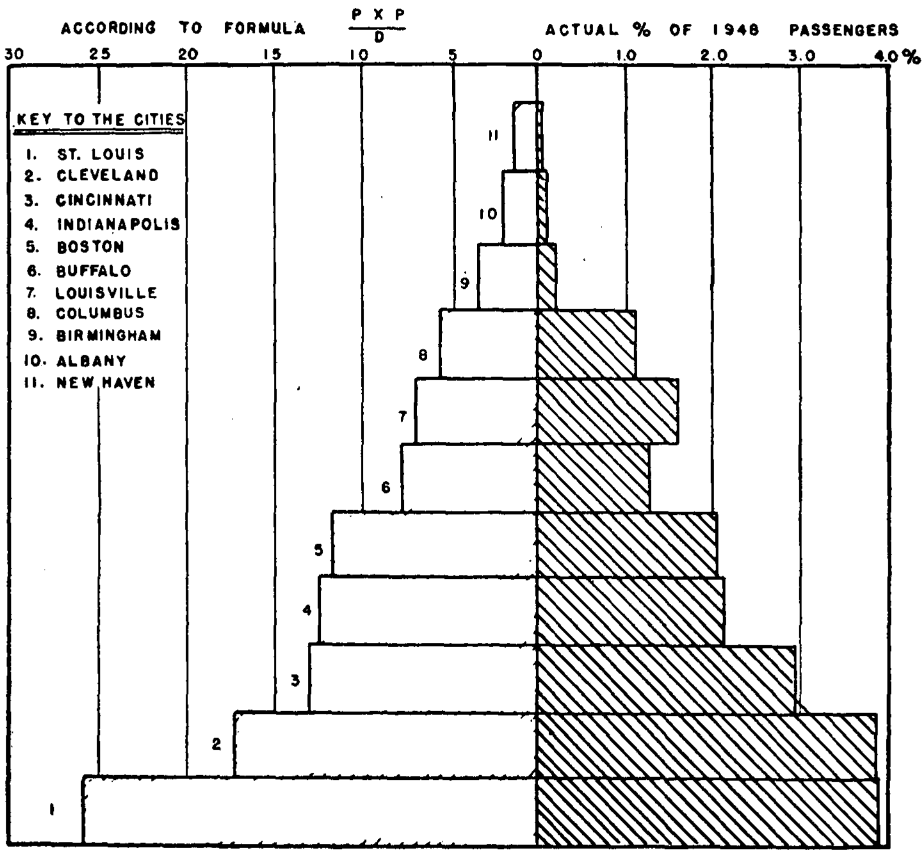
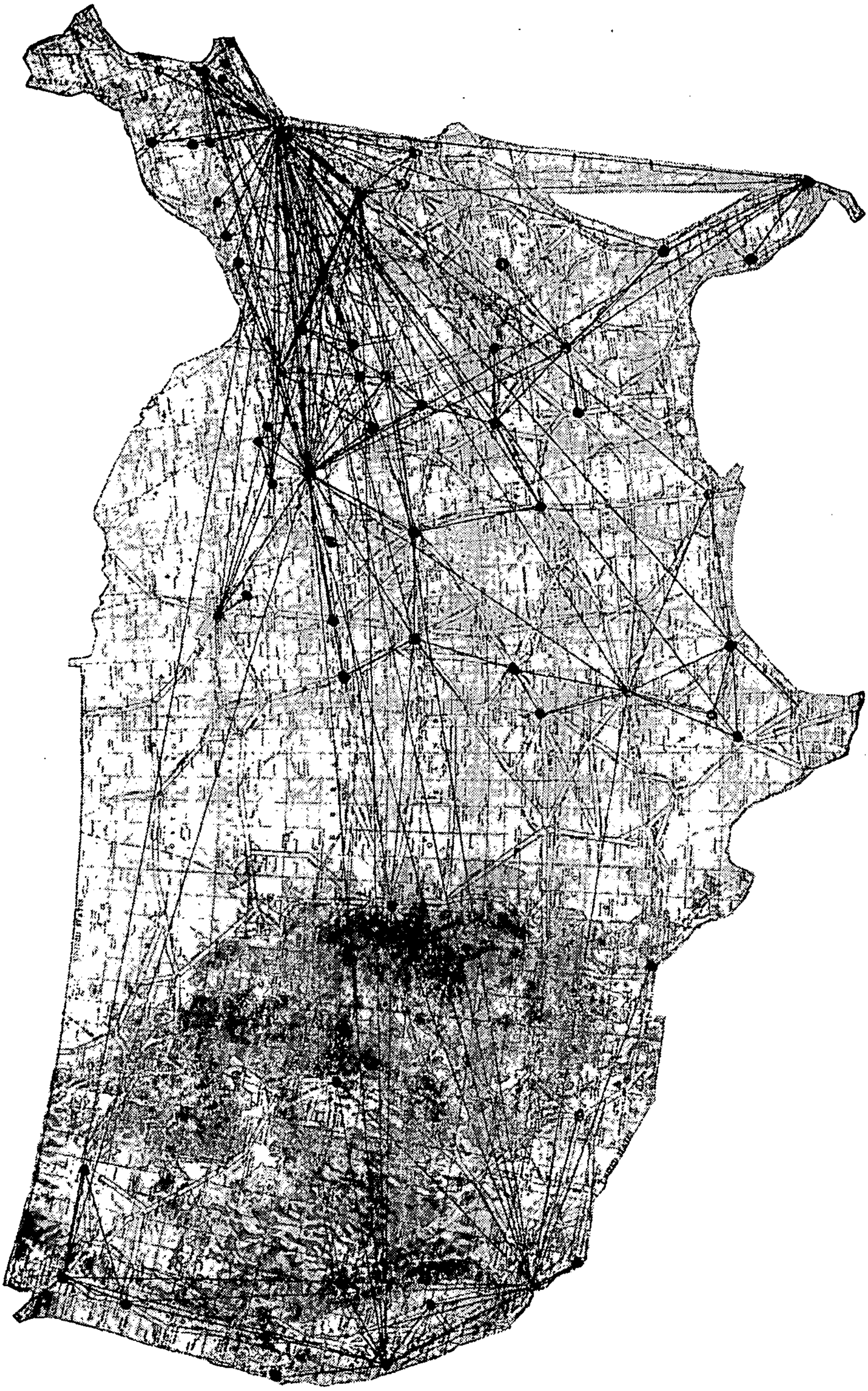


Chart 4. PAIRS WITH 1000 OR MORE PASSENGERS



traffic with New Haven. The actual distribution of Chicago's air passenger traffic during September 1948, on the right side of the chart, shows the close relationship between theoretical computation and actual performance. Again, it is noted that Chicago's largest traffic was actually with St. Louis, the next largest with Cleveland, etc., and its lowest with New Haven. In fact, only one of the 11 communities, Buffalo, was out of line in this comparison of theoretical versus actual distribution. If Chicago's traffic distribution with Marketing Centers were calculated instead of with Balanced communities as in Chart 3, the formula

$$\frac{P \times P}{D}$$

would produce a similarly comparative progression between actual and theoretical traffic distribution by community but on a higher level because of the superiority of traffic-generating power of the Marketing Centers as a group. Conversely, Chicago's traffic with Industrial centers would be on a lower level but still in accordance with the basic formula.

AIRLINE PASSENGER PATTERN

The location of the large standard metropolitan areas within the continental United States, particularly the ones with a population of 1,000,000 or more, establish the basic airline passenger pattern. The pattern so established, shown in Charts 4 and 5, can be likened to a series of "wheels." The "hubs" are communities like New York, Chicago, Washington, Los Angeles and San Francisco, etc., which are connected by "wheel spokes" to lesser "hubs," and "rim-points." High density traffic moves between "hubs"; significant volume occurs between a "hub" and a "rim-point." The volume of passengers for pairs of small cities is relatively unimportant. The concentration of activity around a few "hubs" and in the shorter distance brackets is the trademark of the airline passenger pattern. The passenger patterns for September 1940 and September 1946 were like the one for September 1948. Partial data for September 1949 and 1950 also confirm the September 1948 pattern. This stability occurs because economic geography, rather than chance, fixes the pattern.

It is evident that the geographic distribution of the large metropolitan areas determines the airline passenger traffic pattern within the United States. Will the present pattern hold true for the future? The answer is an unqualified *yes,* for the population distribution within the United States, as disclosed by the 1950 Census, is similar to the ones for previous years. Probably the outstanding facts in the 1950 Census were the continued urbanization of the United States and the concentration of the 1940-50 population growth within the 168 standard metropolitan areas.

Chart 5. Pairs With 100 or More Passengers