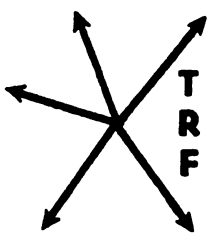
PROCEEDINGS —
Twentieth Annual Meeting

Theme:

"Transportation Alternatives in
A Changing Environment"

October 29-30-31, 1979
Drake Hotel
Chicago, Illinois

Volume XX • Number 1 1979



TRANSPORTATION RESEARCH FORUM

National Airport System Plan Entry Criteria for General Aviation Airports

*by Dr. G. William Dick**

INTRODUCTION

THE AIRPORT and Airway Development Act of 1970 required the Secretary of Transportation to prepare, publish, and revise as necessary a National Airport System Plan (NASP). The plan identifies the composition of a national system of airports and the airport development considered by the Secretary as necessary to meet the present and future needs of civil aeronautics, national defense, and the postal service.

The Airport and Airway Development Act Amendments of 1976 (P.L. 94-353), sections 12(a) and 16(a), require that the NASP, after June 30, 1975, include only the following airports, except that airports in the NASP on that date are not required to be removed:

1. Air carrier airports,
2. Commuter service airports,
3. Reliever airports, and
4. General aviation airports which:
   a. are regularly served by aircraft transporting U.S. mail, or
   b. are regularly used by aircraft of a unit of the Air National Guard or of a Reserve component of the Armed Forces of the United States, or
   c. The Secretary determines have a significant national interest.

Determination of NASP entry criteria for all but the last of these categories of airports is reasonably straight forward and virtually self-evident. But the determination of NASP entry criteria for general aviation airports which "the Secretary determines have a significant national interest" is considerably less obvious and therefore much more difficult, with a wide latitude of judgment and eligibility standards being possible.

Since the initial formulation of the NASP in 1972, the Federal Aviation Administration (FAA) has applied a rather subjective rating system to establish eligibility for entry into the NASP. Each general aviation airport being considered for entry into the NASP is evaluated by summing weights applied to various factors related to activity levels at the airport, such as mail service, military use, based aircraft, air taxi operations, and itinerant aircraft operations, with special consideration given to isolated or remote locations. Inclusion in the NASP requires a rating of 100 for conventional general aviation airports.

The actual numerical values assigned and the sum of these values are not significant nor relevant in their own right. The individual weights do not measure the relative importance of the factors and the sum of these weights does not measure the relative importance of airports in the NASP. The cutoff values are also somewhat arbitrary and do not accurately indicate whether an airport does or does not have value to the system. The weighting system and cutoff values simply reflect the belief that activity levels are somehow the best measure of the importance of airports.

Based on these standards, the NASP presently includes about 3000 of the nation's 13,000 airports, consisting of about 620 air carrier airports, 130 commuter service airports, 150 reliever airports, and 2240 other general aviation airports.

The purpose of this paper is to establish an analytical framework to determine the "national interest" of a general aviation airport to replace the presently used system to determine NASP entry criteria. The analysis examines national interest in terms of the net economic benefits which accrue due to the existence of a general aviation airport. Since these airports are part of, and provide access to, a larger, national system, the benefits derived from such airports are taken as the extent to which access is provided to the larger national system of airports.

ANALYTICAL METHODOLOGY

The "national interest" of a general aviation airport is defined in this analysis as the net benefits accruing to the airport's users. These benefits are in turn defined as the time saved by using the airport, net of the costs of such use, relative to travel by the next best alternative.

This definition of national interest seems reasonable since the time saved by the airport's users can then be devoted to other endeavors, resulting in a net increase in the production of goods and services in the economy. Such a net

**Economist, Federal Aviation Administration, Washington, D.C.*

increase in productive output accrues to the populace, and hence the nation, in general—not just to the users themselves.

The analysis assumes that individuals want to travel from A to B (see Figure 1) and we are considering the benefits yielded by an airport (or potential airport) located at A. The destination airport, B, is located at some distance D_1 from the point of origin; in the general case, B may be located any place on the circle of radius D_1.

The next best alternative to flying from A to B is to drive from A to the alternate airport at C and thence fly from C to B. The alternate airport, C, is located at some distance D_3 from the point of origin; again, for the general case, C may be located any place on a circle of radius D_3.

The time saved by flying from A to B directly is the time it would take to make the ACB trip less the time it takes to make the direct AB trip. The total annual benefit of this time saving is the time saved per passenger per trip times the annual number of such passenger-trips, all multiplied by the value of the passenger's time.

The total annual costs incurred to realize this benefit consist of the direct costs of making the AB flights, less the direct costs of making the ACB trips (avoided costs), plus the annualized costs of building and operating the airport at A. Even if the airport already exists at A, its annualized capital value, or more appropriate in this case, market value, must be regarded as a cost because we would be considering the continued use of the property as an airport versus some alternative use.

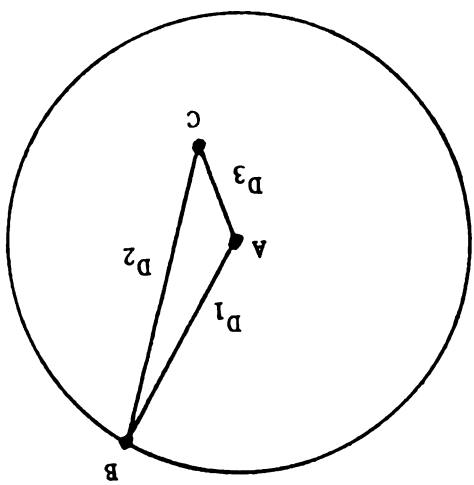


FIGURE 1

The airport costs for the airports already existing at B and C, on the other hand, are not included in the analysis because the operations at these airports which originate or terminate at A are regarded as marginal to these airports. In other words, airports B and C already exist and will continue to operate with or without the traffic from A, and the traffic from A does not alter annual operating and maintenance costs.

To determine an equilibrium solution, benefits are set equal to costs, values are applied for known variables, and the expression is solved for the unknown variables. Analytical details and sensitivity analyses are presented in an appendix to this paper.

RESULTS

Since the objective of this analysis is to provide for NASP entry criteria, the number of passenger-trips required to justify entry of the airport being considered is translated into the number of aircraft that must be based at the airport. Based aircraft is actually a proxy for the number of itinerant operations at the airport and is used because the number of based aircraft can be much more readily and definitively determined than can the number of itinerant operations, especially at small, nontowered general aviation airports. Based aircraft are related to annual passenger-trips by the average number of itinerant operations per based aircraft and the average number of passengers per trip.

The resulting number of based aircraft required at the airport being considered to justify its entry into the NASP is dependent upon the time required to drive to the nearest alternate airport and the capital value of the airport being considered, other determining variables being taken as given. Fewer based aircraft are required to justify the existence, or inclusion in the NASP, of an airport the farther away is the nearest alternate airport or the lower is the capital value of the airport.

These results, for selected airport capital values, are presented in the form of the curves shown in Figure 2. The number of based aircraft required for NASP entry are shown as related to the driving time to the nearest alternate airport. The values applied for the "known" variables in the analysis are listed below.

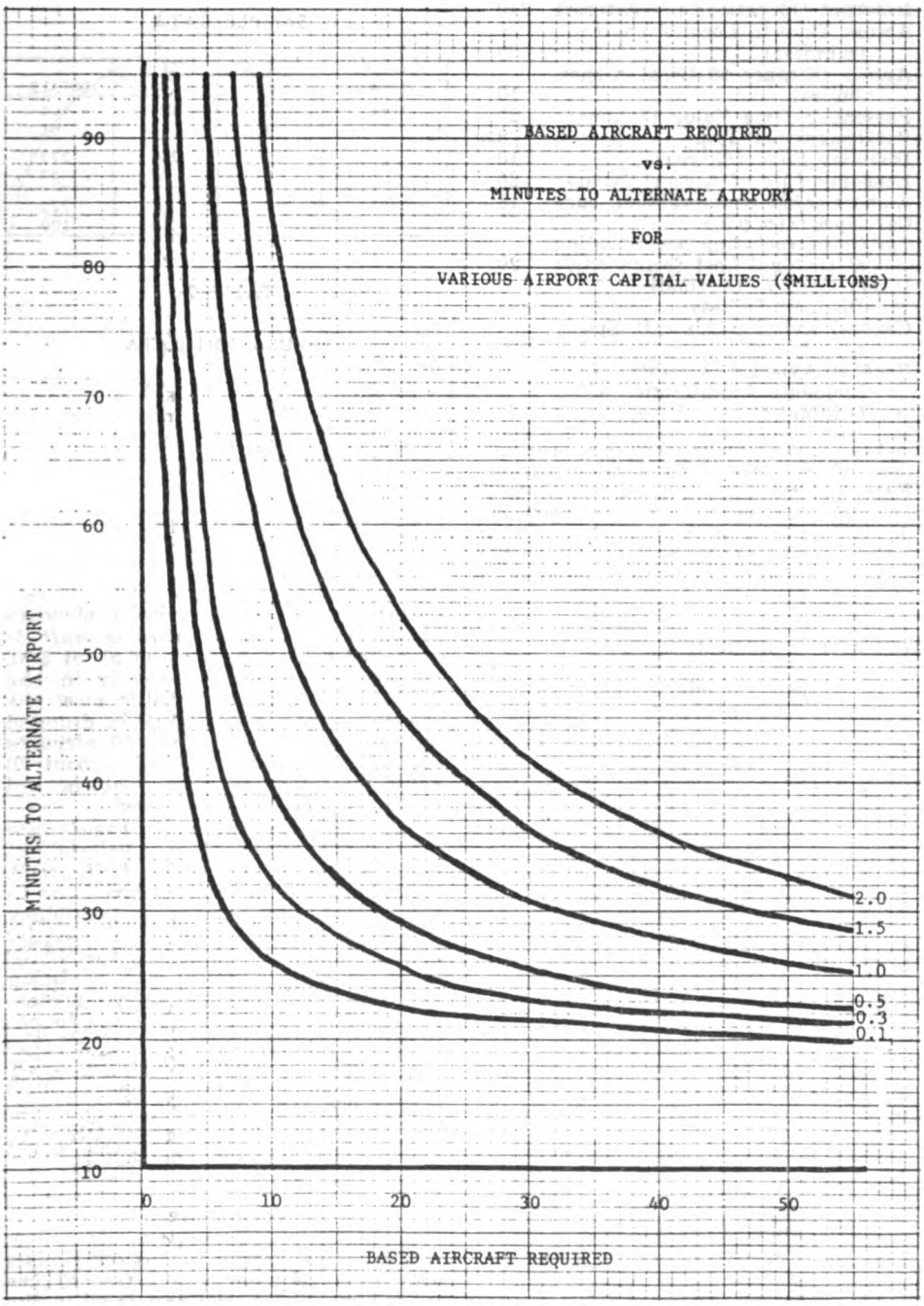


FIGURE 2

VARIABLES	VALUES
Itinerant Operations per Aircraft	340
Access Time to Local Airport (minutes)	20
Access Distance to Local Airport (miles)	10
Passenger Time Value ($/hour)	20
Passengers per Trip	2.5
Discount Rate (%/year)	10
Economic Life of Airport (years)	20
Airport O&M Costs ($1000/year)	15
Car Speed (m.p.h.)	45
Car Costs, Including Amortization of Original Cost (cents/mile)	20
Direct Origin—Destination Distance (miles)	200
General Aviation Aircraft Speed (m.p.h.)	130
General Aviation Aircraft Cost, Including Amortization of Original Costs ($/hour)	75

The curves are based upon these values, which were derived from various FAA publications.* Of course, instead of using these curves, an airport specific determination can be made by using known values for these variables at the airport in question and the equations in the appendix.

IMPACT ASSESSMENT

To estimate the effect that application of these NASP entry criteria might have, an impact study was made, assuming an airport capital value of $300,000. A random sample of publicly owned general aviation airports having fewer than 20 based aircraft was taken across the nine continental FAA regions. The total sample size of 720 represents about one-third of the population of some 2000 of this type of airport, which are the more or less marginal airports likely to be affected by the application of these criteria. The sample data are summarized in Table 1; the upper figure is the number and the lower figure is the percentage in each cell.

Applying the sample percentages to the universe total of about 2000 airports yields the following estimates of the effects of the new entry criteria on the NASP.

Thus, the net change in the NASP of publicly owned general aviation airports having fewer than 20 based aircraft is estimated to be a decrease of about 500. Of the 1230 airports presently in the NASP, about 570 would fail to meet the new entry criteria and would be dropped from the system. Of the 770 airports that are not now in the NASP, about 70 would meet the new entry criteria and would be added to the system.

This estimated impact is based only on the application of the criteria set forth in the $300,000 curve of Figure 2. It does not take account of variations in airport capital value or the possibility that some of the airports eliminated by these criteria may yet qualify for NASP entry for other reasons, such as being necessary for health and safety, protection of national resources, access to national recreation areas, or to meet the special needs of Indian tribes. Thus, the estimated decrease may be slightly high but the order of magnitude of change in the size of the NASP resulting from application of the new entry criteria would be a reduction of 500 or so airports.

TABLE 1

SAMPLE DATA

Presently In NASP	MEET NEW CRITERIA YES	MEET NEW CRITERIA NO	TOTALS
YES	237 33	204 28	441 61
NO	25 3	254 35	279 39
TOTALS	262 36	458 64	720 100

TABLE 2

POPULATION DATA

Presently In NASP	MEET NEW CRITERIA YES	MEET NEW CRITERIA NO	TOTALS
YES	660	570	1230
NO	70	700	770
TOTALS	730	1270	2000

APPENDIX

The analysis assumes that individuals want to travel from A to B (see Figure 1) and we are considering the benefits yielded by an airport (or potential airport) located at A. The next best alternative to flying directly from A to B is to drive from A to the alternate airport

* (1) "National Airport System Plan Entry Criteria, Revalidation and Rationale," May 1972, distributed by Notice N5090.12 of June 19, 1972.
(2) Report No. FAA-AVP-76-6, "General Aviation Activity at Nontowered Airports," April 1976.
(3) Report No. FAA-AVP-76-12, "Selected Statistics, United States General Aviation, 1959-1975," July 1976.
(4) Report No. FAA-AVP-76-9, "General Aviation: Aircraft, Owner and Utilization Characteristics (1974 data)," November 1976.

ECONOMIC ANALYSIS OF GENERAL AVIATION AIRPORTS

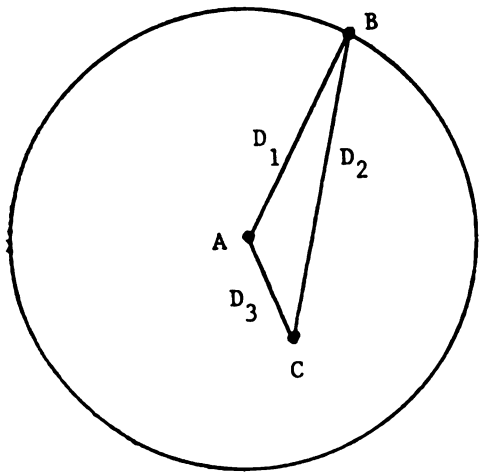


FIGURE 1

at C and thence fly from C to B. The benefits are taken to be the time saved by making the direct AB trip as opposed to the ACB trip. The costs incurred to realize this benefit consist of the direct costs of making the AB flights, less the direct costs of making the ACB trips (avoided costs), plus the allocated costs of the airport at A.

Referring to Figure 1: $D_2^2 = D_1^2 + D_3^2 - 2D_1 D_3 \cos A$. If B may be located at any point on the circle of radius D_1 and C may be located at any point on a circle of radius D_3, which represents the generalized case, then angle A varies continuously from 0° to 360° and $\overline{D}_2^2 = D_1^2 + D_3^2$.

The following variables are considered in the analysis:

- X Number of based aircraft at subject airport.
- I Itinerant operations per based aircraft per year.
- V_1 Subject airport capital value ($).
- V_2 Annualized airport capital value ($).
- T_1 Access time to subject airport (hours).
- T_2 Access distance to subject airport (miles).
- P_1 Passenger time value ($/hour).
- P_2 Number of passengers per trip.
- R Discount rate (%/year).
- L Economic life of subject airport (years).
- M Subject airport O&M costs ($/year).
- H_1 Car Speed (m.p.h.)
- H_2 Car costs, including amortization of original cost ($/mile).
- D_1 Direct origin-destination flight distance (miles).
- D_2 Alternate airport - destination flight distance (miles).
- D_3 Origin-alternate airport highway distance (miles)
- G_1 GA aircraft speed (m.p.h.)
- G_2 GA aircraft costs, including amortization of original cost ($/hour)

Benefits (value of time saved per year)

$$\text{ACB time} = D_3/H_1 + D_2/G_1$$

$$\text{AB time} = D_1/G_1 + T_1$$

$$\text{Benefits} = P_1P_2I \times (D_3/H_1 + D_2/G_1 - D_1/G_1 - T_1)$$

Costs (per year)

$$\text{AB Direct Costs} = G_2D_1\,IX/G_1 + H_2T_2IX$$

$$\text{ACB Direct Costs} = G_2D_2\,IX/G_1 + H_2D_3\,IX$$

$$V_2 = \frac{V_1R/100}{1 - (1 + R/100)^{-L}}$$

$$\text{Costs} = IX(G_2D_1/G_1 + H_2T_2 - G_2D_2/G_1 - H_2D_3) + V_2 + M$$

Equilibrium (benefits = costs)

$$P_1P_2\,IX(D_3/H_1 + D_2/G_1 - D_1 - T_1) = IX(G_2D_1/G_1 + H_2T_2 - G_2D_2/G_1 - H_2D_3) + V_2 + M$$

This expression can be rearranged to give:

$$X = \frac{(V_2 + M)G_1/I}{(D_2 - D_1)(P_1P_2 + G_2) + P_1P_2G_1(D_3/H_1 - T_1) + G_1H_2(D_3 - T_2)}$$

If D_2 represents the average distance from the alternate airport to the destination airport, then:

$$D_2^2 = D_1^2 + D_3^2$$

Thus, for the generalized case, given D_1 and D_3, we would substitute for D_2 in the above expression for X:

$$D_2 = \sqrt{D_1^2 + D_3^2}$$

This expression for the number of based aircraft may be solved for any given set of values for the variables in the expression. The base values used to solve this expression, derived from various FAA documents, were:

I	Itinerant operations per aircraft.	340
T_1	Airport access time (minutes).	20
T_2	Airport access distance (miles).	10
P_1	Passenger time value ($/hr.)	20
P_2	Passengers per trip	2.5
R	Discount rate (%/yr)	10
L	Airport economic life (years)	20
M	Airport O&M costs ($1000/yr.)	15
H_1	Car speed (m.p.h.)	45
H_2	Car costs (¢/mile)	20
D_1	Origin-destination distance (miles)	200
G_1	GA aircraft speed (m.p.h.)	130
G_2	GA aircraft costs ($/hr.)	75

The expression was then solved for selected airport capital values (V_1) and various times to the alternate airport ranging from 20 to 120 minutes. From this solution set, curves depicting the number of based aircraft versus distance (in units of time) to an alternate airport was prepared for the various airport capital values.

SENSITIVITY ANALYSIS

The value of each variable was altered in turn to determine the effect that such changes would have on the results. Two sensitivity indices were calculated for each variable. The first, index #1, is the percentage change in the number of based aircraft per 100% change in the variable, given that the driving time to the alternate airport is 45 minutes. The second, index #2, is the percentage change in driving time per 100% change in the variable, given that there are ten based aircraft. The results of this sensitivity analysis were as follows:

	Variables	Index #1	Index #2
I	Itinerant ops per aircraft	—62	—34
V_1	Airport capital value	57	26
T	Airport access time and distance	52	47
P_1	Passenger time value	—50	—24
P_2	Passengers per trip	—50	—24
R	Discount rate	36	17
H_1	Car speed	—28	—17
M	Airport O&M costs	22	11
L	Airport economic life	—16	— 8
H_2	Car costs	—11	— 7
D_1	Trip distance	7	4
G_1	GA aircraft speed	7	4
G_2	GA aircraft costs	— 4	— 2

This list, ranked in order of sensitivity, indicates that the results are quite sensitive to five variables. These five critical variables are:

1. Itinerant operations per aircraft.
2. Airport capital value.
3. Access time and distance to the airport.
4. Passenger time value.
5. Passengers per trip.

It is clear that considerable care must be exercised in the selection of base values for these five variables. As with all values used in this analysis, the values applied for these five variables are the best estimates of their average values which are available.

The remaining variable values are somewhat less crucial. Changes in the discount rate, automobile speed, airport O&M costs, and airport economic life have some impact upon the results. There is virtually no effect upon the results from changes in automobile costs, origin to destination flight distance, general aviation aircraft speed, or general aviation aircraft costs.