COLLATERAL PROBLEMS

IN THE

LOCATION AND DESIGN OF AIRPORTS
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by

Richardson M. Courtney
Bachelor of Architecture, Carnegie Institute of Technology, 1942

Submitted to the Department of City and Regional Planning on May 16, 1952 in partial fulfillment of the requirements for the degree of Master in City Planning.

IT IS MY THESIS .. that a workable arrangement can be planned forming the basis for: the completion of the airport mission; safe flight operations and related activities; an integrated, harmonious plan of land uses; and an economic balance between the aviation industry and supporting communities.

The analysis of the design and location of typically complex airfield operations will establish adequate proof of the feasibility of the thesis. The planning recommendations, first, for the inclusion of the planning of airports in the comprehensive planning process of the metropolitan region, and second, for the adoption of new airport planning criteria ... offer constructive guides for the development of the thesis.
The report prepared by the planning firm of Adams, Howard and Greeley for the President's Commission on Airports points the correct way to the solution of the thesis. One of the major duties of the following study is to reinforce the recommendations of the report, especially in the detailed explanation and testing of the new planning proposals.

In answering the airport problem the report leads logically in its solution to the requirement for a comprehensive regional plan. This is the second major duty of the thesis to define the conception of the required land use plans, both in the hazardous approach paths to the airport and in the immediate vicinity of the airport.

The third major function of the thesis is the study and explanation of the integration of the urban use areas with the transportation pattern. This entails the study of the effect of airports on the decentralization of the urban area. It is presented in the form of a sketch analysis of several airport-metropolitan plan studies.

Thesis Supervisor: John T. Howard
Associate Professor of City Planning
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Thesis Supervisor: John T. Howard
Associate Professor of City Planning
Dean Pietro Belluschi  
School of Architecture and Planning  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

Dear Dean Belluschi,

May I submit, herewith, a thesis, entitled "Collateral Problems in the Location and Design of Airports", in partial fulfillment of the requirements for the Degree of Master in City Planning.

Respectfully,

Richardson M. Courtney
Acknowledgement

Professors Frederick J. Adams for the opportunity to continue work on the study of the Airport - Community relationship by means of the Report prepared for the President's Commission on Airports.

John T. Howard

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and

Mr. Harold B. Smith .... for much of the experience and training that led to the initiation of this study.

Mr. Donald R. Courtney without his inspiration this work would not have been accomplished.
"The airport planner must be creative and realistic in designing practical, useful, and economical landing facilities for aircraft in order to promote the welfare of society as a whole. To achieve the best engineering compromise, he must appraise all factors which govern aviation as a means of transportation and must try to weigh what were once imponderables. He must direct his efforts toward planning facilities which will be useful units of an integrated whole, forming a broad pattern of civic usefulness and national defense. The economic position of any community or nation that fails to envisage the horizons of aviation and provide adequate landing facilities will be affected adversely."

Edward Rickenbacker
Aviation Pioneer
The experience gained in monitoring the design and construction programs of planned elements in the USAF Air Materiel Command installations has provided an almost inexhaustible store of planning incidents. These have indicated the need for plan studies supervised by a Planner with a span of control extending over the complex use elements in the region of the airfield.

"Although it represents an oversimplification, the planning of most engineering projects, considered in the broad sense, includes the synthesis of six major considerations, and these are the social (including the political), the legal, the functional, the economic, the technical, and the esthetic aspects of the problem." Thus the continuation of the study of airport design and location means more than the solution of a flexible plan insuring future expansion and development of the airport. The requirement is for a study of the airport influence beyond reservation boundaries, and the provision of a correct plan relationship with the neighboring communities.

1. Professor John B. Wilbur, Head, Civil and Sanitary Engineering Department
Welcome Address - Conference on Ground Facilities for Air Transportation.
Current distress in the relationship of airports to their neighboring communities signals the need for a study clarifying and defining a workable land use arrangement. The American people know of the potential hazards connected with airport development and operation but neglect to do something about it until forced by extenuating circumstances. The recent tragic aircraft accidents in the New York area have awakened public action to a condition long dormant. Excessive noise, vibration, and recurrent threats of danger have culminated in accidents which, for the first time on a large scale, have included the destruction of lives and property of people on the ground.

The immediate response to this coincidence of unrelated aircraft mishaps in a single area was for legal action curtailing airline activity. Uninformed, indignant action will seriously hamper the progressive development of the entire aircraft industry. Although the findings of the President's Commission on Airports, under Lt. General Doolittle, will have some measure of success in alleviating the fear complex of the people in the vicinity of major airports, any succeeding, similar air crash will nullify the work of the Commission.

Some positive decision must be presented, under a uniform National recommendation, which will allow the local governments to put into effect adequate safeguards. Only by participating in a planned action can the urban dweller be convinced that his security is being maintained. The planning recommendations forwarded to the Commission on Airports hold the opportunity for such an assurance.
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THE INAUSPICIOUS BEGINNING OF THE PROBLEM

The historical development of airports reveal a varied pattern of criteria, from that of the open field grassed area, of a few acres, to the multi-runway behemoths of several sections of land. McCook Field, for example, was conveniently located "across the river" from Dayton, Ohio on a level plot of ground, with no real obstacles to flight. The first flying machines of the Wright brothers were mere novelties, a fantastic display of man's ingenuity. Only a few could envisage the evil features as well as the good that would result from aircraft progress; and the new demands that would be made on the physical structure of our communities. Perhaps it is sufficient commentary to note that in weighing the future of aviation, Orville Wright felt that the benefits to mankind would mean more to the progress of civilization than the horrors of war and crashes could detract.

PERIODICAL DEVELOPMENT

The flights of Lindbergh, Rickenbacker, and Doolittle were milestones in aviation that brought confidence in this new medium to the American people. The great technical advances come in cyclical periods. After World War I, the first great step came with the all-metal cantilevered wing. A second great advance came during World War II with the advent of the gas turbine and jet propulsion. The demands of the war staggered the imagination of the "groundlings", and President Roosevelt's call for 100,000 aircraft was termed to be absurd. From 1940 to 1945 the aircraft industry grew in one tremendous leap, as the performance of the heavy bombers and cargo carriers enlarged the horizon for commercial aviation. From a barnstorming side-show attraction and intermittent passenger service, the industry grew to provide scheduled service to all parts of the world.
AIRPORT DEVELOPMENT LAGS BEHIND AIRCRAFT DESIGN

The mysteries of flight and aircraft construction were transmitted to aircraft operations and ground facilities procedures. Due to the rapid change in aircraft design and operational requirements, neither the ground facilities nor the layman could keep pace with the varied plan requisitions. Even the flight test and research centers have had difficulty in anticipating moderate future needs. The demands of World War II aircraft, with fixed landing gear and relatively low (compared to anticipated) takeoff and landing speeds, dictated the use of airfields with runways in the major wind directions. Thus the wartime advance in airport design was from the open-field type (at Bettis Field, Pittsburgh, a completely covered surface) to the airfield with runways in three or four directions. Many airfields are restricted today in development by the retention of this system of design.

A NEW PEACETIME EMPHASIS ON AIR POWER

The role of the airport and air travel has been constantly underestimated with the harsh result the air facilities have never received the proper emphasis. The low volume of cargo carried during World War II aided this nearsighted concept. Air Service operations accounted for less than 1% of all railroad, truck and ocean vessel freight. However, the Berlin Airlift and the new Korean supply problem have opened the way to a completely new logistical concept of air power.

Commercial and industrial companies can now afford the use of air transport as a part of their established transportation facilities. It is now included in the general plan of methods required for efficient profit-making management. Airports devoted entirely to cargo and to industry are becoming a vital necessity.
The need for multi-runway facilities was contorted out of all good proportion by the grandiose schemes concocted by the landscape-architect manner, as illustrated above by the proposed airport plan for Chicago.
The real influence of this kind of planning is indicated by the plan of existing runways at the Chicago Midway Airport. The inability to coordinate this complex scheme with an urban area is easily apparent. The pattern of the built-up area completely surrounding the airport is of interest to the study of the effect of airports on urban land values.
THE AIRPORT AS A BLIGHTING INFLUENCE ON LAND VALUES

Studies by the Federal Housing Authority and the Civil Aeronautics Administration disagree on the effect of the airport on the surrounding land values. Each agency has a different purpose in view, and color the findings to suit their prevailing argument. It is true that the initial effect on property values may be detrimental for their existing or intended uses. The common conception is that all land is or should be available for a residential use, and that any other use limiting this purpose has a detrimental effect. The operational requirements of an airport, as indexed by the noise, dangers, and congestion of people and traffic, fit into the general classification of an industry. Industrial and commercial uses integrated with airport usage will, in time, have a salubrious effect on land values.

ENCROACHMENT ON THE AIRPORT AREA IS THE REAL DANGER

Past planning problems indicate the need for the prevention of the encroachment of the airport area by supporting industrial, commercial and residential uses. This development by parasitic attraction denies to the airport its required expansion space and adequate approach zone protection. The reservation of an area required for the healthy development of the air industry is a paramount argument for land use planning. The planning procedure must not only provide a safety factor to residential users by eliminating this use from proven hazardous areas; but must also allow a generous margin of developmental area for the new industry and satellites.
A DEFINITION OF PLANNING

Planning is the method employed to create an effective control of the forces which determine the environment of the areas used for living, working, and playing. It is employed to organize the physical framework upon which communities may achieve their desired environment, and embraces the major considerations of the social, legal, functional, economic, technical, and esthetic aspects of the problem.

Comprehensive planning, both at the community and regional level, is concerned with "the unified development of urban communities and their environs and of states, regions, and the nation, as expressed through determination of the comprehensive arrangement of land uses and occupancy and the regulation thereof." 1.

Whereas the planner has long been endeavoring to sell communities on the need for comprehensive urban plans, it is now imperative that the medium of planning be used to correlate the airport and its problems with other regional use areas. Thus the airport problem brings into clear focus the subtle and often intangible problems of the city. Through common effort a way may be found for the solution to both the planning of communities and the planning of airports.

1. The American Institute of Planners' definition.
GRADUAL DEVELOPMENT OF AIRPORT DESIGN CRITERIA

The advent of heavier, faster aircraft (B-29, B-47 etc.) brought a change in concept of the required runway pattern for present day and future airports. Air Force criteria for design (since 1947) has been indicated by a directive requiring a coverage of 95% on any runway or combination of runways, based on a runway computer system with a wind beam component of 1.3. An evaluation of most airfields indicate the need, under this criterion, for two runways. This is substantiated by an examination of wind data and aircraft movement charts over a 5 to 10 year period. Analysis indicates that the second runway is required for light aircraft (ex. DC-3) in off-wind periods, and occasionally for convenience in obtaining a short taxi distance to the apron area.

The initiation of bad-weather landing techniques has placed the plan emphasis on an "instrument" runway. This facility is chosen as the runway with optimum low-level approaches, the longer runway (or a possible extension), and the best wind coverage. Many instances exist illustrating the need for a new runway superimposed over the existing three or four runway pattern in order to answer the basic demands.

The two runway airport brought a reasonable runway relationship to the airport-urban problem of integration. The CAA and the Air Force then sought to protect the airport investments by insuring the runway approaches from the encroachment of obstacles extending into the glide path of the aircraft. The CAA and AF definitions of the airport area (ie. approach and transition zones) are not completely uniform but are adequate as functional guides for legal ordinance purposes. Radio, airway, and instrument let-down procedures are standarized and adequate to serve as a basis for future recommendations.
The variety and complexity of runways in the Washington area illustrate the need of simplicity in design. During bad weather, traffic has been restricted to one landing at a time, with the result that Washington National and Bolling Airbase are infamous as a "stacking" problem area. The integration of Air Force, Naval Air, and commercial needs...under a comprehensive plan would eliminate this extravagant plan situation.
THE INITIAL ATTEMPT IN THE USE OF PLANNING CONTROLS

Both the CAA and the Air Force have circulated a model zoning ordinance to implement the regulations on installations planning and development. Acceptance of the zoning ordinance is wishfully predicated on the goodwill of the local government agency in jurisdiction over the airport approach areas. The proportion of airfields operating under the protection of this device is so small that its overall national effect is negligible. The Department of Commerce is restrained from introducing Federal legislation imposing the mandatory acceptance of the recommended zoning. In one District of the CAA, Federal funds are withheld until the local government in the airport area insures compliance by enacting an ordinance similar to the model. (This is only in District 4, comprising Texas and Oklahoma, where the great open spaces surrounding new airports can be zoned without great expense to the airport developer, or an immediate loss in land value to the property owner).

The Air Force policy rests with the ability of the Airbase Commander to gain compliance by the local officials. Usually the threat of eliminating the Air Base in the next economy retrenchment program is sufficient to secure enactment of a fair zoning ordinance, insuring protection from the obstacles in the major runway approach zones.

The ordinance is meaningless to an airport whose runways are bounded by built-up urban areas. Avigation easements are tantamount to market values in these areas and are prohibitive costs to airport development. Even so, the securing of an avigation easement over a crowded area or the enactment of a restrictive height zoning ordinance is no guarantee against the crash of an aircraft in the approach pathway.
The failure of the major aviation agencies to secure complete protection for their aircraft operations may be due to the inability of the requested ordinance to provide equitable assurance against damage to the property owner. The need is evident for a planning measure protecting both the airborne craft and the property over which it flies in effecting contact with the airport.

THE METROPOLITAN REGION IS THE PROBLEM AREA

The worst crashes and the major problems of airport location occur in the metropolitan regions. The desire is to place airport facilities as close as possible to the residential, commercial, and industrial areas that are to utilize its services. The resultant competition for space imposes the design problem. In those instances where early airports were placed a "safe distance" from the city, both the airport and city have expanded so that now the airport is all or partially encompassed by other urban uses.

The metropolitan region is the focus of human activities in the pattern of economic and social intercourse that exemplifies our modern civilization. The gregarious nature of these activities demand that people congregate in large groups to carry out their chosen missions. The most recent analysis of this phenomenon has been made by the CAA, in order to classify the proper size of airport to serve a corresponding urban area.
ECONOMIC RELATIONSHIP OF AIRPORT TO SIZE AND TYPE OF COMMUNITY

The general classification of economic types of metropolitan districts are Marketing, Industrials, Balanced, and Institutionals. It is important to note that not only have the number of these districts increased (from 57 districts over 250,000 population in 1940, to 76 districts in 1950), but that the size of these districts has increased in area and population (four-fifths of the total population increase occurred in the 168 standard metropolitan areas) so that now one-half of the entire U. S. population lives in these areas.

It is significant that the problem is to affix the proper relationship of the airport to other use areas so that a functional and economic balance may be effected. This requires a study of the land use pattern and of the transportation network that links the use areas in a workable arrangement.

Until the present, airport location depended on the feasibility of fitting the runways and approaches into already crowded locations, or of ignoring a functional relationship with other use areas. The criteria developed in this thesis should, in providing firm location criteria, serve as a basis permitting a more integrated physical and economic plan pattern.
CRYSTALLIZATION OF FIRM AIRPORT CRITERIA

It is now possible for the design criteria of airport facilities to be derived by a long process of study and evaluation. Initial flight performance data provides the National Advisory Committee for Aeronautics, and the industry it monitors, with an insight into the "crystal ball future" of the new aircraft. Succeeding evaluation is made as the aircraft progresses in tested performance until Air Force and CAA criteria become available.

The comprehensive planner must be appraised of the value of the evolved criteria and must be kept in continual supply of new data based on the progress of the aircraft science and industry. The planner must be able to resolve aircraft flight performance data and requirements into areal terms, thereby delineating the effect of the airport on the use areas of the other components of the regional plan. The location of the airport can then be determined by a reasonable estimate of the priority of use, or a judgement of the highest and best use to which land areas may be utilized.

EFFECT OF AIRPORTS ON URBAN AREAS

In general, airports affect surrounding areas in the following ways; in the navigable airways, in the traffic patterns, in the approach zones, and in the immediate vicinity of the reservation. An inspection is made of the effects imposed by aircraft while in the air. Discussion of the airport as an industrial ground use is outlined in the land use study.
THE DEFINITION OF THE END LIMITS OF THE APPROACH ZONE LAND USE PROBLEM AREA

The transition zones or patterns which aircraft must use to enter or leave the approach zones are the traffic controls areas which segregate aircraft flights from a number of interconnecting or adjacent airfields in a wide region. Thus it is that aircraft in the navigable airspace (above 500') may prescribe scheduled patterns of flights at altitudes which, by means of the recurrent noise and threat of danger impose a partial taking of rights in the area of the traffic pattern. Although this pattern seems to have a great variation due to the range of operating characteristics of the various aircraft, it is possible to regulate the Instrument Flight Rules and Visual Flight Rules conditions so as to delimit the maximum boundaries of the traffic patterns. This would have the effect of regulating minimum altitudes in the traffic patterns ie., as regards the holding area, and in effect changes the existing theory of the approach zone (as defined by the CAA and by Air Force Regulation 86-3), so that the effective limitation of that zone is determined by the point of change in the operating characteristics of the aircraft, ie., from one of cruising flight to one of descent to a landing, and from one of the angle of take-off climb to that of cruising flight.

It is the intention of the corridor principle to establish a channelized approach in such a manner that the sides and ends of the corridor will define minimum altitudes of flight. Aircraft would enter or leave the long corridor at the altitude of cruising flight. At present this averages 1500' but must be raised to an altitude that will aid in reducing the high noise level. An average dimension of 3000' would suffice and yet permit a normal landing and takeoff procedure.
The Massachusetts Aeronautics Commission has instituted a similar procedure at the Logan Airport, Boston as an extension of the existing approach zone pattern, i.e., the wall line of the new corridor area is an extension of the flare of the present two-mile approach zone. This is to permit the channelization of low-flying aircraft (1200' - 1500' altitude). However, Special Aeronautical Regulation No. 50-1 and No. 50-2 to Chapter 799 of the Laws of the Commonwealth of Massachusetts establish a 3000' minimum altitude over the built-up area of Boston.

NEED FOR A CONTINUING STUDY OF THE FUNCTIONAL LIMITS OF THE APPROACH ZONE

The criteria for the areas of the approach zone must be defined so that the Planner may interpret the number of approach zones required, the behavior of aircraft in that zone, and a deliniation of the optimum size of the zone. With these factors known it should be possible to determine the effect of the zone on the land areas under and adjacent to the approaches to the airport.

In the past, and at present, it has been difficult to coordinate city growth with the complex multiple runway systems.

The sixty-degree dual parallel and sixty-degree diverging patterns illustrate the excessive requirements that would be imposed on adjacent property by complex runway approach patterns.

The evolution of a new criterion for the landing and takeoff of aircraft permits a reevaluation of existing airports in relation to urban areas and defines the plan relationship necessary for the siting of new airports.
SIXTY DEGREE DUAL PARALLEL RUNWAY PATTERN

INDICATES FIRST STAGE
120 Operations per Hour, with Loading Apron for 30 Plane Positions at 150° Average Spacing

FINAL STAGE:
240 Operations per Hour, with Loading Apron for 60 Plane Positions at 150° Average Spacing
Area: 3860 Acres

See drawing No. 125-12 for Wind-Traffic Diagrams
RECOMMENDED NEW CRITERIA FOR AIRPORTS

SIMPLIFICATION OF AIRPORT DESIGN AND OPERATION

Competent evaluation of aircraft characteristics for immediate future operations indicate the feasibility of the mono-directional airport. The data supplied by the National Advisory Committee for Aeronautics indicate that single runway operation is now possible for all aircraft. The use of swivel gear on small personal planes will allow their use in the occasional off-wind periods, with only a slight added requirement of increased pilot skill. The CAA, in following this recommendation, is budgeting funds for new construction only for airports capable of one runway operation. A few exceptions are made where it is noted that geographical and climatic factors in some areas require consideration for an off-wind runway. Mountain and water dominated areas subject airports to major wind direction changes as a daily or seasonal occurrence.

THE BASIS FOR A DESIGN SOLUTION TO THE PROBLEM

The mono-directional principle is the first attempt at a reasonable, firm criterion for the planning of airports. It is similar to the railroad track and the truck highway in function. It is the basis for the design of a channelized air highway or air corridor, therefore, is the basis for the determination (as well as restrictive height zoning) in the airport area. The prohibition of highly populated use areas can be legally determined by the comprehensive planning of the location of the single direction runway system. Uses in the revised approach zone conception would be ordained to provide maximum safety for both aircraft and property owner; and would endeavor to conform with the land use pattern normally determined by the comprehensive plan process. The plans of existing airports would be re-examined to introduce this new design principle.
SAN FRANCISCO - OAKLAND AREA has used natural shapes to advantage in a solution of a difficult airport access problem. The airport at Oakland is in alignment with the facility across the bay on instrument runways. Water areas have been used for both the takeoff and landing approach.
THE AIR APPROACH CORRIDOR

Air traffic utilizing the mono-directional airports should be subject to greater but simpler controls, and should assume a more direct approach pattern. To offset the noise and danger factors, and provide for the constant increases in traffic volume, a new channelization of traffic in and out of the airport should be determined. The concept of the approach zone changes with the introduction of land use controls. Instead of a zone determined by the operating characteristics of aircraft traffic in the approach pattern, the corridor is simply defined as a rectangular box to aid the layman's and the legal concept of the danger zone. It is envisioned as a wide and deep spatial traffic channel in which aircraft transition from cruising flight to a landing, and from a takeoff to a cruising altitude.

DIMENSIONS OF THE CORRIDOR

The end limits of the corridor would depend on the position of what is now the holding area pattern used in the instrument let-down procedure. Based on existing let-down formula this is roughly determined to be ten (10) miles from the end of the runway. A similar air corridor should be designed for the takeoff procedure, even though it is estimated that a climbing rate may require less distance to the cruising altitude. Power failure on a takeoff, as well as a missed approach, is aided by the generous over-run areas that are required in the new corridor. Emergency crash landing in the flat areas of the cleared corridor would obviate a looping return of a distressed aircraft to the immediate airport area. (This was the operating condition leading to the recent C-46 crash in the Idlewild Airport area of New York.)
FAIRFIELD-SUISUN AIRPORT, CALIFORNIA

Width of the corridor would vary dependent on the number of parallel runways in use. It is estimated that a four-runway parallel system could be designed without imposing operational restrictions (such as holding a taxiing aircraft at a landing runway before it can gain access to a takeoff runway) provided that the landing runways are staggered from the takeoff runways (see above) and that both sides of the airfield are to be used.
SKETCH LAYOUT FOR LANDING PATTERN ON INSTRUMENT FLIGHT PROCEDURE
PROPOSED PROCEDURE

"Z" marker

end of corridor

procedure turn

not less than 6 mi @ 120 mph
decline 500

EXISTING PROCEDURE

ground line 500' field ele. 200'

approach zone glide path runway clear zone

CRUISING ALTITUDE 3000'

CRUISING ALTITUDE 2000'

CRUISING ALTITUDE 1000'

GRAPIHC SCALE IN MILES

VERTICAL SCALE EXAGGERATED

SKETCH SECTION FOR LANDING PROCEDURE IN PROPOSED AIR APPROACH CORRIDOR
LATERAL DIMENSIONS OF THE CORRIDOR

A distance of 1000' between runways is a criterion dependent on the wing dimensions of the using aircraft. The tendency of the super-sonic aircraft to emulate a rocket or cigar-shape indicate that this dimension range may be held as a standard. The assumption of an overall 4000' (to 5000') width for a two-parallel-runway airport is based on the dimensions of 1500' from the building restriction line to the centerline of the first runway, 1000' centerline to centerline, and 1500' centerline to the opposite building restriction line. In justification of this minimum, it is noted that a two-mile restriction zone (one mile centerline to hangar line) determined in 1946 for the initial flight test base at Edwards Air Force Base has been upheld by subsequent investigation. Wing tank drops and emergency landings have indicated the feasibility of this design for this especially hazardous operation. Millions of dollars of new aircraft have been saved by the establishment of a long clear approach area.

Commercial and accepted military aircraft, however, operate under more exact proven control. Based on standard accepted practice the 1500' dimension centerline to hangar line provides adequate apron area for aircraft parking and ground taxi movement. The extension of this line as the wall line of the air corridor is a reasonable basis, therefore, for the lateral dimension of the new air approach corridor.
AIRPORT CLASSIFICATION CHART DATA

An appreciation of the problems inherent in the classification of airports is obtained by a quick analysis of the existing system, and the number of airports in operation or in process of improvement.

<table>
<thead>
<tr>
<th>OLD SYSTEM</th>
<th>EXISTING SYSTEM</th>
<th>PROPOSED SYSTEM</th>
</tr>
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<tbody>
<tr>
<td>Class</td>
<td>Runway length</td>
<td>Class</td>
</tr>
<tr>
<td>Sub</td>
<td>below 1800</td>
<td>Sub-personal</td>
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<td>1800-2700</td>
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<tr>
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<td>2700-3700</td>
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<tr>
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<td>6700-7700</td>
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<td>8700-9700</td>
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<td>Express</td>
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AIRPORTS BY TYPE AND NUMBER:

- Municipal: 6,561
- Commercial: 2,303
- CAA Intermediate: 110
- Military: 354
- All other: 1,458
- Seaplane bases: 365
- S.A.S. (operating): 538

A total of 11,689 airports authorized by the CAA for regular air service operation.

New airports under the National Airport Plan for 1951 include:

- Improved airports at a cost of $483,800,000 total 2,667
- New airports at a cost of $178,200,000 total 2,288
NEW FACTORS DETERMINING THE CLASSIFICATION OF AIRPORTS

The mono-directional principle simplifies the classification of airport types. Although the single runway principle applies to all airports it must be qualified by variations imposed by different aircraft approach characteristics. The stabilizing effect of the design principles embodied in the mono-directional airport and air corridor assure air operation by future aircraft of increased size, weight, and speed. Flexibility in the expansion of facilities and operations, and a demand for the interchangeability of aircraft types using the facilities tend to reduce airport classification to a common denominator. Thus to be successful the 'intermediate class' will have to be able handle aircraft from both the 'super' and the small 'community' airport types. Functional and locational requirements of the urban traffic potentials will determine the variety of sub-classification types.

COMMUNITY AIRPORT

The local airport is designed for short-range movement in light and small aircraft. This type may be further sub-classed in public and semi-public use categories (scheduled, taxi, courier, charter service, flight schools), and private use (individual commuting, pleasure, business). Several factors temper the rigidity of limiting runways to one orientation for the Community airport. Operating performance of the lighter aircraft indicate a minimum effect on surrounding areas, at present. The reductions are evident in the following:

- The steeper glide angle permits a reduced approach area.
- Noise and vibration effects can be lessened.
- Runway length and required parking space is minimum.
- Commercial and industrial complements are negligible.

The economy of maintaining this facility is dependent on the volume of operations, thereby fixing the location in an area common to the greatest number of users.
THE INTERMEDIATE AIRPORT

The inter-metropolitan type is characterized by many existing airfields (feeder, trunk, express, continental) with multi-runway designs. Retention of this type is predicated on the feasibility of integrating the mono-directional principle on the existing site. Location will depend also on the economic and operational factors inherent in the area that it serves. A metropolitan area may need several intermediate airports to service the peculiar requirements of its commercial, industrial and residential users. The value of the airport facility is balanced finely on the time-distance relationship to its support areas. Experiment is needed to further prove the assumption of a desirable commuting time (now estimated at 25 to 30 minutes) allowable for service. Application of land use studies for the urban use areas in proper relation to the airport and to the surface transportation system will improve the time-distance factors.

As the requirement for the use of larger aircraft becomes economically necessary the type difference between the 'super' and the 'intermediate' airport will not be in the design of the runway and corridor systems, but will vary principally in location with reference to the urban area.
THE SUPER AIRPORT

The classification of 'super' implies the use of the heaviest and fastest aircraft engaged in continental, intercontinental, or even planetary travel. It is reserved for the expression of all the future design criteria that will be required for the application of airport facilities to metropolitan use. The superairport becomes the nucleus of a new segment of the urban region. The future design potentials, as well as its special uses, now permit its location in an area remote from the urban core. The decentralizing effect of this facility is reflected in many ways; but none have a deleterious effect on the urban area.

It will probably be the only facility of its kind in the metropolitan region, due to the costs of operating a terminal for relatively low volumes of traffic for the long distance transport. The close logistical support required of the traffic volumes generated by commercial, industrial, and some residential users will be handled by the intermediate ports.

Land uses in the area adjacent to the superairport will require careful planning consideration and safeguards from encroachment to insure the future area needed for the development of this pseudo-experimental commercial facility, and the organization of the nucleus of specialized uses required for its support.
LEGAL AND ADMINISTRATIVE RECOMMENDATIONS

THE IMPORTANCE OF ADEQUATE LEGAL CONTROLS

The value of any recommendation providing for the safety of aircraft and the lives and property of people on the ground depends on the adequacy of the legal and administrative tools available to implement the plan.

LIMITATIONS OF EXISTING ADMINISTRATIVE PROCEDURE

The limitations of one regulatory procedure has been mentioned - the zoning of areas by height of obstacles. A brief summary of other means of protecting land will be sufficient to indicate the scope of the problem.

The difficulty and complexity of these means are in great measure a reflection of the complexity of past airport patterns and the inability of the administrative authorities to understand and organize effective legal controls to fit the problem in all of its exigencies. It is hoped that the mono-directional airport and corridor will, by its simplicity, convey an appreciation of simple, effective implementation controls.

BASIC THEORIES LIMITING LEGAL CONTROLS

A review of the principal theories of airspace ownership indicate the successive stages of the rights of the property owner in law.

Ad Coelum - ownership to the heavens above.

Easement - a property right in unlimited space subject to an easement or privilege of flight through it, which is vested in the public.

Statutory Height - ownership of space above private premises up to the height fixed by statute. (this has been seldom followed.)

Zone Theory - insures the landowner complete use of the low-flying zone contiguous to his property up to his reasonably estimated future use of the superadjacent airspace.
SOME METHODS OF PROTECTING AIRPORTS AND AIR APPROACHES

Direct acquisition - The development of complete airport potential by the use of the mono-directional, dual parallel runway plan requires extensive acquisition of land for the extension of the runway system, and for overrun areas. Acquisition is also desired for the control of those areas in the glide path that are cut off below a reasonable building height.

Condemnation and resale - Assuming that the airports under this discussion are in public control (i.e., military, state, or municipal), the use of the power of eminent domain could be used to buy and resell property subject to zoning controls on use and height.

Limitations on Damage Claim - The institution of zoning controls could be supplemented by a statute of limitations on the time for filing of claims for damages.

RECOMMENDED INTEGRATION WITH COMPREHENSIVE PLAN CONTROLS

The introduction of controls necessary for the establishment of a sound land use policy in the air corridor and in the surrounding vicinity of the airport must be an extension of, or integrated with the land use policy prevalent in the comprehensive plan for the metropolitan region.
USE RESTRICTIONS

The recommendation of this report is based on the belief that the integration and acceptance of land use controls would effectively solve existing problems.

The controls regulating use in the corridor and immediate vicinity of the airport would be organized in a series of exclusions of use. Thus, business, industry, and residence would be excluded from the immediate over-run areas of the runway system (i.e., the land ordinarily cut off up to the 30' to 50' building heights by the glide angle). Residence uses (except occasional farm houses) would be excluded from all areas of the corridor. Industrial and commercial uses that would not present hazardous obstacles (smokestacks, towers, water tanks, and gasoline and other inflammable tanks) would be encouraged to use the portions of the corridor farthest from the runway.

The air approach corridor should be treated as a limited access highway, protected from encroachment on its entire length by the use, where possible, of natural waterways, ground transportation highways, parks and open spaces.

It is emphasized that uniform regulations are desired but that the acceptance of such regulations should come at the local and State level of government; from a realization of the value of the new criteria; and by studied consideration of each individual problem on its own merit.

Federal agencies, aeronautical societies and advisory groups exist in sufficient power and ability to formulate uniform uniform regulations. Special groups interested in aviation and the proper planning of the nation's cities should be adequate to influence legislators. Proper direction of the public interest in this vital problem is necessary to obtain the needed controls and assure the support and passage of progressive legislation.
LAND USE

INCREASING DEVELOPMENT OF CITIES

The competition for the use of land between the airport and other urban areas is coincident with the increasing growth of cities in the peripheral areas of the metropolitan region. The mobility of our modern civilization, occasioned by the extensive use of automotive transport has equalized or put into new balance the economic relationship between industrial, commercial, residential, recreational, and even agricultural use areas.

The trend in urban development is in the expansion of the major use areas over more extensive land areas as faster methods of transportation become available.

THE EFFECT OF URBAN GROWTH ON AIRPORTS

The size, number and use of the airport facility is proportional to the size and activity of the supporting urban area. (reference Airport Classification Data Chart).

The use and economy of operation is dependent on the harmonious relationship of the airport with the other use areas. This does not refer directly to the problem at Newark Airport but to the economic disadvantage of the location to airports such as Friendship, near Baltimore, and Willow Run, near Detroit. Ease of access from the supporting use areas is generally reflected by the desire to place airports as close to the urban center as is feasible. Logan Airport served by the Summer Tunnel permits the best relationship in existence today.

The urban core has been fashioned in the past around docks, railroad terminals with the automobile terminal facilities still a problem. It is reasonable to assume that a new major influence will be exerted by airports. Due to its location it will have a decentralizing effect on the urban core.
TINKER AIRPORT, OKLAHOMA CITY

This plan illustrates the combination of residential and industrial uses, combining with a highway network to delimit and bind the expansion potential of the airbase. Residential subdivisions have been attracted to the skeletal road pattern, so that now, property acquisition is a major consideration in plan development. Property owners attracted to the airfield now complain of the excessive noise and activity of their neighbor. The industrial facility seriously hampers the future use of the North-South instrument runway.
LAND USE IN THE AIR CORRIDOR

The delineation of the air corridor provides the basis for the arrangement of land uses in the area of the greatest nuisance and hazard. The major problem is in the organization of those uses in competition for space with the proposed corridor. Land space in the urban region is not so scarce that a reasonable reapportionment is impossible. More than one-third of the metropolitan region is in vacant land or improper use today. Large portions of the corridors may be planned to coincide with areas of public ownership. Space for the remodelling or expansion of surface transit, similar to a belt-park highway system, would provide simultaneous access and protection.

Examples of suitable land uses in both the air corridor and airport buffer area might be: surface transportation lines and highways, park lands, low-density recreation space, agricultural areas, disposal areas, open storage yards, waterways, etc. Light industrial units and commercial activities which do not present hazardous obstacles may be permitted where they would normally integrate with similar use areas outside the corridor.

The peculiarities of an airport site, using all the available areas of open ground for flight purposes, allow to remain to other uses the rougher topography that can aid in delineating the airport area. While hill ridges and waterways aid in buffering the airport, man-made transit routes are also a major factor in determining the boundaries of the airfield reservation. Careful planning of highways and railroads is needed to delimit the airport, its open expansion spaces; approach areas and buffer belts.
TRANSPORTATION

THE COHESIVE FUNCTION OF THE TRANSPORTATION NETWORK

The effectiveness of the land use arrangement depends in the physical sense on the design of the transportation network. The demands of our civilization and technology are for increased speed, thereby an increased efficiency and greater production, with the end product an opportunity for a better life. This increased mobility has been offered by the railroad train, automobile, truck transport, and the rapid transit system. Aviation presents the fastest medium for continental and intercontinental transit and is getting ready to challenge ground transit systems for high-speed transit in the urban area.

THE EFFECT OF NEW SURFACE TRANSIT CONSTRUCTION

The increase in the size of the metropolitan area, with what is termed a resultant decentralization trend, requires construction of additional road facilities. Limited-access radial and circumferential highways in the urban area and major trunk highways between cities will have the effect of attracting additional traffic in ever-increasing volumes. So that the existing problem of traffic strangulation is in danger of being repeated in the future. Several rules are recommended as guides in the solution of the traffic problem in the metropolitan region.

First - The time-distance factor is the controlling guide in the effectiveness of mass transportation.

Second - The rapid transit system requires the sole use of a traffic artery.

Third - The need is for the development of suburban areas in the form of centers, rather than in a haphazard urban sprawl.

Fourth - There is a need for a progressive attitude.

1. Mr. F. P. Clark, former Director of the Regional Plan Association of New York, speaking at the Council for Planning Action symposium on "Traffic Strangulation".
The lack of integrated planning is illustrated by the conflict in runway and highway alignments. The runways best suited for a mono-directional airport are in danger of being boxed by industrial and residential development. Note the industrial structure at the East end of the East-West runway. Extensive terminal facilities are being constructed on the side opposite the natural access way from Dayton. The elimination of two of the existing runways is evident from a casual examination of this meager plan.
The airport answers the qualifications as a suburban center in its fringe location; the need is for a rapid transit system that will keep the time-distance factor to the major using areas to a reasonable minimum. Studies indicate that a 15 - 30 minute travel time is a good average but that 45 minutes or more is the indication of an undesirable transit service for the regular airline user.

POSSIBLE EFFECTS OF THE AIR CORRIDOR ON CIRCULATION

The location of the corridor superimposed over other regional use areas, impinges a new problem in the development of the regional plan. Two major plan orientations, one radial to the core and one tangential to the urban core, produce important plan considerations.

The layout radial to the core conforms to the basic metropolitan pattern. It can be located parallel to major urban surface transport lines, and allows indefinite expansion of the runway pattern in length. In detail, this layout would be at a tangent to the major core of the urban area to prevent recurrent movements over the heart of the city.

The tangential layout imposes a major area block in the development of the basic urban land use pattern, in that it is at right angles to the line of lateral urban expansion. Its best application would be in areas remote from the urban core. The superairport, such as Willow Run and Friendship, can be sited without regard to this plan restriction.

The most important plan consideration is the proper relation of each airport with the other. The optimum control of large volumes of air traffic is predicated on the organization of lines of air traffic in space without conflict in procedure. It is necessary to avoid the intersection of traffic patterns by integrated planning of the mono-directional runways and air corridors in parallel.
LEGEND

- URBAN CORE
- HIGHLY POPULATED AREAS
- AIR APPROACH CORRIDOR
- SUPERAIRPORT
- INTERMEDIATE AIRPORT
- COMMUNITY AIRPORT
- SPECIAL USE AIRPORT
- MAJOR HIGHWAY NETWORK
- PERIPHERAL HIGHWAYS
- HIGHWAY INTERCHANGE
- MAJOR RAILROADS
- LIMIT OF NORMAL COMMUTING

SCHEMATIC "IDEALIZED" PLAN of the
AIRPORT - REGIONAL RELATIONSHIP
STUDY OF AIRPORT TYPES IN SPECIFIC PROBLEM AREAS

The effect of the impact of the air corridor design on the airport-urban relationship is best registered by a study of the three general airport types in existing problem areas. Each of the types have a distinct effect in the urban fringe areas on land use and transportation.

The Superairport - when placed far from the urban core may form a new nucleus complete with virtually self-supporting residential, commercial, and industrial areas. When it is necessary to place this facility near the urban core, the design problems become extremely difficult to solve, with the result that the facility reduces in potential to the present concept of the intermediate airport, or is abandoned entirely.

The Intermediate airport - placed as close as possible to the urban core is dependent on the relation of existing airport and urban facilities, or an expensive reshaping of them. This type represents the greatest design challenge today. Perfect use of airport design knowledge and city planning education will be necessary in order to retain the use of these vital facilities.

The Community airport - could have the greatest single effect on land use in the metropolitan area, dependent on the future of the light personal aircraft and air-car. The present economic impossibility of expecting large volumes of privately owned aircraft may be disrupted by future technical developments in the production of a cheap mass-produced model. Just as the automobile seemed an extravagant fad over 40 years ago, so too, some years from now, a faster medium of transportation may be attained. The possibility of such a demand on urban areas should temper the design and regulation of this small but numerous and effective airport type.
NEWARK AIRPORT

NEWARK, NEW JERSEY
NEWARK AIRPORT, THE PORT AUTHORITY OF NEW YORK

At first glance, the Newark Airport problem defies solution by any of the proposed recommendations. Originally a pioneer in aviation development, Newark was constructed on reclaimed salt marsh lands, free of urban entanglement, in 1928. Until the recent series of crashes it has enjoyed a remarkable safety record. The crashes, however, were signaled in the years after World War II by continuous complaints by the local citizens of the noise of low-flying aircraft over the residential areas of Newark and Elizabeth, New Jersey. A new plan, now in the early construction phases, is to increase the size of the field from 1400 acres to 2200 acres, and to construct dual parallel runways in two directions, at almost right angles to each other.

STRATEGIC IMPORTANCE OF NEWARK AIRPORT TO COMMERCE AND INDUSTRY

The need for this facility in this location was established by a report of Harland Bartholomew noting the "necessity for coordinating Newark's fiscal and managerial limitations with the other air and marine terminal facilities". In addition to being of strategic importance to the Air Force as an overseas intransit depot, it is of vital use to both passengers and freight shippers. It is considered in the Port Authority plan as a multi-purpose airport, for domestic commercial services, connecting with nearby, intermediate, and distant points to develop to a full potential of traffic. It is noted that Newark was planned to service the use elements on the west side of Manhattan, and is admirably located to service the industrial, commercial, and residential development of the New Jersey side of the Port District. The population it serves approaches that of the size of the Philadelphia metropolitan area.
PRECAUTIONS TAKEN TO PREVENT DISASTER

A quote from the planning brochure of the New York Port Authority notes that "...great care is being used in the location and orientation of the runways, in order to reduce to a minimum the hazards of surrounding obstructions, and financial estimates include the costs of purchasing air rights beyond the airport property lines". In addition to providing complete air transportation facilities, the Port Authority plans to make this terminal building a community and recreational center for the entire North Jersey area. An expenditure of $70,500,000 is planned, with $50,000,000 budgeted for use before March 1955.

THE NEED FOR COMPLETELY NEW FACILITIES

In order to attain the desired 1000 movements per day (peak hour of 120 aircraft movements per hour), it is estimated by the Port Authority that the present facilities are inadequate physically and commercially. Stabilization of the Elizabeth meadowland marsh areas is necessary to support future plane loads (150,000 to 300,000) pounds; an enlarged flying area is required; increased terminal loads require a 100% enlargement of those facilities.

THE CRASHES - A GUARANTEE FOR FUTURE SAFETY

And ... in order to be reopened successfully, a guarantee must be given to the citizens in the built-up areas of Elizabeth and Newark that adequate protection has been given to their lives and property.
NEW YORK CITY AREA - Indicating the parallel relationship of the monodirectional runways that are feasible at the major airports.
AN AIRCRAFT INDUSTRY RECOMMENDATION FOR OPERATION

Captain Edward Rickenbacker, President of Eastern Air Lines, made the following recommendations for the use of the existing runways, in order to gain reopening of the field as quickly as possible. As yet they have not been acted upon by the local officials. In his estimate, this would eliminate traffic over Elizabeth completely and reduce by 94% traffic over Newark.

Runway 10 - for takeoffs to the East over Newark Bay.
Runway 24 - for landings from the North over Kearny meadows.
Runway 6 - for takeoffs to the North over Kearny meadows.
Runway 28 - for landings from the East over Newark Bay.
Runway 10 - for landings from the West over residential Newark as a third priority and only when necessary.

ANALYSIS OF THIS RECOMMENDATION

This is a clear concession that only one runway direction can be used for a takeoff while its complimentary runway is used for a landing; i.e., to use runway 10 for takeoff assumes runway 24 for landing; runway 6 for a takeoff assumes runway 28 for a landing; runway 10 would be used for both takeoff and landing during periods of high wind velocity.

The plan admits that half an operation is better than none and fixes the relationship that is necessary at Newark under any proposed scheme of future operation. The reservation of an emergency landing requirement on runway 10 undoubtedly decided the local officials against giving the airlines any latitude in operational procedure.
AN ANALYSIS OF THE NEWARK MASTER PLAN

A quick analysis of the Port of Authority master plan for Newark can be based on the decision reached in the analysis of Rickenbacker's plan. The plan for dual parallel runways was originally based on the ability of the airport to function with complete freedom. Thus takeoffs could be made to the East while landings progressed simultaneously from the West; and on other wind conditions takeoffs to the North on one runway with landings from the South on the parallel runway. Operating under the new requirements for this airport-urban relationship dual parallel runways are extravagant, as it is no longer possible to takeoff and land, at the same time, in the same wind direction. It must be recognized that operations are reduced, therefore, to the number of movements that can be handled on two runways at right angles to each other.

APPLICATION OF THESIS CRITERIA TO THE NEWARK PROBLEM

Forewarned that it is almost impossible to achieve a good solution to this complex problem, the mono-directional airport and air corridor principle can be applied only by extensive reshaping of the airport plan and some elements of the adjacent residential areas. In application, the corridor would take advantage of the salt-marsh flats of the Arthur Kill and Hackensack River. Only small sections of eastern Elizabeth and eastern Newark would be in the 4000' corridor zone. Adequate planning and zoning in these areas to induce industrial and commercial development would offset this non-conforming use. Runway 6-24 could be used as a takeoff runway; or to keep the parallel alignment of the recommended mono-directional system, the long runway under construction could be combined with one located in the Elizabeth salt flats that would be used for landings.
Newark Airport - Proposed approximate runway location and air corridors.
The application of the mono-directional dual parallel system could be feasible with the replanning of the terminal area, the hangar and apron areas. Elimination of the Newark railroad spur would not present great difficulty. Added industrial facilities adjacent to the Marine Port could take advantage of operational apron space on the East side of the new runways opposite the passenger terminal, and would be of great aid to the Air Force intrastate depot problem of expansion and access to the port. The use of the budgeted funds should be adequate to construct this simplified version of the plan.
METROPOLITAN PLAN AIRPORTS
CINCINNATI, OHIO
CINCINNATI, OHIO

AN ACCEPTED METROPOLITAN PLAN

A study of the Airports Plan for the Cincinnati, Ohio area permits an evaluation of the thesis criteria as applied to a metropolitan area with an accepted comprehensive plan. The Cincinnati Plan should be a remarkable document as that city has been long under the influence of Alfred Bettman, and used the consultant services of Ladislas Sego and Tracy Augur.

The following outline analysis is based on the Master Plan of 1948, supplemented by the Airports Plan of 1946. Use is made of reproductions of the Regional Plan Commission presentations to adequately convey the analysis.
THE METROPOLITAN MASTER PLAN APPROACH

The plan approach to the solution of airport development by integration with a Master Plan progresses logically in the following stages:

First - An evaluation of the kinds of anticipated flight activity.

Second - An evaluation of the volumes of air traffic anticipated in a reasonable plan future (10 years); and an analysis of the economic relationship of the area with the U. S.

Third - An interpretation of the number, size type, and use type of the airports required to fit the traffic requirements.

Fourth - A selection of sites and recommendations for developments.

Fifth - A Program of plan effectuation.

This study is predicated on the most controversial aspect of the Airports Plan, - that of the selection of the dominant airport and its effect on the metropolitan urban area.

The Master Plan evaluation of the kinds of flight activity and expected traffic volume reveals the need for a Class V airport (old CAA classification system of runways of 5700' - 6700'). Under the new CAA system this could be an Intercontinental type (runways 5900' - 7000'). The plan has considered three major site problems; the existing commercial airport at Boone County, Kentucky; the old facility at Lunken Airport; and a new site. The new site selection was made after consideration of six alternate locations in the northern periphery of Cincinnati.
RELATIVE IMPORTANCE FACTORS:

1. Population.
2. Number of high-income families.
5. Retail sales volume.
The importance of the transportation system in the determination of airport location is stressed in this diagram of Motor Traffic Flow. As a gauge of development this indicates the intensity and direction of the urban growth on the North side of the river.

The need for an expressway connecting the new site with the urban core, and for a circumferential limited-access highway connecting the radial highways in the periphery of Cincinnati is clearly indicated.

The rapid transit system depends on surface transit indicating the need for the reservation of a separate transit artery to permit a reduction of the 30 minute or more travel time estimated from the site to central Cincinnati.
EXISTING COMMERCIAL AIRPORT - BOONE COUNTY, KENTUCKY

Presently in use (1946) as the major commercial terminal, this site presents two difficult and immediately insoluble problems. One is the limited access available to the site with the danger of the occasional flooding of the Ohio River impairing that access. Second is the issue of jurisdiction over a metropolitan facility (Ohio) in the county of another state (Kentucky).

The open areas surrounding this site; the possibility of a short time-distance relationship with downtown Cincinnati; and the orientation of its potential mono-directional pattern force its consideration as a superairport site.

The politically desirable solution at the moment is for a major airport on the North side of the river, under an Ohio authority. If a parallel could be drawn to the New York--New Jersey area, the solution to the access problem and the "authority" issue depends on the volume of future operational requirements and the future importance of the metropolitan area.
THE OLD FACILITY - LUNKEN AIRPORT

This is the only existing site of commercial size intimately related to the urban core. The factors conditioning its use as a major airport are:

First - It is located on low ground subject to flooding at high flood stages.

Second - The high banks (200'-250') of the Ohio river valley and Little Miami river valley form walls of obstructions to existing flight patterns.

Third - The low area formed by the delta of the Little Miami acts as a greenbelt block in the eastward development of Cincinnati. With the exception of a playfield and crossing traffic arteries, the entire delta area could be used for a more complete airfield development.

Fourth - The site is more accessible to more parts of Cincinnati than any other proposed site (4 1/2 miles from the central district).

RECOMMENDATIONS FOR LUNKEN AIRPORT

The Master Plan recommendation is: for the use of private flying, pilot training schools, and other uses that may develop later.

It is noted in the report that Lunken is not adaptable for further expansion, in that the hills constitute obstacles which would exceed the glide angle required for safe landings and takeoffs. Whereas the application of thesis criteria would benefit operation on this site, it is admitted that the site restrictions are too difficult to overcome in establishing a permanent airport. Analysis of the industrial locations indicate that Lunken is in a position removed from existing sites and remote from potential industrial areas of development. Residential expansion trends are in a direction away from the restrictions of the Ohio River, and towards an integration of suburban communities flourishing on the major trunk highways to Dayton, Columbus and Cleveland.
LUNKEN AIRPORT, CINCINNATI, OHIO

Efforts to keep this facility in a high airport classification would result in extensive airport and river protection construction. If it is recommended that this area be maintained as an airport reservation utilizing the natural river buffer, the indicated runway pattern would be the most feasible arrangement to offset natural obstacle restrictions. However, the important element to be considered is the conflict in air approach patterns with other airport facilities proposed in the metropolitan area.
THE PROPOSED MASTER PLAN AIRPORT - BLUE ASH SITE

The acceptance of the Blue Ash site as a firm location in preference to the other sites analyzed in the Master Plan is based on the relative advantages of the site as enumerated in the plan report. These are: the availability of the site, the relative ease of assembling and acquiring the large parcel of land required; its accessibility to both existing and potential residential and industrial areas.

APPLICATION OF THESIS CRITERIA

The runways indicated in Stage I and II of the plan for the Blue Ash site are not all required in view of the advent of the mono-directional criteria. A restudy using this criteria would be guided by the requirements:

First - A dual parallel runway system (minimum 3000' each).
Second - An orientation in a line radial (or tangential) to the urban core.
Third - The ability to maintain an approach corridor of conforming uses.

Although feasible to place two runways in parallel on this generous plot, the approaches to any dual parallel system will not conform to the corridor concept, in that in maintaining either a radial or tangential relationship to the urban core, existing residential areas reduce the effectiveness of the clear approach pattern on the Southwest section.

A relaxing of the parallel requirement by using the NW-SE leg of Stage I and NE-SW leg of Stage II would permit landing and takeoff on separate runways with air corridors free of major residential disturbance. This would allow the location of the terminal and apron area, as indicated, and would not nullify any construction completed since the presentation of the plan in 1946.

1. The obtuse angle pattern was designed by Hq Air Materiel Command for depot operation but has not been completely justified or developed.
The advantage of using the NE-SW runways for landing is predicated on the topography of the site. Rough terrain (200'-250' drop to the Mill Creek level) is a disadvantage to the approaches of the NW and W runways of Stage II, and to the SW and W runways of Stage I. Use of the NW-SE runway of Stage I permits level overrun areas to the Southeast on takeoff. Use of the NE-SW runway on landing permits adequate overrun areas to the Southwest without extending the corridor zone into the major built-up areas of central Cincinnati.
This illustrates the relationship of the Blue Ash and Lunken sites to the existing and proposed thoroughfare plans. The effect of a major airport area as a block in plan development of the transportation system is easily apparent and establishes the need for the location of superairport facilities in remote sections of the rural-urban fringe.
CINCINNATI, OHIO

Illustrating the conflict in the Lunken and Blue Ash flight patterns.

The position of Lunken Airport as a tangential block to eastward development.

The potential effect of a Blue Ash takeoff corridor on the central urban core.
THE LOGAN - HANSCOM COMPLEX

BOSTON, MASSACHUSETTS
THE NAVIGABLE AIRWAY PATTERN IN THE BOSTON AREA

Due to the location of runways and flight patterns the airways are superimposed on existing urban areas, even though the aircraft may be beyond the range of normal sight or sound. Flights in the navigable airway, i.e., point to point between city terminals, are in pathways of wide lateral belts (10 miles), and at altitudes which can be assumed to be an optimum calculated safety risk, and not conducive to a noise level of great disturbance.

Focal points for the pathways are determined by the location of the radio ranges. Their relationship to the urban area is controlled by the planned coordination of the radio sites in the master plan of the region. Although it is important to plan the terminal facilities so that the airways are not concentrated over the heart of the city, the major consideration to be studied is that in the immediate approach pathway to the runway.
THE LOGAN - HANSCOM COMPLEX

Use of the combined Pilot's Instrument Approach Procedure Charts serves to illustrate the problems of potential danger in the extension and classification of the East-West runway (11-29) as the permanent instrument runway at Hanscom Air Base. Future use of high-speed aircraft on an East-West axis will interfere with the safety of aircraft on the North-South axis at Logan Airport, particularly during IFR conditions.

Analysis of the Hanscom Master Plan, and the immediate vicinity of the Base indicates the feasibility of developing a runway parallel to the instrument runway, North-South (4-22) at Logan Airport. Final orientation of this runway need not be perfectly parallel, but sufficiently so, in order to maintain flight procedures without interference. A point of intersection 25 miles from each runway is (at present study) approximately correct as a minimum allowable.
HANSCOM AIR BASE, BEDFORD, MASSACHUSETTS

Final orientation of the NE-SW runway at Hanscom would depend on study and evaluation of topographical conditions in the immediate approach zones; and interference with the residential pattern long in existence in this area. More detailed data is required to determine the necessity of a new runway (at a slight angle to runway 5-23). The only major residential grouping is at Bedford; accurate survey would be needed to determine the effect of the new approach zone on this residential area. However, use of the mono-directional principle would have a beneficial effect on the entire surrounding region.
THE LOGAN - HANSOOM COMPLEX

The presentation of a planning problem to the public affords an opportunity to illustrate the two air approach patterns. The roseate on the left represents the old and existing system used as the basis for restrictive height zoning. The long rectangular box on the right represents the air approach corridor described in the thesis.

The display presents the problem of the potential intersection of high-speed aircraft using approach procedures at right angles to each other.

Prepared for the M I T Open House Exhibit, May 3, 1952
A summary of the thesis proposals and recommendations for the future are made easy by an analysis of the final report of the President's Commission on Airports, recently made public (May 16 1952).

It proposes a series of recommendations that are in the province of the planner; it asks for "the integration of municipal and airport planning to improve highway access to and from airports"; "the establishment of effective zoning laws to provide two-mile safety margins"; and many other planning provisions.

Clearly, much of the responsibility for safety rests with the planning profession. Greater emphasis should be placed on this responsibility.

A campaign to insist on the integration of airport planning with comprehensive planning will eliminate this piecemeal method of attaining the result, and will ultimately lead to a recognition of the planner's true role and responsibility.

The details and mechanics of the planning proposals recommended in the thesis must be, of course, exhaustively studied with reference to many specific problem areas. Continued and increased emphasis must be placed on the airport planning problem in order to enlarge the planner's knowledge of some of the relationships only briefly mentioned here. The planner must be aware of:

The requirements and progress of aviation.

The economic effect of airports on communities, and conversely the effect of industrial and residential areas on the location of airports.

The relationship of the airport to the future residential pattern. A revolution in personal air-car design would find the planner unprepared today.

These, and many more, studies provide a new focus for the planner's attention as a new element is introduced to the already complex scheme of City Planning.
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