

AIRPORTS : THEIR PLANNING, LOCATION, AND CONTROL

by

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Dear Professor Adams:

In partial fulfillment of the requirements for  
the degree of Master in City Planning, I submit this  
thesis entitled, Airports : Their Planning, Location  
and Control.

Respectfully,

William R.B. Froehlich

## PREFACE

The main purpose of this thesis is to investigate the effect of the airport on metropolitan life, to consider the factors involved in judicious airport planning and location, and to investigate and prescribe means of control whereby the airport may be of greatest benefit to the people and the area which it serves. It is a study, primarily, of airports. However, some phases of aviation in general also have been considered in order to trace their effect on airport development.

My thanks are due to the staff of the Department of City and Regional Planning, and particularly to Professors Frederick J. Adams and Roland B. Greeley, for their helpful criticism and guidance in the preparation of this study.

Persons outside of the department were also cooperative. Professor O.C. Koppen of the M.I.T. Dept. of Aeronautical Engineering, Mr. Arthur H. Tully of Harvard's Graduate School of Business Administration, and Mr. A.F. Chargois, Airport Engineer for Region I of the Civil Aeronautics Administration, willingly provided vital bits of information.

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## CHAPTER ONE

### AVIATION — AN INTRODUCTION

In less than a half-century, air transportation has developed from a faltering flight of eight hundred feet over the sands of North Carolina to a major means of transportation. As with any great invention, its initial period has been — and still is — marked by dynamic changes and technological improvements.

So far, aviation's every step has been forward. The passing years have shown many advances including increases in speed, range of flight, and carrying capacity. Exigencies of World War II provided further impetus with such developments as helicopters, jet-propelled planes, turbine engines, and rockets. These improvements, in turn, are producing even greater speeds, longer ranges of flight, and improved load-carrying potentials.

The most striking indications of the growth of aviation and air transportation are the facts and figures of its advance. Figure I shows the number of certificated aircraft at the close of each year. Except for a slight lag during the depression of the middle 1930's, the number of licensed airplanes has increased steadily.

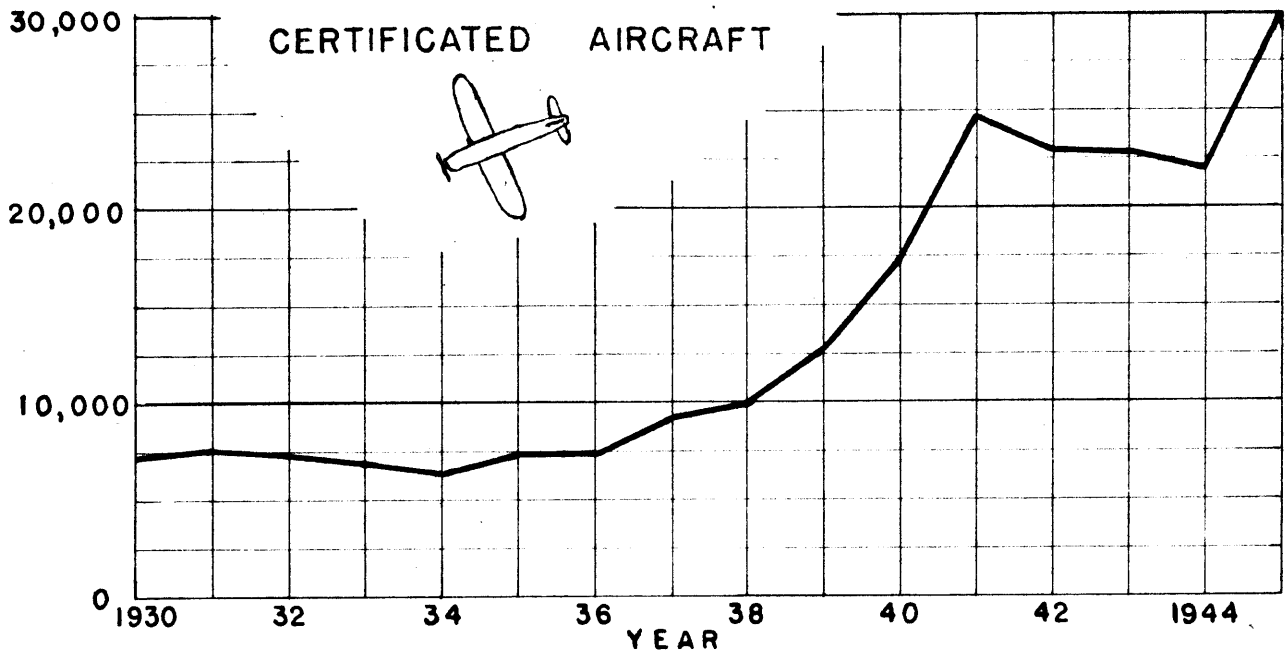


FIGURE I

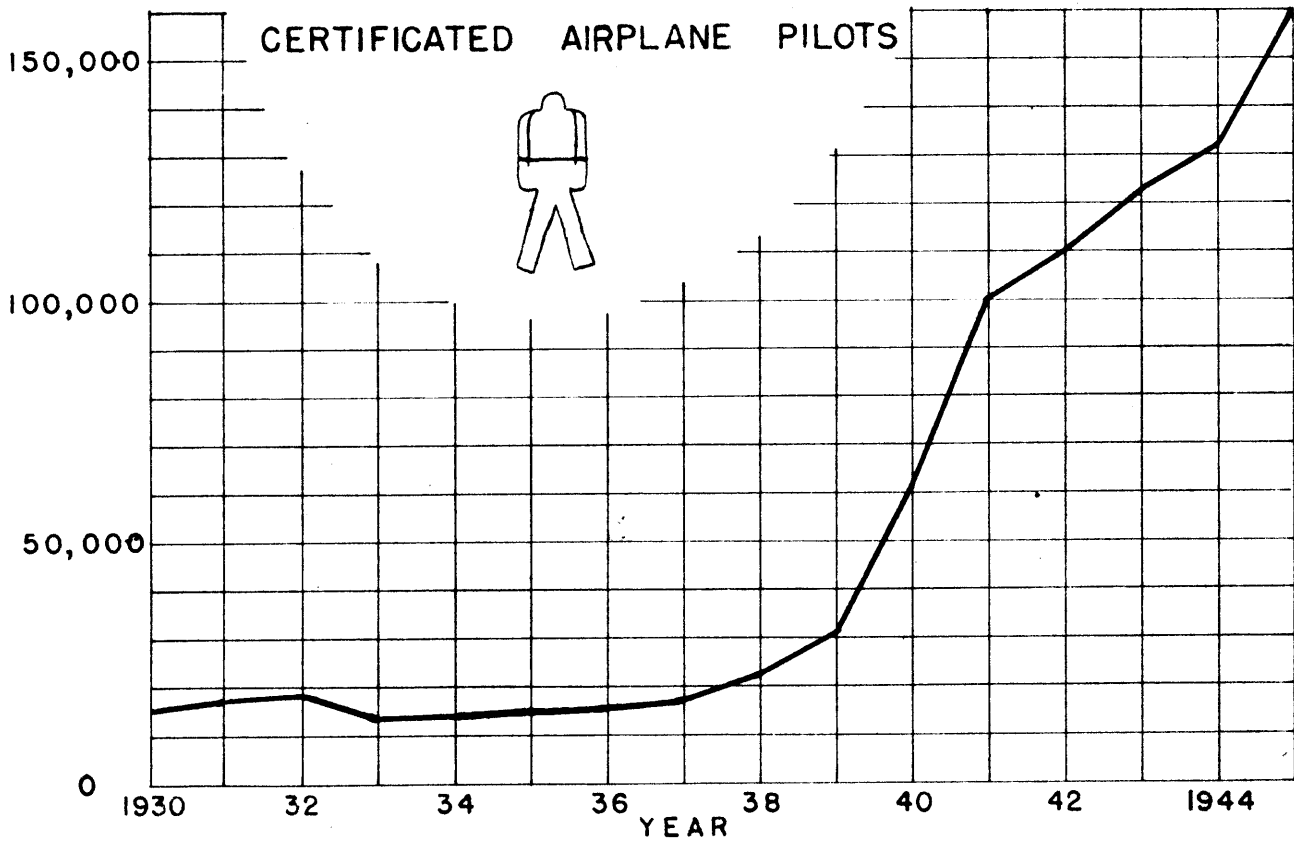


FIGURE II

Over the same period of time, the number of certificated airplane pilots shows a similar pattern of increase, as indicated by Figure II. Preliminary figures for 1946 indicate that the number of certificated pilots now total more than 250,000; this spurt is largely due to the continued interest of army air-force personnel in aviation. The most phenomenal growth, however, has been that of the domestic airlines. From Figure III it can be seen that the number of air passengers carried increased from less than four hundred thousand in 1930 to over twelve million in 1946. A conservative projection based on the present trend would find forty million passengers carried by domestic airlines in 1950. Such a figure would be sixty-nine percent of the railroad Pullman travel for 1944; the comparison is particularly significant when one considers that 1944 was the best year Pullman travel — a relatively unchanging means of transportation — ever had.

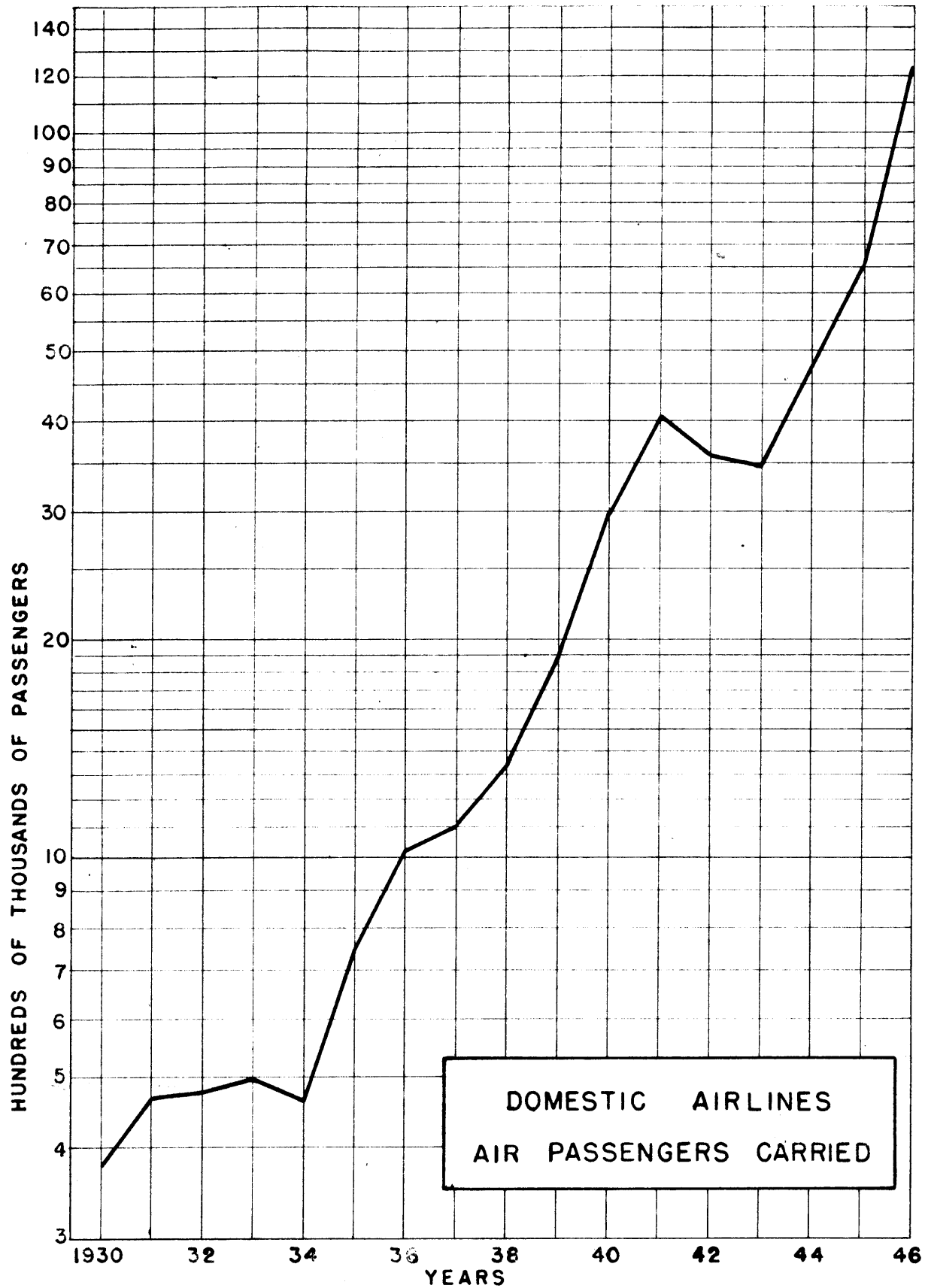


FIGURE III

## I. THE AIRPORT AND AVIATION

"Air transportation as an instrument of commerce and pleasure is now established beyond question, but its expansion and rate of growth will depend upon the technical development of the airplane itself, the available facilities for its use, and the degree of acceptance by the traveler based on safety, convenience, and utility." (1)

### A. Airport Planning and Location

The terminal facility for the airplane is a vitally important part of air transportation. A comprehensive airport system is more necessary for the airplane than the highway system is for the automobile. Without a proper airport, the airplane is completely ineffective. Therefore, it is necessary to know the present requirements and to anticipate the future need for the number and type of airports.

This poses the first question that will be considered. How should a system of airports be planned

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(1) C.Froesch and W.Prokosch. Airport Planning (John Wiley & Sons, 1946), p.20.

within a region? After the general plan of the number and type of airports is established, what factors should be considered so that the airports may be judiciously located?

B. Effect of the Airport on the Metropolitan District

The airport, like all transportation terminals, will, in some way, affect the lives of those people who live near it. Similarly, it will more indirectly, but probably just as vitally, have an effect on the way of life of all people living in the municipality of which the airport is a part.

The second problem of this study will be to consider the effects — physical, social, and economic — that the airport will have on the contiguous metropolitan district.

C. Legal Factors in Airport Control

The third question to be considered will be that of legal controls affecting the airport. This will involve an examination of the means of acquiring

airport land, airspace rights of the landowner and aircraft, and airport approach protection.

D. Planning Agencies and the Airport

Planning agencies must recognize the importance of air transportation. But the method that these agencies should use to attack the airport problem is open to question. This and other questions concerning the planning agencies will be considered.

E. The Effect of Technological Improvements on Airports

The airplane has changed so rapidly in the past, that it would be illogical to assume that these changes will not continue. Undoubtedly, many of the technological developments will affect the airport. The whole field of aviation is so dynamic that one cannot accurately predict what the pattern of the airport of the future will be. However, from present trends and recent technological improvements, an indication of the changes in airport location and construction may be predicted.

This phase of the airport problem will be considered at the end because it is the most nebulous of the problems and is the one which most disturbs airport planners.

II. REQUIREMENTS OF AIRPORTS

There is a general popular misunderstanding of what function an airport serves and the type of airports required for the various classes of air activity. Before proceeding further, it may be well to outline the types of flying activities and to determine the kind of airports needed for these activities.

A. Types of Air Activity

Flying may be classified according to four general types of activity: (1) Scheduled Commercial Operations, (2) Miscellaneous Commercial Activity, (3) Personal Flying, and (4) Military Flying.

Scheduled commercial operations include all passenger, express, and freight activity of the licensed airlines.



In June of 1947, 888 aircraft were being used by domestic and international airlines; the Douglas DC-3 predominated with 518, the DC-4 was second with 257, and the Lockheed Constellation ranked third with 47. Seven other miscellaneous types accounted for the remainder. (2)

Miscellaneous commercial flying includes an abundant variety of activities, the more important of which are: fixed base operations, executive and sales personnel travel, non-scheduled cargo, flight training school, and aerial photography. Many types of planes are used for these miscellaneous operations, but they are predominantly single and two-motor models.

Personal or private flying is almost entirely taken up with instructional, pleasure, small commercial, and business uses. On January 1, 1947 there were approximately 85,000 registered aircraft, a great majority of which were small personal planes. However, post-war personal flying has not developed as the aircraft manufacturers anticipated; and, as a result, the small-aircraft industry is in desperate straits. Several companies have failed, others have

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(2) C.A.A. Journal, July 15, 1947.

been absorbed by financially sound manufacturers, and still others have suspended operations temporarily due to a large stockpile of unsold planes. Reasons for the slow development of private flying are many and varied: first and foremost is that the private plane is still a luxury item that only a few people can afford to operate; second is the lack of utility for the small plane; another factor is the shortage of airports for the small plane; also to be considered are reasons of safety and simple operation, and a large number of bothersome regulations to which private flyers must conform. The critical problems, however, are those of cost and lack of utility.<sup>(3)</sup>

Table 1 shows the estimated annual cost of operating a light personal airplane of 60-75 horsepower with an initial cost of \$3,000.

Military operations are either flight training or tactical. Some of the heaviest planes that require the largest airports are military aircraft. Fortunately, a network of military fields

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(3) John H. Geisse and Samuel C. Williams. Post-war Outlook for Private Flying, C.A.A., September 1943.

TABLE 1 - ANNUAL COST OF OPERATING A PERSONAL AIRPLANE\*

Use per year	100 hrs.	200 hrs.
Direct operating cost	\$ 177	\$ 354
Hangar rent	180	180
Depreciation	300	300
Hull insurance	310	310
Liability & property damage	<u>148</u>	<u>148</u>
Total cost per year	\$1,115	\$1,292
Cost per hour	\$ 11.15	\$ 6.46
Cost per mile(80 m.p.h.)	0.140	0.081

\* Adapted from: J.H. Geisse. Suggestions for Furthering Private Flying, in "Aeronautical Engineering Review", August 1944.

are provided for the exclusive use of the air force. Nevertheless, some of the larger, strategically situated airports must be designed to accommodate heavy bombers and large military transport planes. But such decisions are the concern of the War Department and the Civil Aeronautics Authority.

#### B. Classification of Airports

Airports may be classified in several ways: by size, by use, or by the amount of air activity that is expected. The Civil Aeronautics Administration of the Department of Commerce has jurisdiction over the approval of airports that are used by air carriers. In this role, it has established design standards in which airports are classified, primarily, according to size. Table 2 shows the C.A.A. airport standards.

According to C.A.A., Class I airports should serve small communities not on present or proposed air carrier systems, and act as auxiliary airports in larger metropolitan areas for non-scheduled private flying activities. Class II airports should serve larger communities located on present or proposed feeder line airways and those which have

TABLE 2 - AIRPORT DESIGN STANDARDS\*

Planning Classi- fication	Recommended Landing Strip Lengths	Approximate Minimum Area (Acres)	Type of Aircraft Which Airport May Safely Accommodate
1	1800' to 2700'	60 to 150	Small private-owner type planes
2	2700' to 3700'	160 to 250	Larger size private-owner planes and some small size transport planes.
3	3700' to 4700'	300 to 500	Present-day transport planes.
4	4700' to 5700'	550 to 750	Largest planes in use today and those planned for the immediate future.
5	5700' and over	800 and over	Largest planes in use today and those planned for the immediate future.

\* A modification of a table in C.A.A.'s Airport Design. April 1944.

Landing strip lengths are based on sea level conditions; for higher altitudes increases are necessary.

considerable aeronautical activity (general population range 5,000 to 25,000). Class III airports are adequate for important cities on feeder line airway systems and intermediate points on the main line airways (general population range 25,000 to several hundred thousand). Cities which are major industrial centers of the nation and important junction points or terminals on the airways system require Class IV or V airports.

The airport classification and design specifications should be considered as guides rather than rigid rules that must be explicitly followed. The motivating consideration of C.A.A. in approving airports for certain types of operations is safety, and these specifications are primarily minimum safety standards which have been derived from years of experience in airport planning.

The total number of airports, by C.A.A. classification, from 1940 to 1947, is shown in Table 3.

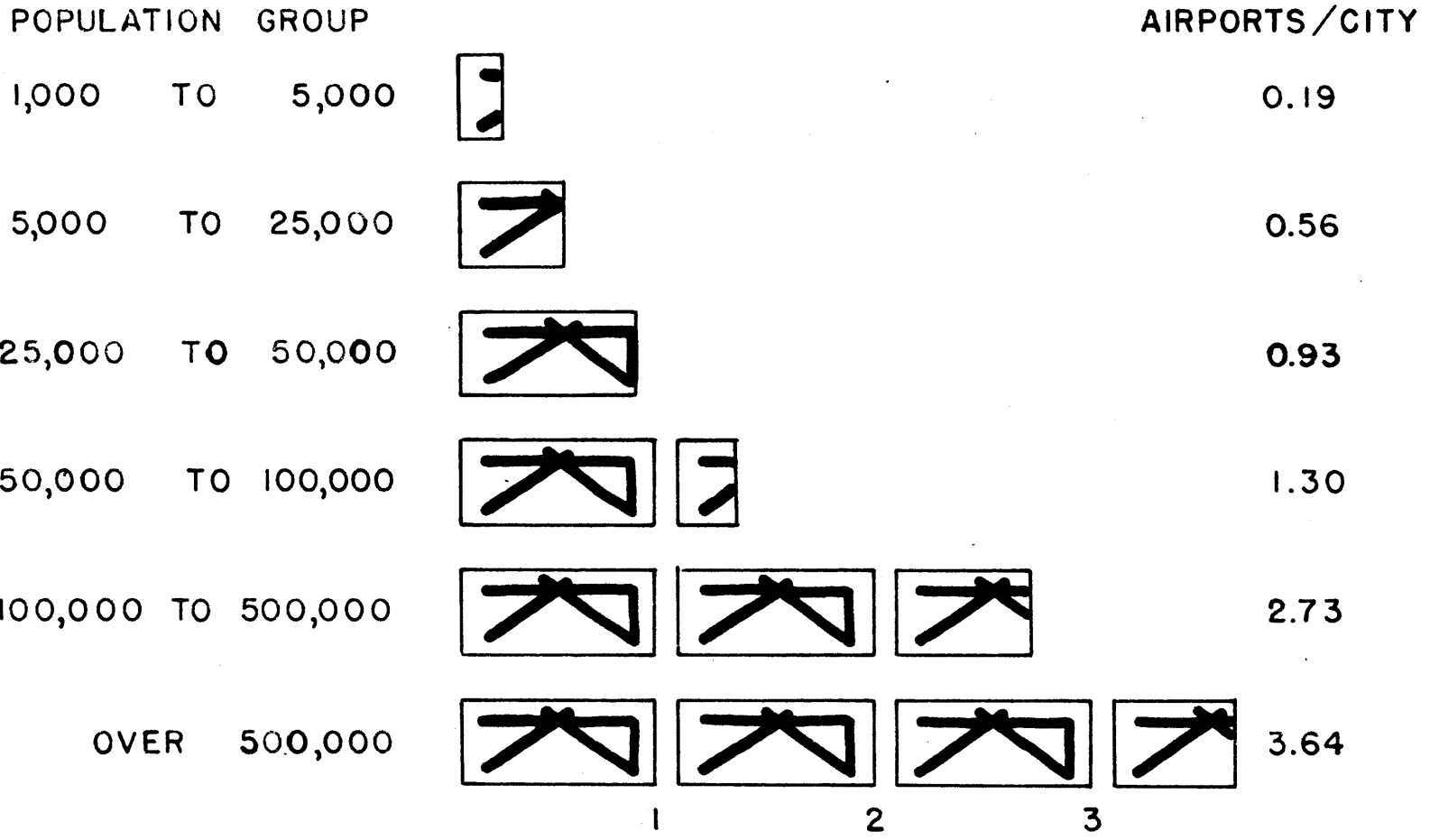
A second, more realistic method of classification is to rate the airport by the type of air activity that should use it. This is based on the postulate that large commercial craft and small

TABLE 3 - AIRPORTS BY C.A.A. CLASSIFICATION\*

Date	CLASSIFICATION				Total over
	I	II	III	IV &	
Apr. 1, 1940**	1693	424	57	2	1,824
Mar. 15, 1941	1488	304	46	9	1,847
Jan. 1, 1942	1523	702	187	72	2,484
Jan. 1, 1943	1238	905	367	299	2,809
Jan. 1, 1944	910	774	430	655	2,769
Jan. 1, 1945	1215	936	464	812	3,427
Jan. 1, 1946	1620	1091	484	831	4,026
Jan. 1, 1947	1396	1249	485	851	4,490

\* Source: C.A.A. Statistical Handbook of Aviation  
-1945, and C.A.A. Journal. February 1947.

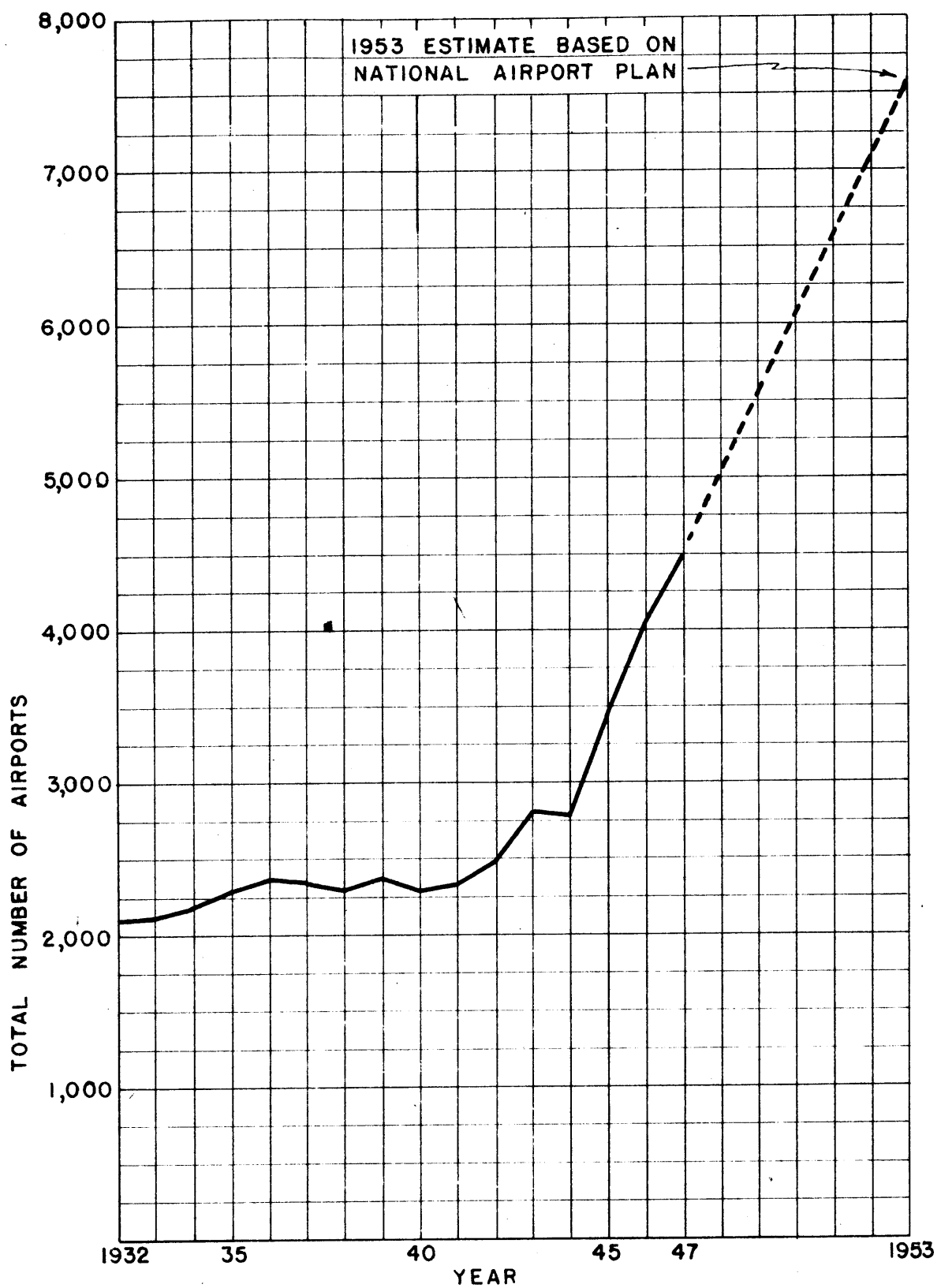
\*\* Military fields are included in the years 1942-47,  
but not in 1940 and 1941.



DISTRIBUTION OF EXISTING AIRPORTS BY URBAN PLACES  
1944

FIGURE IV





INCREASE IN NUMBER OF AIRPORTS

FIGURE V

personal planes should not use the same landing field; such a postulate is justified because the required areas and equipment needed to service the two types of craft are so different that only separate facilities will allow efficient operation. Three general kinds of airports, then, evolve: (1) airline airports, (2) personal plane airports (or airparks), and (3) feeder line airports.

Airline airports are used exclusively for commercial airline passenger and freight operations, and are usually in the C.A.A. Class III, IV, or V category. Freight operations, at present, are not large or frequent enough to demand separate airports for passengers and freight. In fact, passengers and freight are often carried in the same plane. Both United Air Lines and the Air Transport Association envision a combined passenger and freight plane that will be put to use when air freight traffic increases.<sup>(4)</sup> The possibility of separate airports for passengers and freight will be discussed in another chapter.

Personal plane airports are used primarily by light, personal aircraft. They correspond, in

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(4) Cleveland and Neville. The Coming Air Age  
Whittlesey House, 1944. p.175,181.

size, to C.A.A. Class I or II airports. Such airports are small inexpensive fields, probably with a hard-turfed surface rather than a paved landing strip. To the man on the street, the word "airport" suggests a large, intensively developed facility; in order to discourage the association of the small personal-plane airports with the larger commercial fields, the Personal Aircraft Council of the Aircraft Industries Association suggests that the small airports be called "airparks". The term also has propaganda value, for it suggests scenic beauty and a park-like atmosphere. Personal plane manufacturers are avidly promoting the construction of airparks. They envision them in residential areas, as elevated landing strips over railroad rights-of-way in the business district, replacing slum housing in central areas, contiguous to suburban shopping centers, in small communities, and near recreation centers. Certainly, it is true that small, personal-plane airports have a place in the city as a terminal facility for small airplanes. Many cities may need several. However, a rational approach to the problem must be adopted; otherwise a multiplicity of airparks may be more of a disadvantage to the city and to private flying than the lack of them.

Feeder line airports are intermediate between the airline airports and the airparks. They are the catch-alls in which both commercial flying and personal flying are combined. Primarily, the feeder line airport serves the short-run scheduled commercial airlines that connect with the larger airline airports. Also, it will accommodate miscellaneous commercial activities, and will be a base for private planes if no airpark is in the vicinity, or may even act as a service airport for a number of smaller nearby airports.<sup>(5)</sup> The Air Transport Association of America recommends that commercial and non-commercial operations should not be mixed on the runways if traffic volume exceeds forty operations per hour.<sup>(6)</sup> However, traffic will rarely be so heavy on such airports. A typical feeder line airport will serve a small city which has a good potential for commercial operation, yet does not have sufficient air activity of itself to support two airports.

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- (5) Eric von Hauswolff. Airport Planning Requirements in Metropolitan Areas, in the Journal of the American Institute of Planners. Summer 1945.
- (6) Air Transport Assn. of America. Airline Airport Design Recommendations. January 1946. p.1.

Two miscellaneous types of landing facilities are worth mentioning. One is the flight strip; the other is the helicopter field. The term "flight strip" was first proposed — and later copyrighted — by Stedman S. Hanks. Generally speaking, a flight strip is a landing area located in a highway right-of-way whose major use is for emergency landings and as an auxiliary landing area for small planes. Only a few flight strips are in existence today; their future use will be almost entirely dependent upon the development of the personal plane. Landing fields for helicopters are very simple compared with the ordinary airport. Since a helicopter takes off and lands vertically, any space that is large enough to accommodate the span of the rotors may be used in landing. However, a helicopter field should be sufficiently large to allow two or three craft to land simultaneously and should provide storage space for several others. The requirements for helicopter fields will be discussed further in Chapter Six.

The Air Transport Association of America recommends that airports be classified according to their peak hour capacities. Such a method of classification is merely a refinement of the use classifications, since the amount of activity at an airport is usually proportional to its type of use, personal-plane airports having the lowest frequency of use.

## CHAPTER TWO

AIRPORT LOCATION - PAST PRACTICE AND PRESENT CRITERIA

The growth of another means of transportation — the railroads — offers an analogy that may be applied to the planning and location of airports. In the nineteenth century, when railroads were beginning to push their steel rails across the country, those cities and municipalities that objected to the encroachment of the iron giant were bypassed in the rush to tap the resources of the frontier. As railroad transportation improved and traffic increased, those towns on the railroad flourished; on the other hand, those that were not served by the new facility remained relatively static or were drained of their population by the growing railroad towns. But the coming of the railroad was not entirely advantageous to the towns and cities that it invaded. The location and development of the railroads were almost completely uncontrolled in the urban areas. As a result, terminals were not in the best locations, and classification yards and repair shops were sited in areas that later were discovered to be more adaptable

to other uses. The city grew around the railroad and hemmed it in with all types of urban development. Later, the railroads could not expand their terminal and yard facilities when necessary because they were surrounded by the urban growth that they had helped make possible. As a result, the present picture shows inadequate terminal facilities, yards, and rights of way plaguing the railroads, while blighted mixtures of land uses paralleling the railroads, railroad infringement on city streets and residential areas, and uneconomic uses of land hamper city development.

But what are we to learn from such an analogy in regard to airport planning and location? Certainly, the location of air terminals will not be a primary cause for the rise or fall of urban areas. However, results of the railroads' uncontrolled and unplanned growth may well be an object lesson to planners in their treatment of airport problems.

In order to see how the pattern of airplane terminal facilities has developed so far, the past practices of airport location will be investigated.

## I. PAST PRACTICES IN AIRPORT LOCATION

During the first few years of aviation there were no airports built because none were needed. Any level pasture or open field was sufficient to allow the few "flying machines" to take-off and land. As the years passed and the airplane became accepted as a bona-fide means of transportation, separate grassed areas were set aside as airplane landing fields and, on some, crude hangars were constructed to house the craft. During World War I, the army constructed many military airports, and after the war, cities along the air mail routes provided the necessary landing fields. By 1920, the 271 airports were about evenly divided between private and municipal ownership. Then, the primary consideration in locating the airport was cost—both land cost and construction cost. Any other considerations were definitely secondary.

In 1928, a civil engineer with airport experience listed the following factors that should be considered in selecting airport sites: distance from the center of the city, price per acre of land, construction costs, accessibility, proximity to hotels



and fire-fighting equipment, and visibility potential (presence of fog and factory haze).<sup>(7)</sup>

In the 1930's the government exerted more and more control over aviation until the enacting of the Civil Aeronautics Act of 1938 which created the Civil Aeronautics Authority and empowered it to regulate, promote, and control the entire air transport system. Since that time, the planning and location of airports has been on a more responsible basis.

The chief deficiency of the older airports is their lack of area for future expansion. Airplane development in the 1930's introduced increased speeds and heavier wing loadings which extended the distances required for take-offs. Coincidentally, the amount of air traffic at the airports increased. Many of the airports could not obtain additional adjacent land in order to increase the lengths of their existing runways, to add further runways, and to enlarge the airport in general. Often, as a result, many cities were forced to abandon well-located airports and select a site further from the city where sufficient land was available.

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(7) P.A. Fellows, Selecting the Airport Site, in "American City". May 1928.

Other defects of the airports are numerous. Some are located too far from the cities they are intended to serve; others are unduly hazardous due to natural and man-made obstacles near the airport; still others have meteorological defects — are located in areas of low visibility due to fog and haze, or have poorly sited runways according to the prevailing winds.

It can easily be seen that the past practices of airport location are strikingly analogous to the growth of the railroads: both the airport and the railroad were largely uncontrolled and, like Topsy, just grew; both have had expansion troubles; and both suffer from poor locations. Fortunately, aviation has not developed so completely that an unchangeable pattern is set. There is still time for intelligent airport planning and location to correct the deficiencies and to meet the challenge of the new, dynamic mode of transportation.

## II. DETERMINATION OF SIZE AND NUMBER OF AIRPORTS

The determination of the number of airports that will fulfill the future requirements of

a region or community is not a matter that can be decided from the factual information that is gathered in the usual planning survey. Rather, an additional airport survey is necessary to determine the future airport needs of the area in question. However, a great deal of the information that is gathered in the general planning survey will be required in the airport survey.

Although the final decision regarding airport construction is a local problem, the initial planning impetus may be on the national scale. In order to trace the evolution of an airport plan, it may be well to work down from the national level.

#### A. Government Airport Guidance

In November, 1944 the Department of Commerce submitted a National Airport Plan to Congress that had been prepared by the Civil Aeronautics Administration. The plan estimated the airport needs of the nation ten years after the end of World War II, and proposed an airport aid program that would involve construction of 3,050 new airports and improvement of the 3,000 then existing fields over a five to ten

year period.<sup>(8)</sup> Although the plan is detailed to the local level, it is intended to be only a guide and a yard-stick for future planning.

On the basis of the National Airport Plan, Congress enacted the Federal Airport Act in 1946. It provided for \$500,000,000 of federal aid to be spent over a seven year period beginning July 1, 1946, no more than \$100,000,000 of which is to be spent in one year. Any public agency may submit a project application. Federal aid for development of Class III or smaller airports shall be fifty percent of the allowable costs of the project. Larger projects (Class IV or V airports) must be approved by Congress and may be granted an amount deemed appropriate to the C.A.A. Administrator, but not greater than fifty percent of the project cost.

Airport engineers of the C.A.A. are always available to assist any municipality with its airport problem; this assistance includes advice on location and construction problems and airport aid procedures.

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(8) 78th Congress, 2nd Session, House Document No. 807. National Airport Plan. U.S. Gov't Printing Office, Washington, 1945. p.1.

## B. Regional Airport Planning

In estimating future airport requirements, it is first necessary to determine the boundaries of the region involved, if that is not already determined. Then, one of three possible techniques may be used: (1) utilize statistics of the nation's total air activity, (2) compare the region with other similar regions which have aviation experience, or (3) make an analytical survey of the region. The first method is unsuitable because there are so many variable factors which make up the region's air travel potential that a subdivision of the nation's total air activity would not give a true picture. The second method will give a more accurate indication of the airport requirements, but it should not be used as a final answer unless it is impossible to make an analytical survey of the region; the method of comparing the region with a similar region is not completely acceptable because whether their similarity carries through to air transportation may be questionable, nor may the regions be similar in the future. It follows, then, that the analytical survey of the region is the most acceptable method of

determining future airport needs. Such a method is acceptable because it analyzes the forces in the region which affect air travel and which provide a method of measuring the air travel potential. It is this analytical technique that will be considered in detail.

The first step in the analytical study is to forecast the volume of air traffic anticipated for each of the three types of flying — airline commercial, miscellaneous commercial, and personal. A projection of ten years into the future is about the longest forecast that can practicably be made.<sup>(9)</sup> The commercial traffic may be estimated by extrapolating the percent curve of passenger and freight transportation for the area and balancing it against the population trend, the increase or decrease of the higher income groups, and the air mindedness of the region which would be affected by air safety rates and fare rates — both passenger and cargo. The personal flying potential is a more elusive figure. So many variables will affect the number of potential plane owners in a given area that no uniform set of rules can be established. The C.A.A. lists

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(9) C.A.A. Airport Planning for Urban Areas. June 1945. p.60.

the following factors that must be considered in getting an answer; the percent of building coverage; density, or dwelling units per acre; existing and proposed land use; types and adequacy of the existing transportation system; the number of available airport sites; the probable affect of a personal-plane airport on land values in the area; air-mindedness of the people in the community; wealth distrubution; and travel habits of the population.<sup>(10)</sup> In other words, each metropolitan area must be analyzed separately. C.A.A. proposes that each metropolitan area be divided into several zones with varying density, surface transportation, and wealth distribution characteristics. Each zone will have a different set of percentages of plane ownership for varying income groups; the income groups being determined by using U.S. Census rental information. A complete sample case is worked out in the C.A.A. publication, AIRPORT PLANNING IN URBAN AREAS, pages 42-47. In the sample case, percentages varied from 1/10 plane per 100 households to 15 planes per 100 households.

After the anticipated volume of air traffic is estimated, the number, type, and general location of the airports must be established. The number and

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(10) C.A.A. Airport Planning for Urban Areas. June 1945. p.42.

size of commercial airports required would be determined by the volume of traffic per hour that must be handled; however, before a final decision is made, the commercial airport proposal for the region must be checked with the Civil Aeronautics Board to coordinate the proposal with other proposed airways and airline routes. In determining the number of personal plane airports required, the airplane storage space that the airport provides is the most satisfactory criterion. (11) A consideration that is more important for personal-plane airports than commercial terminals, is to locate the small airports near the higher-income groups who will use them; this may be determined by again locating the areas of high rentals, spotting residential areas of high assessed valuation, or spotting two-car families.

After the size, type, and number of airports have been determined in the region, and the regional proposal has been cleared through the C.A.A.,

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(11) von Hausswolf, loc. cit.



the next step will be to select the site for any new airports that are proposed.

### III. SITE SELECTION — PRESENT AND PROPOSED STANDARDS

Many factors, or standards, should be considered in selecting the site for an airport. These standards are often conflicting, so that the final decision is usually the best balance that can be reached. Also, these factors may be of great or small importance depending upon the type of airport in question, the local conditions prevailing, and combinations of the other standards involved. Therefore, the standards that should be considered in selecting an airport site will merely be listed without any predetermined order.

#### A. Proximity to Other Airports

Airports should be located sufficiently far away from each other so that airplanes that have just taken off, or are maneuvering for a landing, will not interfere with aircraft engaged in similar

operations at other airports. As a guide, C.A.A. indicates that, for contact operations, each airport should have a traffic pattern whose radius in miles is equivalent to its classification number. "Airports at which instrument operations are to be conducted simultaneously will require sufficient separation from center to center to prevent conflict and overlapping in the holding and approach patterns during simultaneous instrument approaches." (13) Generally a center-to-center spacing of fourteen miles is recommended for those airports which conduct instrument operations. (14)

#### B. Accessibility

One of the most important factors influencing the selection of an airport site is its accessibility to the destination and source of the passengers and cargo. This is a particularly vital consideration for commercial airports since one of the great advantages of air travel is its advantage of shorter travel time over other means of transportation. If an undue amount of time is required in traveling between the airport and the central city, much of the advantage of air transportation is lost.

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(13) C.A.A. Journal. August 15, 1945.

(14) Wm. E. Thomas. Selection of Airport Sites, in "Opinion & Comment". November 1946.

According to a C.A.A. survey, the average ground time required due to travel between city and airport is one hour and twenty minutes (forty minutes each way); certainly, then, a short trip by air rather than by ground travel would not be a saving of any time. The commercial airport should be located near a main, fast-moving highway artery leading to the city, and near a rapid-transit line when available. If a rapid-transit service does not presently serve nearby areas other than the airport, it is doubtful that a special mass transportation service could be inaugurated. The American Transit Association polled more than one hundred transit companies regarding transportation to airports, and the majority opinion was that a mass transportation facility serving only an airport was not economically feasible.

Personal-plane airports should also be accessible to their users. The realization of such an objective would find small airports located near residential and commercial areas; this controversial issue will be discussed in a later chapter.

### C. Sufficient Size for Future Expansion

The area of the site should be large enough to efficiently accommodate the proposed airport as it will be ultimately developed. An area large enough for the present-day airport will not suffice, since increased air traffic in the future will demand additional airport space.

### D. Approach Zones

The air approach zones, which are the routes the airplanes use in landing and taking off from the runways, should be clear of natural or man-made obstructions. If obstructions do exist, it should be possible to remove them so that the aircraft will not be subjected to undue hazard during the critical periods of landing and taking off.

### E. Topography

Topographical considerations that should be taken into account are: (1) the grading that will be required to meet the standards for maximum runway grades, which vary from one percent to two percent depending upon the class of the airport; (2) selection

of a site which departs sufficiently from the dead level to allow adequate natural drainage, but does not have portions so steep that serious erosion may result; and (3) selecting an area where the soil is pervious, yet has a suitable amount of natural binder, and where the water table (ground water level) does not come too close to the surface.

#### F. Meteorology

The direction and duration of the prevailing winds at the proposed site should be studied since these factors will govern the runway layout and will affect the location and arrangement of the airport buildings. Also, the site should be relatively free from smoke and fog so that the visibility potential of the site will be good.

#### G. Existing Airways

As a rule, cross-country flying today is done within the limits of airways that are equipped with navigational aids and regulated by the national government. Airports should not be sited so near the airways that the airport's traffic pattern would interfere with air traffic using the airways, yet commercial

airports, in particular, should be close enough to the airways to be accessible to the airway traffic.

#### H. Land and Development Cost

The land and development costs of the airport should not be excessive. In addition to grading, drainage, and construction charges, the development cost is affected by the availability of suitable construction materials near the site and the nearness of necessary utilities.

#### I. Comprehensive Planning Considerations

The airport location should tie in with the master plan of the city or region concerned. It should not disturb existing uses or future planned uses to such extent that the development plan of the contiguous areas would be disrupted; the use of such a large area should not interfere too seriously with the street and highway pattern, and consideration should be given whether the site itself might be better used for residential, commercial, or industrial expansion.

As closely as possible, the airport should harmonize with the surrounding land uses. Present-day

airports — and commercial airports in particular — have such a nuisance value and are so demanding of the air space of contiguous areas, that, undeniably, the best site from a land-use viewpoint, would be one that is surrounded by undeveloped areas. Such an undeveloped site, however, may not satisfy enough of the other location requirements to justify its selection. Then, other types of contiguous uses may be adequate substitutes. The airport would not appreciably conflict with a non-commercial active recreation area. In fact, the Detroit City Planning Commission, in commending acquisition of a protective belt around a major airport site, recommended that a forty-acre playfield be placed in the corner of the contiguous area that was nearest the city. Also, a light industrial area, if well planned, would be in concord with the airport. The trend of decentralization of industry, together with the increased use of electric power, and the favored construction of single-story factories, would make such a location feasible. Also, the airplane noise that accompanies airports would have little nuisance value in a nearby industrial area.

The legal machinery available for zoning the airport and its approaches should be investigated.

Also, it should be possible to invoke excess condemnation on the adjacent properties.

#### J. Summary

All of the above listed factors should be carefully investigated and weighed before the proposed site is selected. Often, the airport and aviation interests are conflicting with those of the people's corporation -- the city. Therefore, the site selected should be a careful balance of these conflicting interests and the purely objective locational factors.

#### IV. AIRPORT DESIGN

The controlling feature of an airport's construction should be its master development plan. The master plan traces the development of the airport through various size stages until it has reached the point of ultimate growth; a master plan is a study of all of the physical, economic, and legal features that are involved in the construction and operation of a transportation terminal. The C.A.A. requires all municipalities which seek aid under the Federal



Airport Act of 1946 to have a master development plan for the airports that are to be developed.

Many airports, built only a few years ago, have become obsolete because their runway facilities could not be enlarged, and because their buildings — now inadequate — could not be expanded. The primary design consideration, then, is flexibility. The airport should have the facility of being enlarged, and where necessary, small personal-plane airports should be so designed that they may later be converted to serve commercial traffic.

Other design problems such as runway layout and construction, airport lighting, airport building and hangar design, etc. are important but will not be considered here. They are more technical questions which are treated fully in several recent publications.<sup>(15)</sup>

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(15) See: Froesch and Prokosch, op.cit.; Air Transport Assn. of America, Airline Airport Design Recommendations, January 1946; C.A.A. Airport Design; and Glidden, Law, and Cowles, Airports: Design, Construction, and Management (McGraw-Hill Book Co., 1946)

## CHAPTER THREE

EFFECT OF THE AIRPORT ON THE METROPOLITAN DISTRICT

All major means of transportation, as they have developed, have had an effect on the way of life of the nation. As a direct effect, they have allowed people to travel from one place to another more easily and more inexpensively; those who have lived near the terminal points or way stations have benefited from the convenience, but may also have found the transportation facility a noise-maker and a nuisance in many other ways. Indirectly, these means of transportation have had an even greater effect on our way of life; they have helped increase our standard of living, and have made visible changes on a great number of institutions, customs, and personal values.

Aviation, too, shows a similar effect on our society. It provides a swift, comfortable means of travel for the busy executive and the vacationing traveler. It gives us strawberries in January, delivers much-needed parts to crippled industries,

and speeds mail across the nation. One could list many thousands of ways in which the airplane has changed our manner of living. The important fact is that our society is different because of the airplane, and will undoubtedly continue to show other changes as aircraft become faster, cheaper, and more responsible carriers.

The focal point of air travel, through which all airplane loads must go, is the airport. In a derivative sense, the airport will also affect life in the metropolitan area which it serves. It will more directly have an effect on the people, property, business, and industry near its site. In this chapter, then, the physical, social, and economic aspects of the effect of airports on the metropolitan district will be examined. Little forecasting of future effects will be attempted; however, the pattern of effects, as they have developed to date, may be an indication of future trends.

#### I. PHYSICAL EFFECTS

In this section, the effect of the airport on the residential, commercial, and industrial sections

of the city will be investigated.

A. Residential

Nearby residents of airports claim that the airport is a nuisance. Specifically, they complain of dust, lights, and noise.

In the past, on unpaved and unturfed fields, the backwash of the airplane propellers did create quite a dust cloud. However, on present-day fields, the dust problem has been almost entirely solved by the use of paved runways and the planting of grass. Small airports without paved runways have dense, low-growing, wear resisting turf surfaces. Therefore, airport dust should no longer be a problem to nearby leeward areas.

The complaint of annoyance by airport lights is more justified. Runway landing lights are not the prime offender, since they are of steady intensity and usually hooded. Most of the objection comes from the rotating or flashing beacon which is usually of high intensity and periodically splashes nearby areas with light; as with a flashing electric

sign, the intermittency of the light is more objectionable than the light itself. The nuisance factor of airport lights is not very far-reaching, however, since only those areas immediately adjacent to the airport are affected.

The airplane noise that, so far, has been an inevitable heritage of every area near an airport is the most objectionable of the three nuisances. The principle sources of airplane noise are the propellers, engine exhausts, the engines themselves, airstream, and vibrating parts. The noise of the individual airplane is greatly intensified at an airport because of the increased engine power and propeller speed necessary for a take-off.<sup>(16)</sup> The noise level is greatest around large commercial fields since the air traffic is heavier, and larger planes are used. But the small personal aircraft using the smaller airports are also objectionable; and no matter how volubly the small airplane manufacturers deny that the personal plane makes any noise, the fact remains that most people think they do. The noise factor has provided the most forceful popular argument against locating airports near residential areas; it is a definite

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(16) Chatfield, Taylor & Ober. The Airplane and Its Engine. (McGraw-Hill, 1936) p. 195.

problem to community and airport planners. There seems to be some chance, however, of decreasing the noise level of the small plane; this will be discussed further in the chapter on technological improvements.

It has also been claimed that it is dangerous to live near an airport because of the possibility of a plane crashing into the home. Although it is true that the most critical period of an airplane's flight is the take-off, the C.A.A. has shown in a study of collisions of airplanes with buildings that the probability of damage to a dwelling or injury to a person about a residence as the result of an airplane collision with the dwelling is extremely remote. Table 4 analyzes accidents from 1940 to 1943 involving collisions with buildings. With all airplane collisions striking only seventeen dwellings and injuring only one person in four years, the relative danger of living near an airport is not great enough to be seriously objectionable.

The location of a residential area near an airport is not entirely disadvantageous. A nearby airport makes a major form of transportation readily accessible. For airline airports, this is not so

TABLE 4 - AIRPLANE ACCIDENTS INVOLVING COLLISIONS  
WITH BUILDINGS\*

Subject	1940	1941	1942	1943	Total
Collisions of airplanes, in flight, with buildings	7	3	9	11	30
Collisions of airplanes, on ground, with buildings	7	14	8	10	39
Total collisions with buildings	14	17	17	21	69
No. of persons on ground injured	0	1	0	0	1
No. of buildings involved used as dwellings	2	6	4	5	17

\* Source: C.A.A., Airport Planning for Urban Areas. June 1945. Appendix II, p. 58.

important today as it may be in the future when air traffic increases and fares are reduced. However, the small plane owner and sometime flyer would find it definitely advantageous to live near an airport (or airports) which he may use as a base for operations. To have an airport immediately adjacent to the home so that the airplane may be parked in the back of the lot (as some aviation enthusiasts have suggested) would be impractical for all except a few enthusiasts since so many other determinants affect the location of a home; however, it could be possible and practicable to locate an airport within short time-distance of residential areas. A residential area near an airport would be advantageous for those airline and airport employees who desire to live near their place of work; also, lower-income employees may find it necessary to live near the airport due to the lack or shortcomings of mass transportation facilities serving the airport.

Since the airplane is essentially a long distance form of transportation, it has not been a decentralizing influence on city growth as have the automobile, railroad, and other means of mass transportation. Therefore, we have not seen communities develop around outlying airports. However, the recently developed helicopter may be a decentralizing



influence in the future; this will be discussed further in a later chapter.

### B. Commercial

The ordinary airport is not such a revenue-producer that it alone would support even a medium-sized shopping center nearby. In the past, there have been some spotty commercial developments opposite airports, but they consisted largely of hot-dog stands, quick lunch emporiums, and filling stations which catered to the airport sightseer. Now, these facilities are being incorporated in the grounds of the airport, itself, and are being let out as concessions in order to take advantage of all income-producing possibilities; primarily, these include lunch rooms, news-stands, novelty shops, drug counters, and gasoline service stations.

Existing business districts near the airport or on a main route to an airport are not appreciably benefited by their connection with the airport. Most air passengers travel by air because they want to save time; therefore, they wouldn't normally be tempted to stop in a business area along the way to do some shopping.

If a commercial airport is located in the metropolitan area, some business would undoubtedly benefit by the availability of air-cargo service. Intrinsically, the airplane is not the most economical vehicle for carrying goods. But it is the fastest; and this gives it all the advantages that are attached to speed and the saving of time. Types of goods carried by air are valuables, perishables, spare parts, printed material, luxury and emergency goods. An analysis of the goods shipped by air in April, 1941 is given in Table 5. Air cargo operations have increased tremendously since the end of the war. The amount of cargo shipped by air has jumped from 3,500,000 ton-miles in 1940 to 44,800,000 in 1946. (17) Several influences are responsible for the sudden spurt: (1) a stimulus has been provided by contract operators using war surplus equipment; (2) sharp reductions in rates have been effected which result from increasing competition and specialized cargo operation; (3) there is an increased reliability and dependability of operations; and (4) the generally high level of business activity has benefited operations.

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(17) Alan Passen & J.L.Drew. Air Cargo: A New Force in Marketing. in "Journal of Air Law and Commerce". Winter 1947.

TABLE 5 - GOODS SHIPPED BY AIR : APRIL, 1941\*

Commodity Group	Per Cent of Total	
	Shipments	Weight
Machinery-Hardware	23.26	31.67
Printed Matter	15.11	28.06
Store Merchandise	13.39	9.25
Motion Picture Films	4.32	5.62
Electros-Matrices	6.11	3.51
Cut Flowers	3.63	2.48
Valuables	8.25	4.24
Miscellaneous	2.44	2.01
News Photos	4.42	.79
Drugs	1.46	1.08
Transcription Records - Radio Parts	4.53	2.04
Freight Manifests	4.36	1.61
Jewelry	2.60	.75
Food & Raw Samples	1.78	1.02
Optical-Camera	1.85	1.14
Personal Baggage	2.19	4.52
Liquor	.30	.21
	100.00	100.00

\*Source: Association of American Railroads. Initial Study of Air Transportation. January 1944. p.42.

Increasing air cargo operations prompts the question whether separate cargo airports will be necessary in the near future. More and more air freight is being carried in all-cargo planes, yet a large part of air cargo will continue to be carried in combined cargo and passenger planes. Although air cargo operations have greatly increased, it is still doubtful that, except for the nations largest transportation terminals, combined passenger and cargo operations will be so great that separate airports will be required for each type of operation, within the next decade at least.

### C. Industrial

The advantages of an industrial location near an airport are great enough to be significant. A nearby airport would provide an accessible transportation outlet for executive and sales personnel travel, and would necessitate only a short haul for air freight; however, for most industries, these factors would not be important enough to seriously influence the location of the industry unless other industrial location factors (access to rail facilities, large area for future expansion, accessible to labor force, etc.) compare favorably

with alternate areas.

On the other hand, the airport would not appreciably benefit from nearby industries from an economic viewpoint since it would usually get the industries' air cargo business in any event.

The commercial airport's air cargo services would be useful to industry as well as to commercial organizations. The airplane may serve as a carrier of raw materials, spare parts, or the finished product if the bulk is not excessive and time is at a premium.

## II. SOCIAL EFFECTS

The mixture of land uses, train noise, and dirt adjacent to railroad rights of way often have caused a blighting effect on land near the railroad. When the blight was far enough advanced to depress the values and the rents of the adjacent properties, those people who could only afford to pay low rentals gravitated to the district. Since a high proportion of these people were socially less than desirable, a stigma was attached to the area in general; and most people who lived "down by the railroad tracks" were socially unacceptable in many branches of society.

Do airports exert such a depressing position upon the people who live near them? In considering commercial airports, it will be shown later that an airport has the effect of slightly decreasing the value of nearby residential land. However, the value of the land has not been lowered to such an extent that it has been stamped as a low-rental area. Therefore, the blight has not been progressive, and an individual's residence near an airport does not have any social significance.

On the other hand, if personal-plane airports become feasible, it may be highly fashionable to live near such an airport, or airpark; the airparks will be located near high-income families who will be the largest users of personal planes in the near future, and the mere fact that a wealthy group is using the small airport will attract other members of the socialite class so that the airpark may take on a country club atmosphere. However, the possibility of such a condition coming about would be entirely dependent upon the construction of airparks in or near residential areas.

### III. ECONOMIC EFFECTS

#### A. Effect of Airport on Property Values

Like any transportation terminal, the airport affects the value of nearby land. In a poll of real-estate assessors in sixteen cities, taken in 1941, it was discovered that the presence of an airport near residential properties decreased their value slightly.<sup>(18)</sup> This is particularly true of properties located in line with the airport runways. It is over these properties that the aircraft fly while in the process of landing and taking off; and it is these properties that have restricted air rights, since no obstructions can project above a plane which extends on direct line from instrument landing runways at a slope of one foot vertical to forty feet horizontal. At a distance of one-quarter of a mile from the runway, no building could be higher than 35 feet, which is usually the zoning height limitation for a single-family residential zone. Residences closer than one-quarter mile, and in line with the runway, would be further restricted.

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(18) National Association of Assessing Officers. Effect of Airport Development on Value of Adjacent Real Estate. Bulletin No. 25. December 1941.

The value of business properties are not so likely to be affected by the noise and light nuisances of the airport since people in business establishments are generally indoors and do not occupy the buildings after working hours. Those businesses located immediately adjacent to airports were found to have benefited from the airport, and therefore, showed a slight increase in property value. (19)

In 1946, the Detroit Metropolitan Aviation Planning Authority had a study made of five airport sites to determine the effect a major airport would have on the surrounding property. In developing the estimate, the area surrounding each site was divided into two strips, the first of which was one-half mile in width adjacent to the airport, and the second included the succeeding one-half mile beyond. Table 6 below shows the average estimated depreciation that an airport would cause on various types of property.

TABLE 6 - DEPRECIATION OF ADJACENT AIRPORT PROPERTY -

DETROIT\*

Zone	Depreciation in Per Cent		
	Residential	Subdivisions	Farm Land
0 - 1/2 mile	27.5 to 34.1	74.4 to 92.7	No loss
1/2 - 1 mile	14.7 to 20.7	71 to 89.5	No loss

\*Source: John B. Bayard, Jr. Effect of Airports on Surrounding Property in "Planning - 1946"  
Amer. Soc. of Planning Officials. p. 56.

(19) Ibid.



Although it is true that subdivided property that is not built upon will have a high depreciation, it seems that the depreciation percentages given are excessive.

#### B. Airline Passenger and Cargo Rates

At the present time, airline passenger fares average 5.0 cents per mile. Railroad rates are 2.5 cents per mile for coach and 3.8 cents per mile for Pullman (including berth). Railroad distances, however, are almost always longer than airline distances. But, as a compensating factor for the railroads, the ground transportation charges from the airport to the passenger's destinations are almost always greater than from the railroad station. It has been estimated that within the next five years passenger fares may be in the range of 3.0 to 3.5 cents for domestic operations. "On the above assumptions, it is reasonable to expect that the air lines will early divert from surface carriers approximately 75 per cent of Pullman traffic moving distances of over 500 miles, a smaller percentage, perhaps about 30 per cent, of coach traffic moving a like distance, possibly 50 per cent of Pullman traffic traveling between 100 and 500 miles, and 15 per cent of coach travel between 100 and 500 miles. For trips less than 100 miles, air

transportation is not in a favorable competitive position."(20)

In 1940, the average air cargo rate was 80 cents per ton-mile; in 1946 it averaged about 30 cents per ton-mile.(21) Effective August 1, 1947, nineteen airlines adopted Official Airfreight Tariff No.1 which establishes one rate - 33 cents per ton-mile -- on shipments of twenty-five pounds or less moving short distances; the rate decreases slightly with each added pound of weight through ninety-nine pounds; then, a rate of 24.5 cents per ton-mile applies on all shipments of one-hundred pounds or over.(22)

This corresponds to a railway express rate of 10 cents per ton-mile, a less-than-truckload-traffic rate of 5.5 cents per ton-mile, and a rail carlot freight rate of less than 1 cent per ton-mile. Rate estimates offered in testimony before the C.A.B. indicate average air cargo rates as low as 10 cents per ton-mile may be in effect by 1950.(23)

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(20) Irston B. Barnes. The Economic Role of Air Transportation, in "Law and Contemporary Problems". Winter-Spring 1946. p.444.

(21) Alan Passen & J.L.Drew. Air Cargo: A New Force in Marketing, in "Jl. of Air Law & Commerce". Winter 1947.

(22) Uniform Air Tariff Cut Rates, in "American Aviation" August 1, 1947. p. 16.

(23) Passen & Drew. loc. cit.

Such estimates seem to be unduly optimistic; however, a rate bordering on 15 cents per ton-mile by 1950 may be possible if the volume of air cargo continues to increase. According to present indications, it hardly seems likely that air cargo will cause any revolutionary changes in our present distribution system. Air freight and air express cannot conceivably capture the business of the ships and railroads; yet, they may effectively complement these services to the benefit of the nation as a whole.

### C. Municipal Ownership of Airports

In a following chapter, it will be shown that airports are a public purpose. Secondly, airports satisfy the requirements of a public utility in that they offer a service which is essential to the public welfare and they are, by their very nature, subject to monopolistic tendencies.

Let us consider commercial airports. If they are a public purpose, and satisfy the requirements of a public utility, certainly they should be owned and operated by the public, who would be represented by the political subdivisions -- city or county -- that the airport serves. The question

then arises as to whether the cost of constructing and operating airports should be borne out of general tax revenues or should be covered by airport user fees. Usually, tax-supported public services are those: (1) in which individual benefits cannot readily be ascertained, and (2) whose general benefits clearly outweigh their value to special groups. Air terminal facilities apparently do not meet either of these requirements. Also, charging airport users for airport services tends to promote more efficient use of resources, and makes air transportation more self-supporting, not giving it a subsidized advantage over other forms of transportation. On the basis of these arguments, airport costs should be covered by user fees. However, past experience in municipal airport operation is not encouraging from an economic point of view. Of sixty-eight airports surveyed by C.A.A. only sixteen reported a profit over operation and maintenance costs in 1933 and 1934. A recent intensive study of terminal airport financing and management by the Harvard Business School concludes that "the majority of terminal-type airports can be made self-supporting within a comparatively few years without an undue

burden on aviation, provided that a sound financial plan is established and all revenue sources including terminal building concessions are aggressively developed." (24) Specifically, all of the following charges should be explored and developed: hangar rentals, terminal building charges for aviation activities, terminal building concession rentals, and landing area charges.

The future of the personal-plane airport is not as clear-cut as that of the commercial airport. Those opposed to municipal operation of lightplane airports argue that only a high-income, special interest group will benefit from the facility, and therefore, such an airport is not a public purpose. In the near future, it is true that mostly high-income groups and those people definitely interested in flying will use the personal-plane fields. But such an argument does not disprove the public purpose of the facility; municipal golf courses and other municipal recreational areas are used only by special interest groups, yet they are clearly a public purpose. The case for the personal-plane airport as a public purpose is further strengthened by the fact that such an airport would

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(24) Lynn L. Bollinger, Alan Passen, & Robert E. McElfresh. Terminal Airport Financing and Management. Harvard University, Graduate School of Business Administration, (Andover Press, 1946). p.4.

be available for emergency use by other aircraft, and the airport, itself, would be a stand-by facility to meet personal or community emergencies.

Probably the most serious stumbling-block to municipal operation of small personal-plane airports is the fact that the possibility of the airport being financially self-sufficient is not promising.<sup>(25)</sup> The relatively small number of users of such an airport and the improbability of the interest of the non-flying public forecasts a low revenue potential. If such a condition will prevail, the municipally operated personal-plane airport will have to be maintained by user charges and concession rentals, supplemented by a partial subsidy from the municipality. Consequently, whether municipalities construct and operate personal-plane airports will be largely determined by the demand of the residents of the municipality for the services of such an airport.

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(25) A study of small airports accomplished by the Harvard Business School reaches the same conclusion. This study will soon be published.

## CHAPTER FOUR

AIRPORT LEGAL CONTROLS

During the first twenty years of its existence, the airplane was no legal problem. So few of the flying machines were in the sky — and on the ground — that no more than a passing thought was given to the novelty. However, as air transportation passed from the novelty stage and came to be accepted as a true means of transportation, its legal difficulties began. Enough land had to be acquired to provide a landing space for the airplane; this landing space had to be protected from spite structures that were erected adjacent to it by nearby property owners who considered the airport an undesirable neighbor; and subjacent property owners objected to the airplanes overhead that were using their portion of the sky.

During the passing years legislative bodies of the nation and the states have come to recognize the need for laws regulating and protecting the airplane and its terminal facility. The courts, in turn, are becoming more liberal as aviation continues to

advance. However, many state laws are ambiguous regarding aircraft and airports, and many courts still fail to recognize the place of the airplane in the life of the nation. But legal machinery cannot be expected to run smoothly for such a changing entity as aviation. Nevertheless, each year brings improved legislation and clearer definition of the law — an indication that equitable solutions will eventually be found to problems that are now most perplexing.

#### I. AIR SPACE RIGHTS

One of the first legal problems that arose regarding the airplane was the question of air space rights of the property owner and the aviator who flew over the property. Before the advent of the airplane, the courts usually upheld the early concept of ownership in air space by the surface owners up to indefinite heights. However, the ownership of air space above the property was clearly a qualified ownership; nobody questioned the flight of birds, balloons, and kites over their property. Similarly, upon the introduction of the airplane, nobody seriously took exception to the occasional high flight of an airplane over private property. But litigation



did arise concerning the flight of airplanes near airports where it was necessary for the airplanes to fly low over the land while leaving or approaching the airport. The landowners claimed disturbance from dust, noise, and other nuisances and asked the court for damages or injunctions to prevent the airplanes from continuing the disturbances.

Many cases were heard in the various states with varying results. As a consequence of these cases four other theories of air space rights have been advanced. These theories are: "(1) the landowner owns all the air space above his property to an unlimited extent subject to an "easement" or "privilege" of flight in the public; (2) the landowner owns the air space up to such height as is fixed by statute, with flights under that height "trespasses"; (3) the landowner owns the air space up as far as it is possible for him to take effective possession but beyond the "possible effective possession zone" there is no ownership in air space; and (4) the landowner owns only the air space he actually occupies and can only object to such use of the air space over his property as does actual damage."<sup>(26)</sup> The last theory

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(26) Charles S. Rhyne. Airports and the Courts.  
(National Institute of Municipal Law Officers,  
Washington, D.C., 1944). p.155.

seems to be the most reasonable. Under it, damages or other relief from low flights are denied the landowner unless actual damage or interference with the enjoyment of his land is proved. Such a theory allows for the balancing of interests between the landowner and the airplane, and the form of relief to be taken will be dependent upon the facts of each case and the public interest involved.

A decision by the Supreme Court of the United States in 1946 bears out the above contention.<sup>(27)</sup> Although the respondent was awarded damages due to the depreciation of his property's use, the decision affirmed the right of flight and declared the ownership in airspace by subjacent owners to be limited to the zone of effective possession. A majority opinion rendered by Mr. Justice Douglas declares, "It is the owner's loss, not the taker's gain, which is the measure of value of the property taken. .... Flights over private land are not a taking unless they are so low and so frequent as to be a direct and immediate interference with the enjoyment and use of the land." This decision negates some previously

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(27) U.S. vs. Causby et ux. U.S. Supreme Court Reports. Vol.328. May 27, 1946. p.256.

troublesome lower court decisions by definitely affirming the right of flight and conclusively determining that surface owners do not own air space to the periphery of the universe.

## II. ACQUISITION OF AIRPORT LAND

The right of a municipality to acquire land for use as an airport is dependent upon the question of whether municipal airports are a public purpose. The courts of the nation have come to recognize that they are a public purpose.

As early as 1928, Mr. Justice Cardozo, in upholding the right of the city of Utica, N.Y. to issue bonds for the development of an airport, made the following statement: (28)

"We think the purpose to be served is both public and municipal. A city acts for city purposes when it builds a dock or a bridge or a street or a subway. Its purpose is not different when it builds an airport. Aviation is today an established method of transportation. The future, even the near future will make it still more general. The city that is without the foresight to build the ports for the new traffic may soon be left behind in the race of competition."

Today, all states have legislation authorizing cities to acquire airports; this legislation, in most

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(28) Hesse vs. Roth. 249 N.Y. 436, 164 N.E. 342' (1928)

instances, expressly declares that publicly-owned airports are a public purpose.(29)

Cities may acquire land for airport purposes by direct purchase, grant or gift, lease, or eminent domain. Often, when cities seek to acquire property for an airport site, the owners of the land concerned attempt to secure a higher price for the land than its true worth; other times, owners may attach a sentimental value to the property and may not desire to sell, even at an inflated price. In such cases, the power of eminent domain may have to be employed in order to collect all the necessary land. The Supreme Courts of fourteen states have upheld the right of municipalities to acquire airport property under eminent domain, and there is little doubt that the right will be upheld in all states.(30)

### III. AIRPORT APPROACH PROTECTION

The protection of the approaches to airports against the erection of barriers and obstructions to safe flight is important to the airport and the persons

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(29) Rhyne. op. cit. p.26.

(30) Factual Items on Airport Zoning. "Air Transportation" March 1945.

using it and to the inhabitants of adjacent areas.

It is relatively easy for airplanes to control their rate and angle of descent when making a landing in clear weather. But the take-off is a more critical period. The rate of climb of an airplane immediately after taking off is a function of its wing loading and its power loading; many large, heavily loaded airplanes are limited to a very low rate of climb. During inclement weather, when instrument landings are necessary, both landings and take-offs require clear approaches; in landing during periods of instrument weather, the pilot must make a slow, gradual approach to the runway so that he may more safely bring the airplane to a landing.

For sea-level conditions, the Civil Aeronautics Authority recommends that the approaches to runways and landing strips shall be clear within a glide path of 20 to 1 from the end of the usable area for Class I airports and 30 to 1 in the case of Classes II, III, IV, and V airports except for instrument landing runways for which the ratio shall be 40 to 1.<sup>(31)</sup> For airports above sea-level, the glide path slope decreases as the airport elevation increases due to the fact that decreased atmospheric densities lessen the lifting

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(31) C.A.A. Airport Design. April 1944. Table 2.  
p.9.

effect of the air on the airplane wings. Figure VI shows the effect of increasing altitude on the glide path ratio.

The approach zone that must be protected is a trapezoidal inclined plane beginning at the ends of each landing strip and increasing in width for a distance of two miles from the airport, inclined at the prescribed glide path slope. A graphic illustration of the approach zone is depicted in Figure VII. A sample set of airport approach standards as prescribed by C.A.A. is shown in Figure VIII.

#### A. Methods of Airport Approach Control

Several ways for municipalities to control the height of structures or trees in the airport approach area have been suggested.<sup>(32)</sup> These are:

- (1) Voluntary action by adjoining landowners,
- (2) Obtaining title to all land near the airport through direct purchase or use of the power of eminent domain,
- (3) Acquisition of air space rights over the land near the airport through purchase and eminent domain,
- (4) Police power condemnation of hazards dangerous to

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(32) Rhyne. op. cit. p.164.

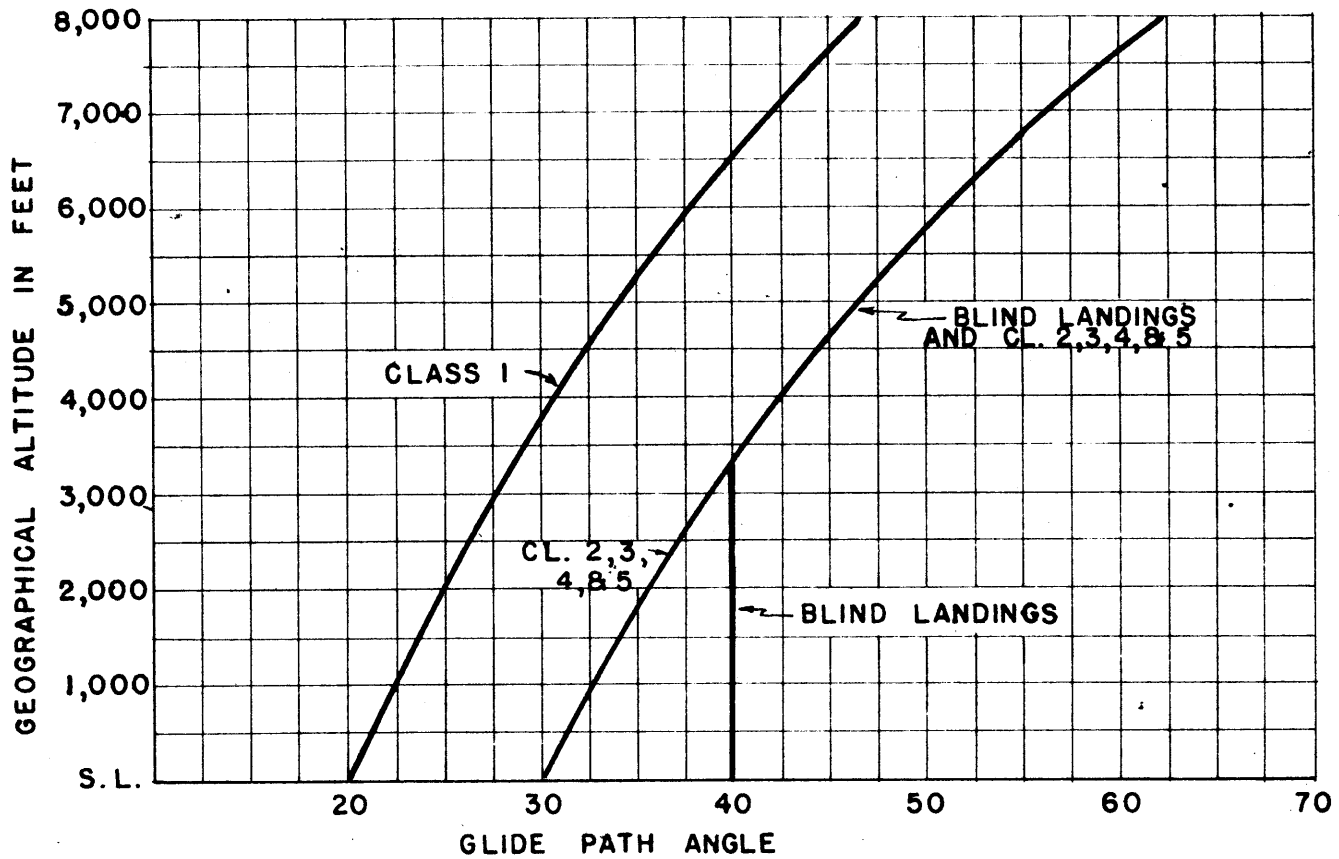
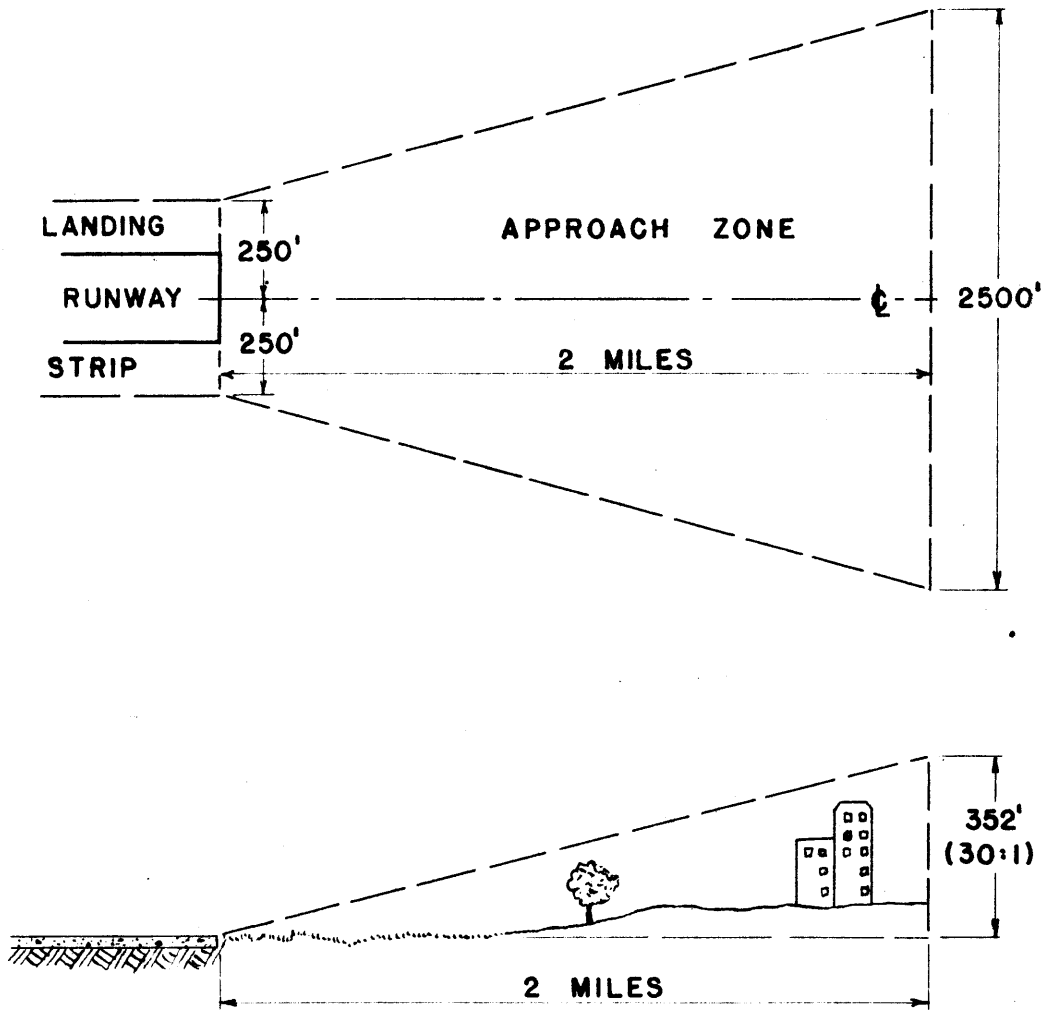


FIGURE VI

## AIRPORT OBSTACLE ZONING RATIO

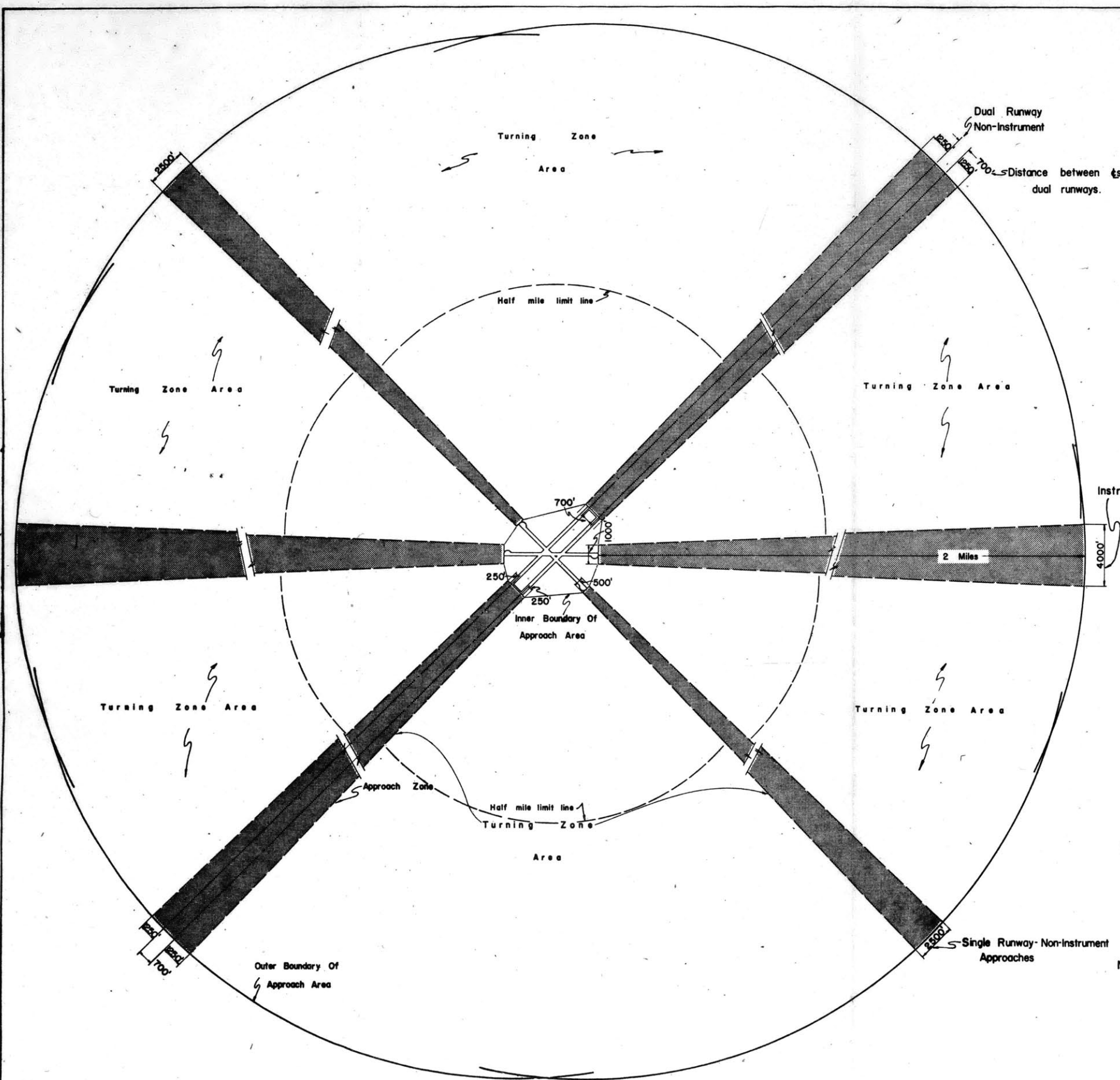
ADAPTED FROM C.A.A. DATA



**RUNWAY APPROACH ZONE**  
NOT TO SCALE

FIGURE VII





Approach zones to all instrument runways should be 1000' wide at the airport boundary, widening to 4000' at a distance of 2 miles.

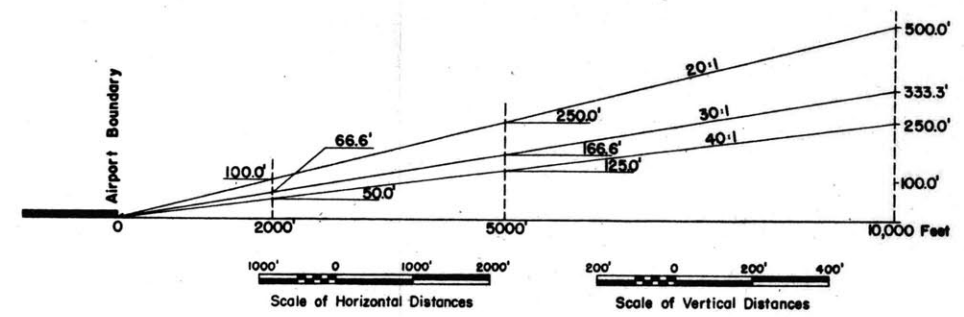
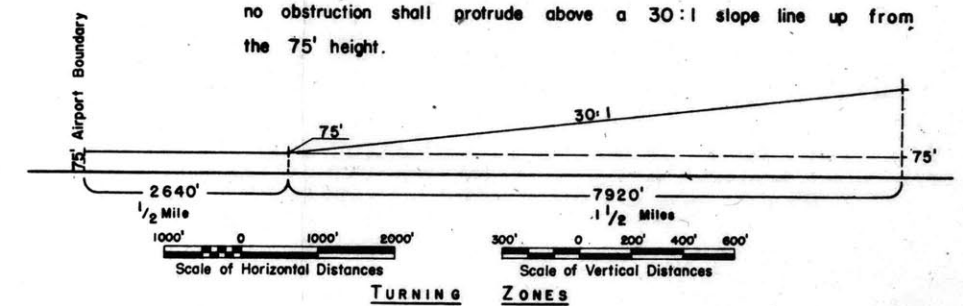
Approach zones to noninstrument runways should be 500' wide at the airport boundary, widening to 2500' at a distance of 2 miles.

Recommended maximum height (above elevation of landing area) of structures and other objects located in airport approach areas. (In terms of fraction of distance of such objects from inner boundary of approach areas.)

Zone	Obstruction Ratio			
	Class 1 Airport	Class 2 Airport	Class 3 Airport	Class 4 Airport
Turning zones	1/20	SEE NOTE	NOTE	NOTE
Approach zones not to be used for instrument landing.	1/20	1/30	1/30	1/30
Approach zones to be used for instrument landing.			1/40	1/40

**For Turning Zones  
In Class 2, 3 and 4 Airports.**

No obstruction protruding above the following limits - From the boundary of the airport for a distance of 1/2 mile away; there shall be no obstruction above 75' in height. From the half mile away to 2 miles no obstruction shall protrude above a 30:1 slope line up from the 75' height.



NOTE: These tentative approach standards should not be confused with airport lighting standards. For lighting see C.A.A. standard specifications for airport lighting

DEPARTMENT OF COMMERCE  
CIVIL AERONAUTICS ADMINISTRATION  
AIRPORTS SERVICE  
ENGINEERING AND CONSTRUCTION DIVISION

**AIRPORT APPROACH STANDARDS  
(TENTATIVE)**

REV. APPROVED: *W.B. Morrison*, DIVISION CHIEF  
REVIEWED: *Charles B. Bonallie*, SECTION CHIEF  
SUBMITTED: \_\_\_\_\_  
CHECKED: \_\_\_\_\_  
DATE: 1-6-41 SCALE: SHEET 1 OF 152-C

Figure VIII

those using the airport, and (5) Zoning regulations.

Voluntary action on the part of public spirited property owners may have worked in some instances, but it is too uncertain and not uniform. The risk of property sales bringing new uncooperative owners is too great. In practically all cases, it would be financially impossible to obtain title to all the land under the protective areas; also, the airport authority would have title to an area of land much larger than the amount that would ever be necessary for airport expansion. The acquisition of air space rights has some merit. However, the value of air space is often difficult to determine and, occasionally, the cost of the air easement may be so high that it would approach the actual purchase price of the land itself. Police power condemnation of existing hazards is too drastic since the property owner receives no compensation for being forced to remove the tree or structure; because of its unreasonableness, such a measure would probably be declared illegal. The application of zoning regulations in controlling airport approaches is the most generally recognized method of control; this will be discussed below.

## B. Airport Zoning

Airport zoning involves control of the height of structures and of objects of natural growth in the approach zones of airports through the use of the police power.

Many states, not believing that cities were given sufficient power under the general zoning enabling act to zone airports, adopted airport zoning legislation that would give them such power. As of March 1945, thirty-one states had enacted airport zoning legislation. Most of these laws are patterned after the Model Airport Zoning Act drafted jointly by the Civil Aeronautics Administration and the National Institute of Municipal Law Officers, the most recent revision of which is dated November 7, 1944.<sup>(33)</sup> The model law is divided into thirteen sections as follows: (1) definitions, (2) airport hazards not in public interest, (3) preparation of airport approach plans, (4) adoption of airport zoning regulations, (5) permits and variances, (6) procedure — adoption and administration of zoning regulations, (7) judicial review, (8) enforcement and remedies, (9) acquisition of air rights, (10) severability,

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(33) John M. Hunter Jr. The Conflicting Interests of Airport Owner and Nearby Property Owner, in "Law and Contemporary Problems". Winter-Spring 1946. p.552.

(11) short title, (12) repeal, and (13) time of taking effect. This law has been carefully drafted and emphasizes that all regulations that are imposed shall be reasonable.

Airport zoning has been challenged by several students of planning law in that it is not a true application of the police power.<sup>(34)</sup> However, airport zoning, alone, seems to be a proper exercise of the police power, in that the regulation is substantially related to the community health, safety, convenience, and general welfare, and if properly applied, is reasonable. It has been emphasized, previously, that an airport is in the public interest, and airport zoning would protect property owners, the airport, and the city as a whole, against future injury.

All statutes and ordinances are clothed with a presumption of constitutionality and legality until they are upheld or rejected. As yet, the validity of airport zoning has not been settled by the courts. A recent case involving the city of Newark, N.J. caused a pessimistic reaction among airport zoning advocates.<sup>(35)</sup>

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(34) See: Alfred Bettman, Airport Zoning(?), in "A.S.P.O. News Letter". Sept. 1939; and Philip Nichols. The Massachusetts Law of Planning and Zoning. (Mass. Federation of Planning Boards. 1943). p. 208.

(35) Yara Engineering Corp. V. City of Newark. 235 CCH 1989 (N.J. Sup. Ct., Jan. 8, 1945)

The Supreme Court of New Jersey declared that Newark's airport zoning ordinance was unconstitutional. The decision, however, was based on the fact that the city lacked the power to adopt such an ordinance in the absence of state enabling legislation. Another previous case held that the Baltimore airport zoning ordinance was unconstitutional as it applied to the Baltimore Municipal Airport.<sup>(36)</sup> But the ordinance was undoubtedly unreasonable, some of the height restrictions being as low as five feet from the ground. So far, then, the test cases have shown only specific ordinances to be unconstitutional and have not rendered any clear-cut decision against airport zoning generally.

In most instances, airport zoning should be supplemented by land acquisition, by purchase or eminent domain and/or the acquisition of aviation easements; this is particularly applicable to that land which is so close to the airport that the obstruction line (glide path plane) would be so close to the ground that a height restriction by zoning would be an unreasonable taking of the land.

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(36) Mutual Chemical Co. V. Mayor and City Council of Baltimore. 235 CCH 1821 (Cir. Cit. No.2, Balt., Md. January 25, 1939)

When airports are located in developed areas, the airport approaches should be protected under height restrictions in the city's comprehensive zoning ordinance. Whatcom County and Seattle, Washington have included such a section in their zoning ordinances;<sup>(37)</sup> usual height limits in the region of the airport are below the inclines extending from the edges of the landing stripes. Again, in areas contiguous to the airport, the city should purchase land and air rights of that land which is unreasonably restricted.

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(37) J.H. Vogel. Airport Protection by Zoning and Neighborhood Planning, in "American City". September 1941.

## CHAPTER FIVE

PLANNING AGENCIES AND THE AIRPORT

Planning agencies and planning staffs must constantly maintain a broad outlook. The effect that a decision will have on the entire area with which the planners are concerned should always be considered. Secondly, all phases of life must be examined so that the plans will be attuned to the good of the whole.

Transportation systems are only one of the many parts of the unit's physical shell that planners need to evaluate. Furthermore, aviation is only one of several transportation systems, and airports are only the terminal facilities for the aircraft. Airports, then, are just a part of the whole; and it is from this perspective that airports must always be viewed by the comprehensive planner.

But it should not be assumed that airports will be neglected in the comprehensive plan. Rather, their true function will be determined and the airport system will be planned on that basis. A too extensively developed airport system will wither, and an inadequate system will

later suffer from growing pains. Therefore, even from the aviation enthusiasts viewpoint, an airport system that fits harmoniously into the economy and physical development of the region will be the one that will be most universally beneficial, and the one that will most effectively insure the development of air transportation.

#### I. STATE AGENCIES

The usual airport agency for the state is the aeronautics commission. Ordinarily, aeronautics commissions are planning and regulatory bodies. As one of several functions, they plan and coordinate airport development within the state and often are responsible for the distribution of national and state airport funds. As regards airport planning, the aeronautics commission should work with the C.A.A. on the higher national level, should facilitate and control the plans of the smaller political subdivisions, and, when necessary, should coordinate the activities of contiguous municipalities and counties in order to avoid the possibility of redundant airport facilities.

State planning commissions should be more than



normally concerned with airport planning due to the dynamic quality of aviation. A close liaison should be maintained between the planning commission and the aviation commission. Planning commissions, with their extensive knowledge of fundamental background data and information, ought to be called upon to participate in the airport planning and should, themselves, take active steps to insure that their viewpoint is recognized by the aviation commission. An indirect way of accomplishing this liaison is to have a responsible member of the aviation commission serve, also, as a member of the planning commission.

## II. REGIONAL AGENCIES

For regional areas or large metropolitan areas a central agency is necessary to assure integrated airport planning. This could effectively be accomplished by a specially created airport authority, a public corporation, which would plan the regional or metropolitan airport system; the authority should also have the power to construct and operate those airports that are clearly regional or metropolitan entities. In this current year, the states of New York and New Jersey have

enacted legislation conferring such powers on the existing Port of New York Authority. Whether a special authority is the best solution may be debatable. However, it seems to be a good answer to a need for a relatively permanent organization that will have the responsibility of planning, construction, and administration. Most states need legislation that will enable metropolitan regions to initiate an integrated airport program and that will facilitate joint action of municipalities in planning, establishing, and operating airports.

### III. LOCAL AGENCIES

Although the federal and state governments provide financial assistance for constructing airports and make skilled engineers available for consultation, the responsibility for initiating airport projects usually rests with the towns and cities concerned. Therefore, the county and city planning commissions should be fundamentally concerned with airport planning and location.

The airport plan of a city should be included in the master plan, which is an integrated program,

prepared by the planning commission, for the future development of the city or county. Existing and proposed airports will be shown on the master plan map -- the graphic presentation of the master plan indicating land uses, circulation, and facilities for community services. The master plan map will establish the airport's location, show the inclusive airport areas, and indicate the airport's relation to other communication facilities and the surrounding areas.

The planning commission should also be concerned with the airports' design since the runway layout will have a definite effect on surrounding areas. Runways should be sited so that airplanes making a direct approach to the runway would not pass over residential or other developed areas. The runway layout will also affect the airport zoning regulations which is an indication that airport zoning, as well as comprehensive community zoning, should be based on the integrated future plan.

A definite problem which planning commissions must face is that of setting aside land, now, for future airport development and expansion. For commercial airports, the problem is not so acute since the airports are or will be located in relatively undeveloped areas

and options on the land or land purchase will not be particularly expensive or will not cause any stir of public opinion. However, the problem of future airpark location is quite different. If the nuisance stigma of small airports is reduced or eliminated, the small airport may be located nearer residential and commercial districts. However, at present, the airpark is a nuisance, and any move on the part of planning commissions to locate an airpark or even set aside an area for the future location of an airpark near a residential area would probably encounter serious public opposition. But the lack of present action in setting aside airpark locations may in the future, find the selected airport sites cut up by some other use. A possible solution may be for the municipality to obtain title to the projected sites, then lease them to some authorized private use on short-term lease, or keep the land in some temporary public use such as a recreation area. At some future time, when the need arises, and if the airpark is no longer regarded as a nuisance, the areas concerned may be converted into airparks.

## CHAPTER SIX

TECHNOLOGICAL IMPROVEMENTS AND THEIR EFFECT  
ON AIRPORTS

Can we foresee the effect that the recent technological improvements in aircraft will have on the airport in the future decades? To answer that question is something of a venture. There is little adequate measurement on which to base predictions, and the deciding factors in the eventual adoption of new improvements are dependent upon many interweaving phases of our life. We do know that, ordinarily, the lag of application behind the original development of an aeronautical invention is from three to five years; and, it may take another five years before the innovation is available in sufficient quantities or becomes acceptable so that it will affect air transportation as a whole. Then again, even though the fundamental problems of an invention are solved, the invention may never become widely used. Also, there is nothing to prevent some types of innovations from being applied almost immediately

with a just as immediate effect on aircraft operations. However, the function of a structure such as aviation follows a trend even though there is a radical change in the form due to a new invention.

It may be concluded that the effect of technological improvements in aircraft and aircraft service facilities on the airport may be predicted with reasonable accuracy after analyzing the present potentialities and the future promise of such improvements. However, any predictions beyond a decade, other than general trends, are unreasonable because of the dynamic uncertainty of aviation in its present state.

## I. SMALL PLANE IMPROVEMENTS

One recent innovation and another development that is still in the experimental stage give promise of allowing the small airplane and the small airport to be more acceptable in the community. These are cross-wind landing gear and airplane noise eliminators.

### A. Cross-wind Landing Gear

In June, 1947 the Civil Aeronautics Administration approved the cross-wind landing gear (or

castered-wheel landing gear) for installation on small personal airplanes.<sup>(38)</sup> The cross-wind landing gear will allow light airplanes to use single-runway airports irrespective of which direction the wind is blowing. Cross-wind landing gears operate on the same principle as casters on furniture. The wheels turn on a vertical shaft and, upon touching the ground, run parallel to the direction the plane is traveling at the instant of contact, regardless of the direction in which the plane is pointing. Consequently, the plane can head into the wind while landing, decreasing the possibility of being overturned by the cross-wind.

In August, 1946 the C.A.A. financed research work on the cross-wind landing gear because landing in cross-winds with conventional landing gear frequently resulted in ground looping and similar accidents. Also it was realized that a cross-wind gear would permit more use of single-runway airports. The idea of the castered wheel was a sound one, and in the Spring of 1947 the new type of landing gear was successfully tested under wind conditions of fifty mile per hour gusts blowing perpendicular to the axis of the runway.

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(38) C.A.A. Journal. June 15, 1947.

Universal adoption of cross-wind landing gear on light airplanes would allow small single-runway airports to be constructed. At the present time, Class I airports require two runways and average from 60 to 150 acres in area; the adoption of single-runway airparks would decrease the required area to sizes of from 30 to 50 acres. Such a decrease would make it possible for airparks to be located in long, narrow areas of small acreage and to be located in sections where land costs for airports of larger acreage would have been prohibitive.

The possibility of using cross-wind landing gear on medium-sized transport type planes is being considered. This idea, however, must be further pursued and proposed gear must be tested under varying conditions.

#### B. Noise Eliminators

In 1946, the National Advisory Committee for Aeronautics announced that the noise pressure of a lightplane could be appreciably reduced through the use of a multi-bladed fan-type propeller.<sup>(39)</sup> In the Spring of 1947, public tests were made using a five

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(39) Theodore Theodorson & Arthur A. Reiger. The Problem of Noise Reduction with Reference to Light Airplanes. N.A.C.A. T.N. No. 1145. 1946.



-bladed fan type propellor, and it was agreed that the noise level was appreciably reduced. At the present time, the Aeronautical Research Foundation is experimenting further on the reduction of noise of small airplanes.<sup>(40)</sup> By muffling the engine exhaust and using a multi-bladed fan-type propellor, the noise level has been reduced from 85-95 decibels to from 60-70 decibels at a distance of 100 feet.<sup>(41)</sup> The maximum acceptable street noise level in a residential district is usually considered to be 75 decibels during the day and 60 decibels at night. On such a basis, the adoption of these noise-reducing devices on all small planes should make the noise level of the plane no more objectionable than any other residential street noise.

As yet, no extensive noise reduction experiments have been conducted on larger airplanes. So, it is not known whether such reduction will be physically or economically feasible.

#### C. Effect of Cross-wind Gear and Noise Eliminators

Fortunately, the multi-bladed propellor, which is a noise reducing factor, also enables the lightplane to climb at a steeper angle after take-off,

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(40) Technical experimentation is under the direction of Professors Otto C. Koppen & Edward S. Taylor of the Massachusetts Institute of Technology.

(41) Information received in an interview with Prof. O.C. Koppen, Aeronautical Engineering Dept., M.I.T.

and allows a steeper angle of approach for a landing. Consequently, it is believed that the glide path angle could be increased from 20 to 1 to about 6 to 1 for personal-plane airports.(42) Such a prediction, however, is based upon the assumption that all lightplanes would be equipped with multi-bladed propellers.

Both the cross-wind landing gear and the noise eliminators are developments which would make it more possible for airparks to be located in metropolitan areas. The cross-wind landing gear would allow smaller areas to be used for airports, and the noise eliminators would decrease the noise potential of the small plane as a noise nuisance; due to the possibility of steeper climbing angles, the multi-bladed propellers would enable the airport zoning regulations to be less restrictive, and would give residents adjacent to the airport a greater feeling of security because the airplanes would not be required to fly low over so many dwellings.

Other physical and economic factors will affect the ultimate fate of personal-plane airports. The effect of all these combined factors will be finally discussed later.

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(42) Ibid.

#### D. Roadable Airplanes

Engineering problems of the roadable airplane are not insuperable. In fact, several types of combination automobile and aircraft have been constructed; to date, however, the result has either been a mediocre automobile and a poor airplane or a poor automobile and a mediocre airplane. The technological problems of the roadable airplane could undoubtedly be solved if there were sufficient demand for it.

If roadable airplanes became universally used, the demand for small airports would be increased, since it would still be necessary for the plane to land at an airport before taking to the road. The roadable airplane would undoubtedly have a greater utility than the personal airplane. However, the expected competition of the helicopter, expensive engineering research difficulties, and the present poor financial condition of the personal plane manufacturers who would probably pioneer roadable airplane research, will probably keep the roadable plane from developing for at least a decade.

## II. HELICOPTERS

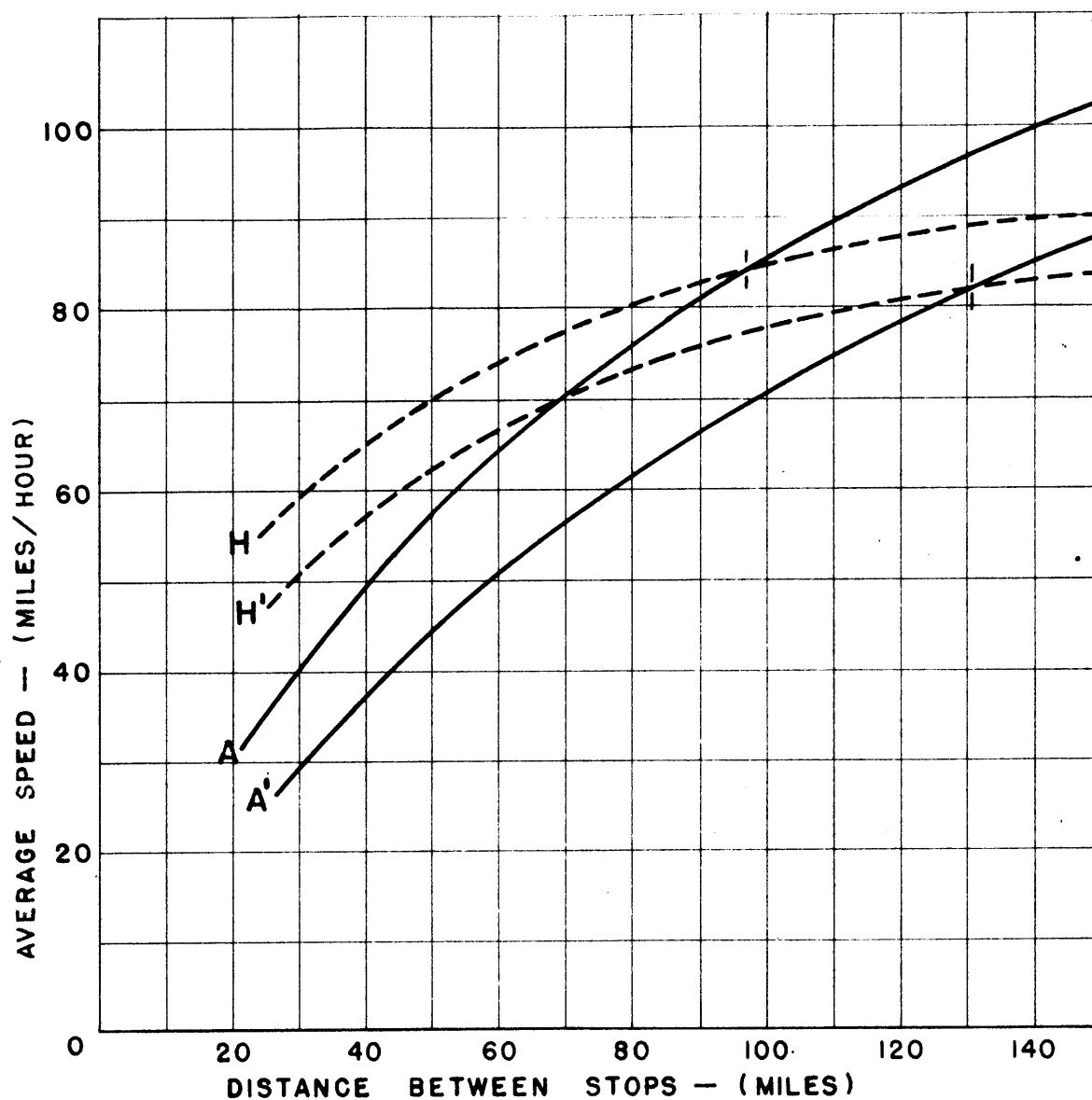
Although the idea of the helicopter is an old one, the fundamental problems of helicopter design and operation have been solved only recently. The ability of the helicopter to take-off and land vertically, and its ability to fly slowly when necessary make it more flexible than the ordinary airplane. These unique advantages have already made the helicopter useful in many ways.

There are several problems in regard to helicopter operation which should be solved so that the helicopter may become more widely acceptable: (1) the possibility of engine failure and rotor breakage should be further reduced; (2) the complicated controls of the craft must be simplified so that such a high degree of skill will not be required to operate them; (3) vibration should be reduced; and (4) the problem of ice formation on the rotors should be solved. Before the helicopter will find use as a private vehicle, its price must be reduced to a reasonable rate; the present price of over \$10,000 makes even the smallest helicopter a luxury vehicle for private flying.

### A. Probable Uses of Helicopters

One of the most promising uses of the helicopter is as an air bus. Except for very short distances, helicopters are always faster than automobiles, buses, or local trains and mass transit. As shown by Figure IX, the helicopter may be faster than the airplane for short distances. Therefore, the helicopter may be used for commuter transportation from outlying suburbs, may act as an air bus within the metropolitan area, and may be a time-saving connecting link between the airline airport and the central city.

When some of its engineering problems are solved, the helicopter may challenge the light airplane for the personal flying trade. The helicopter's landing facilities are potentially less troublesome than a lightplane since a much smaller area is needed to land a helicopter than is required for a light airplane. In the intensively developed areas of the city, the helicopter may be landed on the flat roofs of apartment houses or office buildings. In residential areas a vacant lot near the home may be used as a commercial helicopter field, or, for those residences



A & H = AIRPLANE AND HELICOPTER, WITH GROUND  
TIME TO AIRPORT OF 1/2 HOUR

A' & H' = AIRPLANE AND HELICOPTER, WITH GROUND  
TIME TO AIRPORT OF 3/4 HOUR

## EFFECT OF AIRPORT LOCATION ON OVERALL SPEED - AIRPLANE VS. HELICOPTER

FIGURE IX

with large lots, the helicopter may land in the individual lot.

There are so many possible uses of the helicopter that one could fill many pages enumerating those uses and speculating on the effect they would have on the life of the nation. Practical application of only a few of these uses would, nevertheless, be a substantial contribution to the advance of civilization.

#### B. Effect of Helicopters on Airports

The helicopter used as an air bus would encourage long-distance passenger travel via commercial airplanes since it would expedite city to airport travel; consequently, the need for airline airports would be greater, and the number and size of commercial airports would increase.

On the other hand, the helicopter used as a personal craft might seriously compete with the personal airplane. In that event the number of personal airplanes would decrease and the need for personal-plane airparks would consequently decrease. The ability of the light airplane's competitor to land in a small

space would offset the necessity of maintaining a large number of airparks.

The helicopter could conceivably add to the trend of decentralization started by the railroad and automobile. If the private helicopter and helicopter bus can provide a rapid and dependable means of travel into the city, they may scatter population farther outward, and may fill in those areas in the periphery that are now inaccessible to ground transportation.

It must be remembered that the listed effects of the helicopter assumes: solution of the machine's several problems, mass production, and acceptance of the helicopter as a means of transportation. Several years of research may yet be required to test all of the possibilities of the helicopter. Engineers discourage prospective buyers who expect to be able to obtain a helicopter in the near future.<sup>(43)</sup> So, it may be close to a decade before the helicopter will be able to become a significant factor in the field of air transportation.

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(43) William F. Ogburn. The Social Effects of Aviation.  
(Houghton Mifflin Co. 1946) p.258.



### III. GENERAL IMPROVEMENTS

#### A. Airplane Size

It is not expected that passenger airplanes serving average distances of air travel (up to 1500 miles) will undergo any radical changes in size or design within the next decade. The next few years may find improvements in the direction of greater speed, improved brakes, higher wing loading, and other adaptations leading to greater efficiency and more economical operation. The trend, now, is toward using more of the four engined planes carrying from forty to sixty passengers for middle-distance travel. But since these planes are already in use, their increasing use will not affect present airport design standards.

The demand for non-stop cross-continent travel and inter-continental travel — distances of around 2500 miles — is even now being felt. For this travel, larger planes than those now in use may be developed. The largest plane on order by the airlines has a capacity of 204 passengers and weighs 320,000 pounds.<sup>(44)</sup> Aerodynamically, there has been no proven limit to the size of airplanes. Yet, there will be

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(44) Ogburn. op.cit. p.87.

a practical limit to the size of planes, although such limits may be set by economics rather than by technology. These large, long distance airplanes will be used at only a few major air terminals and will not affect the design or construction of the usual commercial field.

#### B. Assisted Take-offs and Landings

An important factor in determining airport design and size is the possibility of assisted take-offs and landings. Mechanical take-off devices of the catapult type were first suggested. They have been used to some extent but, in their present form, are not practical for general use because of the manpower required to operate them, and because the rapid acceleration is objectionable for passenger operations.

During the recent war, rocket canisters fastened under the wings of heavily loaded planes reduced the take-off run required through their jet action. The employment of jet-assisted take-offs for passenger planes is even more objectionable than the mechanical devices. Not only is the rapid acceleration

uncomfortable, but the whole operation is rather frightening due to the resultant noise and smoke of the jets. The most promising use of jets is on all-cargo airplanes; a jet-assisted take-off would enable the cargo plane to carry a heavier payload. However, the controlling factor is one of economy. At the present time, the four jet "shots" that are usually required for one take-off cost around \$800. Reductions in the cost of the jets would undoubtedly find them being used to a greater extent.

The length of the landing run of airplanes is not such a critical problem. However, various methods of shortening the landing run are being worked on. Brakes on heavy planes are not satisfactory because they generate so much heat that they often vulcanize the tires to the wheels. On propeller driven planes the most hopeful development is the reversible pitch propeller which will slow the plane due to a reversal of the blade angle. The use of jets to slow the landing of jet-propelled planes has been suggested, but, as yet, such a measure has not been proven to be practical.

### C. Jet Propulsion

The introduction of jet propelled planes to civil use will not affect the design of airports. Take-off distances are approximately the same as for equivalent weight propellor-driven planes. Landing distances are often longer due to increased landing speeds, but since the landing distance required is shorter than the take-off distance, no increases in runway lengths should be necessary.

### D. Instrument Landing

Airport design is also affected by methods of instrument landing. The technique that now is approved and promoted by C.A.A. is Instrument Landing System (I.L.S.), based on an electronic beam projected into space. The number of planes per hour that can be handled on an instrument landing runway is no more than twelve per hour; C.A.A. maintains that this may be increased to twenty operations per hour. By the I.L.S., certain runways are designated for instrument landings, and special equipment is required for its operation.

Another technique, Ground Controlled Approach was developed during the war and was used

by the Army and Navy in low-ceiling weather. The fundamental characteristic of G C A is the use of a radar scope by which a ground crew "talks" the pilot to the ground. G C A is highly sensitive. A trained operator can direct a plane to within inches of the ground at the desired point of contact. This method is not entirely satisfactory because it, too, allows only a small number of operations per hour since only one plane at a time may be "talked" to the ground.

The use of radar in the airplanes themselves is a development that has been demonstrated to be possible. By this method, the pilots will be able to see the airport through a radar scope, and operations in the foggiest weather will be able to proceed at the same rate as contact operations. However, several technical difficulties must be eliminated and it will probably be from three to five years before radar operations will be completely practical.(45)

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(45) J.W. Adams, Make Your Municipal Airport Practical, in "American City". December 1945.

## CHAPTER SEVEN

### CONCLUSION

The foregoing chapters have presented in some detail the problem of the airport — how it affects our society, how it should be planned, where it should be located, and how controlled and protected. Some of the conclusions that may be drawn from the preceding dissertation are obvious, others are somewhat obscure, and a few are completely indefinite. The following discussion will emphasize the obvious, will attempt to clarify the obscure, and will try to explain the indefinite.

#### I. THE AIRPORT PLANNING QUESTION

Above all, airport planning and airport plans must be flexible. Nobody knows how far aviation is going, nor can the rate of its development be accurately predicted. Therefore, all airport planning -- from the national level, through the region and state, and to the smallest political subdivision -- must be readily adjustable to changing conditions.

Almost equal in importance to flexibility is the requirement that airports and airport systems must be carefully coordinated. Airports are interdependent. One is of little value, but a skillfully meshed, harmonious system of airports is a vital phase of the transportation system of the nation. Planning commissions and agencies, aviation commissions and administrations, and airport authorities, of all levels of government must work together in order to accomplish an adequate system of airports.

A definite aid to the development of aviation would be the establishment of airport size and capacity standards. The C.A.A. classifications should be finally determined and not changed as they have been up until now. Each newly designed transport airplane has needed longer and longer runways, thus making airports obsolete and imposing additional financial burdens on the municipalities who must enlarge the airports. On the other hand, aircraft designers have been handicapped by the uncertain size and strength of runways which would be available at various airports. The C.A.A. is now investigating the possibility of standardizing runway length, width, and capacity. (46)

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(46) C.A.A. Asks Comment on Proposed Runway Lengths and Widths, in "C.A.A. Journal". June 15, 1947.

Such a standardization would be particularly beneficial to airport planning since plane designers would be required to keep within the standards.

## II. WHERE SHALL AIRPORTS BE LOCATED?

In a survey of ten major cities taken by the Urban Land Institute in 1945, the majority opinion of the people was that major (commercial) airports should not be located nearer than two miles from a residential area.(47) The commercial airport is definitely a nuisance when located in developed sections of metropolitan areas; indications are that it will continue to be a nuisance in the future. For this and other reasons, commercial airports should be located in relatively undeveloped areas on the city's periphery, and major highways should connect them with the center of the city so that the time-distance from city to airport will not be excessive. If it is financially possible, major airports should be surrounded by a protective belt of land so that both the airport and future nearby developments will be protected from one another's encroachment.

In considering personal-plane airports, several factors point to their increasing acceptance, in the

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(47) Technical Bulletin No.3. Urban Land Institute.  
June 1945. Table VI.



near future, as a part of the community. The possibility of the reduction of lightplane noise, increased glide angle, and a smaller required area due to the adoption of a single-runway airport, may eliminate the noise objection, decrease the airport's capital cost, and make available more metropolitan locations. However, other requirements must be met before the private field will become acceptable as a part of the city. Clear-cut standards of flight patterns and operation of aircraft over the city must be evolved; also, the airport must be made more physically and financially attractive to the community as a whole. The possibility of the small-plane airport becoming financially sound is not likely; the ultimate solution may be a partial subsidization of the personal-plane airport by the city. There will undoubtedly be a future need for airparks, although private airplanes probably will not be as numerous as the aircraft manufacturers claim, since the personal airplane does not have a great deal of utility. Some of the airparks should be located in the city, properly sited so that both the airpark and the adjacent uses will be suitably protected. An airpark may be located near a residential area, but there

is no reason to put it in the very middle of the area unless special conditions warrant such a location.

### III. THE AIRPORT AND THE METROPOLITAN AREA

The airplane and the airport have changed the city to some degree. Aviation, as it advances, will continue to affect the way of life in metropolitan areas. Planners must realize the import of these effects in order to plan intelligently for the future.

### IV. ROLE OF CITY IN AIRPORT OPERATION AND CONTROL

The city has been playing an increasing role in the construction and operation of airports. Indications are that the city will become even more involved as an airport operator — both of commercial airports and smaller private-plane airports. Airports that are now existing and those that will be constructed in the future should be protected and controlled by the city through airport zoning, condemnation of restricted land, and the purchase of air rights; such control will benefit all concerned — the airport, the nearby property owner, and the city as a whole.



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