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The Impact of the Genesee County Airport on Genesee County

FRANCIS P. KULKA

ABSTRACT

In this study of the Genesee County Airport and its economic impact on the local economy, the costs and benefits of the airport to the city of Batavia and the remainder of the county are examined. The goal of this study was to demonstrate that general aviation airports provide an essential service in complementing an area's entire transportation system. As such, any airport development will incur its share of local costs (for development and operation), but at the same time it will generate a set of economic benefits directly because of its use and indirectly through the creation of additional income and purchases of goods and services in the local economy. The point to be made is that the key for any local decision making concerning airport development should reflect a balanced evaluation of an airport's costs and its benefits, placed in the context of how a community (or county) perceives the long-range need to provide public services to its residents, businesses, and other institutions. The conclusions drawn from this study provide some interesting perspectives on the behavior of general aviation in smaller urban areas and rural communities. A survey of airport operations in 1983 showed that 18 percent of all aircraft operations were for business purposes. Of the manufacturing firms that have 25 or more employees, 37.5 percent use the airport to some degree. Use of the airport ranges from a few trips to several hundred trips per year. What is interesting about the use of the airport by the manufacturing firms is that all the firms that use it have at least 100 employees. For small manufacturing firms, the airport does not appear to be essential for conducting business. This point was brought out by discussions relating to local business expansions. As a recruiting tool for manufacturing firms, it is safe to conclude that in seeking firms that may hire or employ 100 or more people, the presence of the airport could be an essential part of any presentation to a prospective new company. In 1983 local airport businesses were employing 16 full-time and 4 part-time individuals and a total payroll of $159,876. These businesses contributed directly and indirectly more than $861,000 in local economic expenditures. As a conservative estimate there was $3,654,999 in direct and indirect economic expenditures within the local economy. These expenditures in turn provided direct and indirect fiscal benefits that cannot be quantified, yet they exist. The range of these direct and indirect fiscal benefits reduces the county's average annual net operating cost of $37,400. Through a method of estimating the county's revenue capture rate, it appears that between 1978 and 1983 the county earned from $3,000 to $8,000 per year using the indirect revenue estimates to offset average annual operating costs.

Much has been written about airports and airport development and the costs and benefits to the communities they serve. In larger urban areas, the need for aviation is accepted and services are supplied to a variety of users. In smaller urban areas and rural counties the need for aviation sometimes becomes less clear and local critics ask: "Why do we need an airport and all its related costs?" Proponents highlight the benefits of aviation and other aviation-related groups to their business community.

This study provides background information on the Genesee County Airport and its economic impact on the local economy. The costs and benefits of the airport to the city of Batavia and the remainder of the county are examined. A profile of the airport's operational activity, which manufacturing firms (more than 25 employees) use it, the effect the airport has had in attracting new businesses, and the economic impact of the county's airport capital development program are presented in this paper. In addition, a discussion of the impacts of the businesses that derive their livelihoods from the airport is provided and the fiscal impacts of the airport on Genesee County are discussed.

Following the general conclusions of the study, other considerations are highlighted that need to be evaluated to provide a balanced perspective on the question of local airport development.

The goal of this study was to demonstrate that general aviation airports provide an essential service in complementing an area's entire transportation system. As such, airport development will incur its share of local costs (for development and operation), but at the same time it will generate a set of economic benefits directly because of its use and indirectly through the creation of additional income and purchases of goods and services in the local economy. The key for any local decision making concerning airport development should reflect a balanced evaluation of an airport's costs and its benefits, placed in the context of how a community (or county) perceives the long-range need to provide public services to its residents, businesses, and other institutions.

Certain benefits that accrue to other units of government were not examined in this study. There was no attempt to quantify the contributions of the airport to federal and state income taxes, federal fuel and excise taxes, the state sales tax, and local and school property taxes. Instead, the effort concentrated on the fiscal impacts on the airport owner, Genesee County. These other benefits exist but it was believed that the effort in the study should, more appropriately, be concentrated on the county.

ECONOMIC ACTIVITY AND THE GENESEE COUNTY AIRPORT

Airport Activity and Use

The relationship of the county's economic activity and the need for air transportation can be demonstrated in a number of ways. A profile is given of aviation activity at the Genesee County Airport and the demands placed on it by the county's manufacturing firms.

Genesee County Airport serves general aviation and is located north of the city of Batavia (1980 population 16,703) and east of the New York State Thruway interchange on East Saile Drive. The airport was first opened as Batavia Airport in 1943 by Gilbert Chapell. The original facility was used primarily for flight instruction and consisted of sod landing strips located on the western portion of the present airport.

In 1963 Genesee County (1980 population 59,400) realized the need for public ownership of the facility and purchased the airport and 98 acres from Chapell. The facility included existing Runway 10-28, a short stub taxiway, an apron of 25,000 ft^2, medium intensity runway lights, a lighted wind cone, segmented circle, and rotary beacon. Shortly thereafter the airport was leased to Batavia Aviation, Incorporated.

In 1965 the airport experienced a major expansion of facilities. A new terminal building, aircraft maintenance and storage hangars, additional taxiways and apron areas, service roads, and fuel storage facilities were added. The automobile parking area was paved and additional lighting was installed. Another expansion period occurred in 1978 and ended in 1983. Improvement projects included land acquisition for a runway extension and parallel taxiway project, and work was completed on an apron expansion project in 1983. Genesee County Airport now has a 4,400 ft runway, parallel taxiway, and an Instrument Landing System (ILS).

The airport recorded its highest number of based aircraft (58) in 1975. In 1983, 43 aircraft were based at the airport. On the basis of the Genesee/Finger Lakes Regional Aviation System Plan forecasts for Genesee County, the airport will have between 88 and 110 based aircraft by the year 2000.

In May 1983 the Regional Planning Council conducted a 3-day survey of aircraft operations. According to this survey, the airport handled approximately 24,000 operations in 1983. The purpose of each operation included the following:

- Private, 19 percent
- Business, 18 percent
- Instruction and training, 60 percent
- Agricultural application, 3 percent

Eighty-seven percent of all operations were conducted by single engine aircraft and 52 percent of these operations were generated by aircraft based at the airport.

In November 1983 all manufacturing firms with 25 or more employees were surveyed. On the basis of the survey results, the following general conclusions can be drawn about the use of the Genesee County Airport by manufacturing firms.

1. More than one-third (37.5 percent) of the companies use the airport to some degree. This use ranges from a few trips to several hundred trips per year.
2. All the firms that use the airport have at least 100 employees.
3. There is a demand to haul (outbound) 75,600 lb of freight per year that is not being served from the Genesee County Airport.
4. Sixteen percent of all business trips originate from the Genesee County Airport.
5. The lack of scheduled air service is a deterrent to more companies using the airport.

As a follow-up to this survey, the Regional Planning Council met with the Genesee County Industrial Development Agency to obtain a complete picture of recent economic development activities in the county. Between 1978 and 1983, 16 new plants or business employing 10 or more people located or expanded their operations. These expansions and new locations accounted for 614 new jobs with a payroll of approximately $5.4 million and capital investment of more than $22 million. The airport had no significant role in any of the expansions or new locations. This result is not surprising given the survey results from the manufacturing firms.

In contrast to the more positive results of industrial expansion, during the same general period, more than 2,000 jobs were lost because of plant closings and major reductions in the work force. Three companies accounted for almost 1,300 lost jobs. The net result is that almost 1,800 manufacturing jobs have been lost during the last 5 years.

Direct Economic Benefits of the Genesee County Airport

During 1983 there were six companies actively engaged in operations at the Genesee County Airport. [Note that all the businesses are aviation related; the fixed-based operator (FBO) runs the airport. There is an air taxi service, a flight school and aircraft rental operation, a company that provides aerial application, a maintenance shop, and a shop that sells and repairs avionics equipment.] These companies had 16 full-time and 4 part-time employees and a total payroll of $159,876. They paid $10,297 in direct revenues to the county. In addition, they spent $296,694 buying goods and services in the county's economy. A total of $491,875 was generated and spent in Genesee County.

It is generally safe to conclude that without the presence of the airport, this mini-industry would not be located in the county. In interviews and follow-up telephone conversations with the fixed-based operator, the county Industrial Development Agency (IDA), and the Superintendent of Highways, it was learned that airport-related businesses have been relatively stable operations. Some companies have changed ownership and other short-term ventures are no longer located at the airport, but during the last 6 to 8 years the number of companies remained stable, and the level of activity has fluctuated with general economic conditions.

Indirect Economic Benefits to the Genesee County Airport

Any industry or business that generates a substantial payroll provides indirect benefits to the local economy in which it conducts its operations. The same holds true for airport-related businesses. In addition, there are indirect benefits that accrue to an economy because of the nature of capital development for a publicly owned airport.

In this section an attempt is made to measure the value of these indirect benefits and show their magnitude in the local economy. This includes demonstrating the indirect impacts of airport construction projects and the impact of those businesses that operate at the airport. This involves applying the concept of an economic multiplier.

In examining the indirect benefits, airport development projects were examined over the last 6 years. This included three projects that involved an apron extension, runway extension, and construction of a parallel taxiway. The total costs of the projects and the year in which they were constructed are given in Table 1. Direct and indirect expenditures total $2,818,272 (see Table 2).

For the airport businesses the direct expenditures and indirect expenditures are given in Table 3. Indirect expenditures for taxes and charitable donations were not calculated. The total direct and indirect benefits of the airport-related businesses amounted to $861,735.

Fiscal Impacts of Genesee County Airport

Along with the benefits of airport development comes the responsibility of paying certain costs. For Genesee County, these costs include providing the local match for airport development projects as well as annual maintenance and operation costs.

During the last 6 years (1978-1983) the county's capital development program for the airport totaled $1,484,083. The county's local share of these costs totaled $52,123. This results in an average development cost of $8,688 per year since 1978.

During the same period, the county's average yearly operating expenses were $47,614. The county's average annual revenue from the airport was $10,214. [Note that the county's two sources of revenue are a $0.03/gallon fuel flowage fee and 15 percent of the fixed-based operator's total rental income.] The rental income could have been higher but there were short-term gaps when a full-time fixed-based operator was not at the airport. The net operating cost to the county on the average between 1978 and 1983 was $37,400. The county has no outstanding bond debts for the airport. The county's total annual average cost over the 6-year period then is $46,088 ($37,400 average net operating costs plus $8,688 development costs).

Because averages tend to smooth over actual year-to-year expenditures, and sometimes distort patterns or levels of expenditure, one specific year of the airport's operation was examined more closely and an effort was made to incorporate other revenue generated by the airport but not directly received by the county.

In 1983 the county's share of direct airport development costs was $586. This represents its 2.5 percent local share. Its total operating cost was $40,289. Thus, the county's total costs for 1983 were $40,875. It received revenues of $10,297 directly from the airport and $7,240 from the county's share of sales taxes derived from airport businesses. This results in a net operating cost of $23,328 for the county in 1983. The 1983 cost is $33,186 less than the average for the 6-year period.

Between the county's direct revenues and sales taxes generated by local airport businesses, the airport appears to be an apparent "money loser" from a fiscal point of view, but its net operating cost is within the county's ability to cover as a needed public service.

There is another source of revenue to the county that can be explained but is extremely difficult to quantify. As a general statement, most people accept the concept of the economic multiplier when evaluating the impact of a new injection of money into the local economy. This is particularly true of airport development and its related businesses. The airport improvement program of the Federal Aviation Administration (FAA) is based on a user's fee program and the monies raised through it are used exclusively for airport development. These funds cannot, under current federal legislation, be used for any other purpose. As a corollary, without the airport, airport-related businesses would not be located at the Genesee County Airport. If the economic multiplier concept of direct and indirect economic benefits is accepted, then another point to realize is that there are also direct and indirect fiscal benefits.

Between 1978 and 1983, the direct expenditures of airport development projects were $1,484,083; the indirect expenditures were $1,334,189 for a total of $2,818,272. In 1983 local airport businesses generated $456,570 in direct expenditures (this excludes $35,305 paid in rental fees and other taxes). This in turn generated $380,157 in indirect expenditures for a total of $836,727. For both capital development and airport-related businesses total direct and indirect expenses were $3,654,999. It is important to note that information was obtained on airport-related businesses for 1983 only. In this time period (1977-1983) there were obviously additional direct and indirect expenditures by these businesses. The $3,654,999 total is a conservative estimate.

Given this total, how much additional revenue was secured by the county? Between the wages and salaries paid and goods and services obtained, airport-related projects have generated additional revenues for the county by way of real property and local sales taxes. By exactly how much is difficult to determine but it is safe to conclude that the county's average operating cost is much lower than $37,400. Depending on the revenue capture rate of these direct and indirect expenditures the airport could be "making money."

It was extremely difficult to find an application to reasonably calculate an indirect capture rate for the purchase of economic goods and services and to apply to fiscal (revenue) benefits. No usable

TABLE 1 Airport Development Projects[a] (1983 dollars)

Project	1978	1979	1980	1981	1982	1983	Total
Parallel taxiway	139,483	517,864	88,254				745,601
Runway extension		56,073	470,388	74,376			600,837
Apron extension			47,722	22,965	43,523	23,435	137,645
Total	139,483	573,937	606,364	97,341	43,523	23,435	1,484,083

Source : Genesee County Department of Highways.

[a]The county's share of the apron extension and parallel taxiway project was 2.5 percent; and its share for the runway extension project was 5 percent.

TABLE 2 Airport Development Projects: Direct and Indirect Economic Expenditures (1983 dollars)

Year	Direct Expenditures ($)	Indirect Expenditures[a] ($)	Total ($)
1978	139,483	125,395	264,878
1979	573,937	515,969	1,089,906
1980	606,364	545,121	1,151,485
1981	97,341	87,509	184,850
1982	43,523	39,127	82,650
1983	23,435	21,068	44,503
Total	1,484,083	1,334,189	2,818,272

[a]The indirect expenditure is determined by multiplying the direct expenditure by the industry-specific earnings multiplier given in Table A-1 in the Appendix for the general construction industry (0.899).

literature was found. There are, however, intuitive and inductive applications that appear reasonable, and a range of estimates can be suggested for indirect fiscal benefits based on the total airport-related expenditures in Genesee County.

1. To begin the analysis, estimates of the direct and indirect expenditures of the airport's capital projects and airport businesses are developed. The estimates are identified as conservative, middle, and optimistic. The conservative estimate reflects the total direct and indirect expenditures presented in the earlier discussion (6 years of capital spending and 1 year of airport business expenditures).

The middle estimate takes into account that the airport businesses were in operation between 1978 and 1983. For the period 1978-1982 the assumption is made that this rate of expenditure on the average is 50 percent less per year than for the surveyed year 1983: $418,363 x 5 (1978-1982) = $2,091,815 + $836,727 (1983 estimate) = $2,928,542. The optimistic estimate assumes that the rate of expenditures for the airport businesses on the average per year is 75 percent of the 1983 total for the period 1978-1982 (see Table 4).

The middle and optimistic estimates were developed for one basic purpose: to find the boundaries or limits of reasonable expectations for airport sales in this time period. The estimates are provided as a demonstration of reasonableness for acceptance rather than accuracy for verification. The information developed in the study suggests that actual sales from 1978 to 1982 may be higher than the optimistic estimates. Both estimates, however, provide a more realistic picture, albeit a conservative one, of the economic activity generated by airport-related businesses.

2. The next step was to outline a range of the indirect revenue capture rate for the expenditures identified in Table 4. On the basis of the level of expenditures, the data in Table 5 show the estimates of revenue the county obtains from these expenditures by type: conservative, middle, or optimistic. The capture rates range from 1 to 5 percent and serve as a surrogate for the county property tax and its share of the state sales tax.

3. After the calculation of the indirect revenue estimates, an average operating cost reduction was determined for each expenditure level by capture rate estimate. For example, the capture rate of 1 percent for the conservative estimate of $3,654,999 is $36,549 over the 6-year period. The average operating cost reduction per year is determined by $36,549 divided by 6 = $6,091 (see Table 6).

4. Next, a method was needed to incorporate and consider the direct sales tax revenue generated by the airport businesses for the period 1978-1982. In 1983 the airport businesses contributed $7,240 to the county through the state sales tax. This contribution was based on expenditures of $296,012 or 2.445 percent of the businesses' total spending for goods and services. Assuming that business spending patterns change slowly over time, the proportion of 1983 expenditures for goods and services was held constant for previous years. Thus 50 percent and 75 percent of these expenditures were used to determine previous sales tax contributions at the rate of 2.445 percent for the middle and optimistic expenditure estimates.

The yearly sales tax estimate for 5 years was

TABLE 3 Airport Businesses: Direct and Indirect Economic Expenditures, 1983

	Direct Expenditures ($)	Indirect Expenditures[a] ($)	Total Expenditures ($)
Payroll	159,876	122,784	282,660
Taxes	25,008	NA	25,008
Fuel, supplies and equipment	233,051	189,936	422,987
Advertising	1,947	2,153	4,100
Services (repair)	61,014	65,284	126,298
Charitable donations	682	NA	682
Total	481,578	380,157	861,735

Note: NA = not applicable.

[a]The direct expenditures were calculated by using the following multipliers from Table A-1 in the Appendix by industrial sectors: payroll - 53 - 0.768; fuel, supplies and equipment - 51 - 0.815; advertising - 54 - 1.06; and services - 56 - 1.07.

TABLE 4 Estimates of Direct and Indirect Airport-Related Expenditures (1983 dollars)

	Conservative ($)	Middle ($)	Optimistic ($)
Direct and indirect expenditures (capital projects)	2,818,272	2,818,272	2,818,272
Direct and indirect expenditures (airport operations)	836,727	2,928,542	3,974,452
Total expenditures	3,654,999	5,746,814	6,792,724

TABLE 5 Indirect Revenue Capture Rate (1978-1983) (1983 dollars)

Capture Rate (%)	Conservative ($)	Middle ($)	Optimistic ($)
1	36,549	57,468	67,927
2	73,099	114,936	135,854
3	109,649	172,404	203,781
4	146,199	229,872	271,708
5	182,749	287,340	339,636

TABLE 6 Average Operating Cost Reduction Per Year (1978-1983) (1983 dollars)

Capture Rate (%)	Conservative ($)	Middle ($)	Optimistic ($)
1	6,091	9,578	11,321
2	12,183	19,516	22,642
3	18,274	28,734	33,963
4	24,366	38,328	45,284
5	30,458	47,890	56,606

then added to the 1983 total to develop an average direct sales tax contribution, given in Table 7. This revenue source was then deducted from the average annual operating costs to develop net operating cost for each expenditure estimate category.

5. The final step, given in Table 8, presents the average annual net operating cost for each expenditure category by the capture rates of indirect revenue contributions taken from Table 6. For example, in the conservative estimate at a capture rate of 1 percent, the final cost of operating the airport is ($30,160) - $6,091 = ($24,069). If the conservative estimate and the 1 percent capture rate are considered reasonable, then between 1979 and 1983 the county was paying on the average $24,069 to operate the airport.

Given the assumptions and the scenarios presented, the difficult question becomes one of determining which expenditure category, conservative, middle, or optimistic, and indirect revenue capture rate(s) present the most reasonable range of county costs or profit. For discussion purposes, the capture rates of 1 percent and 5 percent can be eliminated from any additional consideration. As direct and indirect expenses occur, the county would likely capture more than 1 percent but nothing as large as 5 percent. Removing these estimates from consideration leaves the county examining a range of estimates from losing $17,977 to earning $13,615 per year.

Examination of the expenditure categories leads to another range of estimates that should not be considered. The conservative estimate includes only 1 year of expenditures for airport-related businesses. On the basis of the history of the airport it is reasonable to assume that, in the years 1978-1982, there were direct and indirect expenditures by these establishments. Consequently, it appears appropriate to discount the conservative expenditure category. This leaves the county examining a range of estimates from losing $14,021 to earning $13,615 per year.

Between the two remaining expense categories, the question becomes which one represents the actual or realistic pattern between 1978 and 1983. In conversations with the fixed-based operator, the county Industrial Development Agency, and the county Highway Superintendent, the businesses at the airport have historically been stable entities. Over the past 6 years, the same number of businesses plus occasional short-term ventures have been located at the airport. The pattern of expenditures has fluctuated; 1978-1980 were relatively strong years, 1981 and 1982 were weak years, and 1983 was a recovery year. This suggests that the optimistic category of expenditures is reasonable and the 75 percent of expenditures for 1978-1982 more closely reflects actual business spending habits.

Given these observations and the fact that the indirect revenue capture rates represent the obtainment of revenue from the county real property and state sales tax (7 percent), of which 3 percent is shared with the county, it is reasonable to conclude that the county's capture rate for airport capital projects and its related businesses is between 3 and 3.5 percent and is probably closer to the upper range. Therefore, it is estimated that the county earned between $3,000 and $8,000 per year between 1978 and 1983.

This conclusion is based on one critical consideration. First, the 1983 survey data are a good representation of the average amount expended by the airport businesses. Even under difficult economic conditions, companies usually do not have fluctuations in expenditures by amounts of 50 percent from one year to the next. Furthermore, the optimistic expenditure level probably underestimates actual purchases of goods and services.

TABLE 7 Estimate of New Operating Cost (1983 dollars)

	Conservative ($)	Middle ($)	Optimistic ($)
Average annual operating cost	(37,400)	(37,400)	(37,400)
Direct sales tax contribution	7,240	4,223	5,731
Net operating cost (loss)	(30,160)	(33,177)	(31,669)

TABLE 8 Average Annual Operating Profit (Loss) with Indirect Revenues

Capture Rate (%)	Conservative ($)	Middle ($)	Optimistic ($)
1	(24,069)	(23,599)	(20,348)
2	(17,977)	(14,021)	(9,027)
3	(11,886)	(4,443)	2,294
4	(5,794)	5,150	13,615
5	298	14,713	24,937

GENERAL CONCLUSIONS

The conclusions from this study provide some interesting perspectives on the behavior of general aviation in smaller urban areas and rural communities. The general aviation airport does provide a variety of services and uses for an area's business and aviation community. Because of the nature of this study, the economic and business aspects of the airport received more attention than other uses that are equally important, yet the economic and business aspects are the most criticized portions on the total general aviation industry.

1. A survey of airport operations in 1983 showed that 18 percent of all aircraft operations were for business purposes. Almost one out of every five operations is conducted by local companies within the county.

2. Of the manufacturing firms with 25 or more employees, more than one-third (37.5 percent) use the airport to some degree. Its use ranges from a few trips to several hundred trips per year. What is

interesting about the use of the airport by the manufacturing firms is that all the firms that use it have at least 100 employees. For small manufacturing firms, the airport does not appear to be essential for conducting business. This point was brought out by discussions relating to local business expansions. As a recruiting tool for manufacturing firms, it is safe to conclude that in seeking firms that may hire or employ 100 or more people, the presence of the airport could be an essential part of any presentation to a prospective new company.

3. In 1983, local airport businesses were employing 16 full-time and 4 part-time individuals and had a total payroll of $159,876. These same businesses contributed directly and indirectly more than $861,000 in local economic expenditures.

4. The county, through its capital development program between 1978 and 1983, generated directly and indirectly $2,818,272 of local economic expenditures. This economic benefit cost the county, through the local match for the projects, $52,123.

5. The average net annual operating cost for maintaining the airport between 1978 and 1983 was $37,400. The average annual development cost to the county for the airport was $8,688 for the same period. The total direct average cost was $46,088.

6. As a conservative estimate, there was $3,654,999 in direct and indirect economic expenditures within the local economy between 1978 and 1983. These expenditures in turn provided direct and indirect fiscal benefits than cannot be quantified, yet they do exist.

7. Through a method of estimating the county's revenue capture, it appears reasonable to suggest that the county, between 1978 and 1983, earned $3,000 to $8,000 per year using the indirect revenue estimates to offset average annual operating cost.

GENERAL OBSERVATIONS

During the time this study was undertaken, different perceptions, thoughts, and opinions were generated by people being interviewed, the Regional Planning Council, staff, and other interested parties. Because of the scope of the study, some relevant aspects of it did not receive a great deal of attention yet they should be mentioned in some manner. These observations help to bridge some of the points considered about the economic impact of the Genesee County Airport but not discussed in their entirety.

1. Studies of this type are needed to help justify general aviation. Unlike other modes of transportation in which the projects or services provided serve a basic public purpose and all are generally accepted as such, general aviation airport development continues to be misunderstood and misrepresented. Better communication needs to be developed, particularly at the state and local levels, by both public and private interests if general aviation is to make a long-term and stable contribution in meeting a community's total transportation requirements.

2. It is encouraging to know that a public airport with as few as 40 to 45 based aircraft is making a positive economic and fiscal contribution. Within the time period studied, the county has been rocked by some major plant closings, which has resulted in the net lost of almost 1,800 jobs despite an active and aggressive industrial development program.

3. The method used to suggest the profitability for the county was basically an indirect one. The assumptions used in its formulation and the conclusions that came out of it appear reasonable and sound. A more definite process would have been preferred but one was not found. However, the concept of the indirect revenue capture rate is extremely useful and could have other applications.

4. Many benefits derived from the airport, especially fiscal benefits, are not estimated. The amount of time needed for research of the county's various construction contracts to determine expenses for labor, equipment purchasing or renting, and supplies would have involved a considerable effort. Nevertheless, the benefits credited to federal and state income taxes, the state's sales tax, federal excise taxes, and municipal and school property taxes exist. The New York State Department of Transportation or the Federal Aviation Administration may want to consider a study designed to track exactly how a specific construction project's monies are distributed and spent in a local economy.

ACKNOWLEDGMENT

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APPENDIX: INDUSTRY-SPECIFIC MULTIPLIERS

This Appendix contains an explanation of the calculation of the industry-specific earnings multipliers (1) used in this study. Industry-specific earnings multipliers estimate the regional total-earnings impact from an initial change in final demand originating from a particular industry sector. Consider the following example: a $100,000 increase in final demand for transportation equipment (sector 51) in the Buffalo, New York, area. According to the industry-specific earnings multipliers given in Table A-1, the increase in final demand would result in a regional total-earnings increase of $81,500 ($100,000 x 0.815).

Calculation of the industry-specific earnings multipliers follows the methods reported by the Regional Economic Analysis Division of the Bureau of Economic Analysis, U.S. Department of Commerce, in its publication, Industry-Specific Gross Output Multipliers for BEA Economic Areas (2). This publication provides (where available) industry-specific

TABLE A-1 Industry-Specific Earnings/Gross Output Ratios and Industry-Specific Earnings Multipliers

Sector No.	Industry-General Earnings/Gross Output Ratio (E_j)	Earnings/Gross Output Ratio (e_j)	Industry-Specific Earnings Multiplier
18	0.289	0.296	0.899
50	0.308	0.303	0.943
51	0.267	0.288	0.815
53	0.311	0.304	0.768
54	0.513	0.376	1.06
55	0.160	0.234	0.496
56	0.487	0.364	1.07

TABLE A-2 Industry-Specific Gross Output Multipliers: Buffalo Area[a] *(2)*

Sector No.	Industrial Sector Definitions	Gross Output Multiplier (M_j)
18	General building contractor, heavy construction contractor, special trade contractors	3.027
50	Electrical equipment and supplies	3.111
51	Transportation equipment	2.822
53	Transportation, communication, and utilities	2.52
54	Wholesale and retail trade	2.812
55	Finance, insurance, and real estate	2.12
56	Services	2.939

[a]Genesee County is considered part of the Buffalo economic area.

gross output multipliers (M_j; see Table A-2) and the following method of calculating industry-specific earnings multipliers: given M_j, the industry-specific gross output multiplier for industry j and earnings/gross output ratio (e_j) is calculated as follows:

$$e_j = (1/M_j)\ (E_j) + (1 - 1/M_j)$$

where e_j is the industry j's earnings/gross output ratio and E is the national earnings/gross output ratio (0.3008). Having computed e_j for each of the regional industries, then ($M_j e_j$) represents the industry-specific earnings multiplier for industry j. The industry-specific earnings multipliers reported in Table A-1 were applied to the payroll expenditure categories as well as to the expenditure categories of goods and services.

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Methodology for Forecasting Air Travel and Airport Expansion Needs

WAHEED UDDIN, B. FRANK McCULLOUGH, and MELBA M. CRAWFORD

ABSTRACT

Forecasting to assess future needs for a business or facility has become an indispensable part of the planning process. The air travel market appears to be very sensitive to the prevailing business cycles, and it demands frequent updating of forecasts. A methodology is presented for statistically forecasting airline passenger traffic and for assessing the future needs for expansion of airport facilities. Two basic approaches to develop models based on statistical fit of the historical time series data are described. The total airline passenger data collected at the Robert Mueller Municipal Airport in Austin, Texas, were used in the analyses. Several regression models developed by using annual airline passenger data show sales tax revenue as a strong predictor. The same data collected on a monthly basis are analyzed by using Box-Jenkins univariate time series models. The best fitting Box-Jenkins seasonal ARIMA model is later used to forecast airline passenger traffic for specified lead times. Forecasts for longer lead times are also made by using the selected regression equations, which indicate that around 5.5 million total airline passengers are projected for 1990. Finally, the impact of the projected air travel demand in 1990 on existing aviation and terminal facilities is examined.

Forecasting in aviation and airport planning is needed (a) for airport design, which is based on the projected level and pattern of demand; (b) to evaluate airport performance to determine how well the demand placed on an existing level is handled; (c) to prepare a master plan; and (d) for financial planning. Demand projections include volume and peaking characteristics of airline passengers; mix and number of aircraft needed for air carrier operations; terminal area requirements; ground access system, gate position, taxiway, apron, and runway requirements; and so forth. The most important of all these is total airline passenger demand, as the rest of the airport planning is based on volume and peaking characteristics of airline passengers. In this study forecast models are developed for monthly and yearly volumes of airline passengers.

The airline passenger data in this paper refer to total arriving and departing passengers on an annual or monthly basis at a given location. Such data are vital to the operating agency of a particular airport and to the commercial airlines. A methodology is presented for predicting the air travel demand and its impact on future expansion of related airport facilities by using the Robert Mueller Municipal Airport in Austin, Texas, as an example.

AIRLINE PASSENGER TRAFFIC IN AUSTIN

The airline passenger data at Robert Mueller Municipal Airport, Austin, Texas, are used in this paper as a case study to empirically compare different statistical forecasting models. The region surrounding the airport has experienced tremendous economic and urban growth during recent years, and this trend is expected to continue in the foreseeable future. The aviation and passenger handling facilities at the airport are currently being utilized at near capacity. Figure 1 shows annual airline passenger

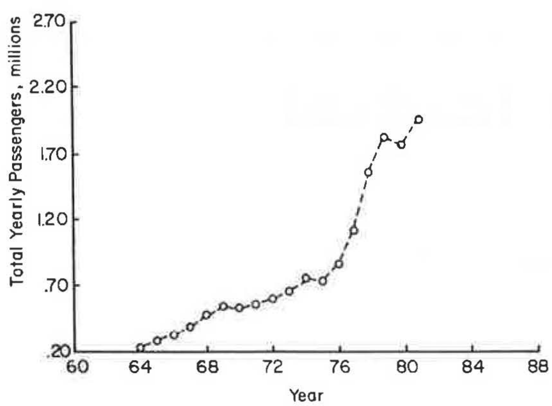

FIGURE 1 Annual airline passenger series at Robert Mueller Municipal Airport, Austin.

data from 1964 to 1982 for the Robert Mueller Municipal Airport in Austin. Exponential growth such as that observed in this figure for Austin is not uncommon in the air travel history of a rapidly growing area.

FORECASTING TECHNIQUES IN AVIATION

Forecasting is not a precise science. Reliable forecasting costs more but better knowledge of the magnitude and fluctuations of the response variable will ultimately result in satisfactory performance of an airport. Most of the approaches used in aviation forecasting fall into one of the three major categories discussed next.

Judgmental Forecasting

This is a subjective approach that relies on a survey of professional judgments, but it lacks any statistical measure. This method is not considered in this study.

Market Analysis Methods

In the market-share model, the forecast is based on a proportion of the regional or national level of activity assigned to the local level, which is assumed to be a regular and predictable quantity. In this method, the existence of a data source minimizes the cost of forecasting but it neglects abnormal growth factors at the local level and will generally underestimate the projection for an area such as Austin.

In the market-definition method, behavioral characteristics of travelers in a region are examined by separating them into distinct groups according to income, occupation, age, and so forth. Travel characteristics of each group are then studied. Forecasting is accomplished by simply projecting into the future the size of groups. It is a time-consuming and relatively expensive method that requires large samples to identify socioeconomic factors underlying travel choice. This method was beyond the scope of this study.

Statistical Techniques

Statistical modeling is widely used for forecasting air travel demands. Simple regression analysis is used to develop a trend or exponential extrapolations. A multiple regression model is the most reliable method; it relates variations in air traffic to variations of different socioeconomic factors. This approach has been used in this study to develop an annual airline passenger model.

Time-series modeling of airline passengers is also done by using the Box-Jenkins approach. The Box-Jenkins ARIMA models are stochastic process models especially useful for modeling a time series with seasonal components, as shown in Figure 2, for

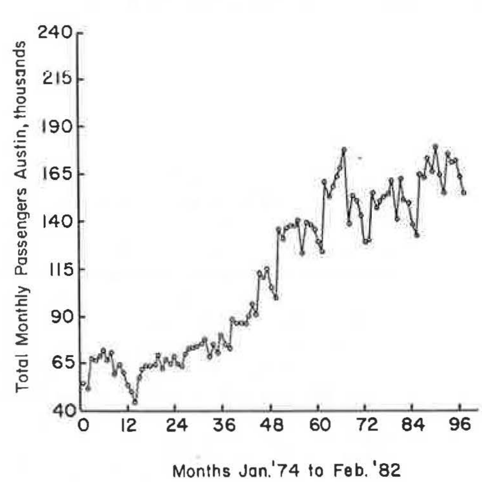

FIGURE 2 Monthly series of total airline passengers at Robert Mueller Municipal Airport, Austin.

the monthly airline passenger data for the Austin airport.

DEVELOPMENT OF STATISTICAL MODELS

Application of Time-Series Models

Time-series analysis is used extensively to model processes that exhibit dynamic characteristics over time. These models typically yield improved forecasts for problems in which the dependent variable is autocorrelated. The application of time-series models for airline passenger data is described by various authors (1-3). Box-Jenkins time-series models in this study are developed for monthly data of total airline passengers at the Robert Mueller Municipal Airport in Austin.

Box-Jenkins ARIMA Models

An observed time series can be considered as the realization of an underlying stochastic process. Box-Jenkins ARIMA models are built empirically from the observed data on three underlying process components:

1. An autoregressive (AR) component: an observed event at time t is regressed on its previous values.
2. An integrated (I) component: represents the trend in the data. Trend can be removed by differencing operation.
3. A moving average (MA) component: an observed event at time t is linearly dependent on a finite number of previous shock terms.

The mathematical theory and detailed treatment of Box-Jenkins models are contained in Time Series Analysis, Forecasting and Control (1). ARIMA model building is an iterative procedure, as shown by the flow diagram in Figure 3.

The first step is to identify the form of Box-Jenkins model that is most suitable to fit the given time series. The basic tools of the model identification are

1. A plot of the data versus time,
2. An autocorrelation function (ACF) graph of the original series, and
3. A graph of the partial autocorrelation function (PACF) of the original series.

If the series is nonstationary (indicated by a linear damping in the ACF graph), then it can frequently be made stationary by a differencing operation of an appropriate order.

At the estimation stage the model parameters are calculated and the model is then subjected to diagnostic checking. Box and Jenkins (1) recommend that in order to accept the model, the residuals must be uncorrelated and normally distributed. The chi-square statistic is used to satisfy this requirement. Graphs of the ACF and PACF of the residuals are then examined to reveal any hidden autoregressive or moving average terms not included in the initial ARIMA model. Appropriate model modifications are made by repeating the identification and estimation procedures until

1. The chi-square statistic is acceptable,
2. All autocorrelations in the ACF graph of the residuals are insignificant,
3. All partial autocorrelations in the PACF graph of the residuals are insignificant, and
4. The estimated parameters meet the required stationarity and invertibility conditions (1).

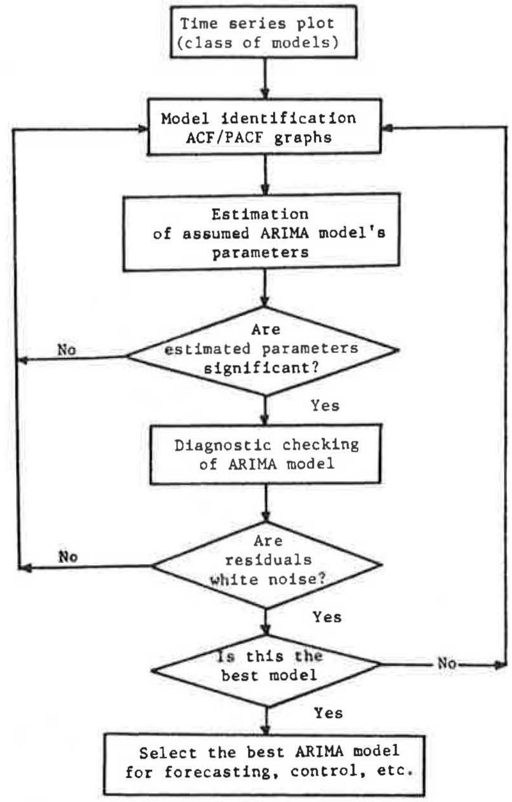

FIGURE 3 Iterative procedure of ARIMA model building.

List of Notations

The general seasonal ARIMA model for a discrete time series $Z_1, Z_2, Z_3, \ldots Z_{t-1}, Z_t, \ldots$ (measured at equal time intervals) can be represented as

$$(1 - \phi_1 B - \phi_2 B^2 \ldots - \phi_p B^p)(1 - \Phi_1 B^s - \Phi_2 B^{2S} \ldots - \Phi_N B^{Ns}) \cdot \nabla^d \cdot \nabla_s^D \cdot Z_t$$
$$= (1 - \theta_1 B - \theta_2 B^2 - \theta_3 B^3 \ldots \theta_q B^q)(1 - \Theta_1 B^{1s} - \Theta_2 B^{2s} \ldots - \Theta_n B^{ns}) \cdot a_t.$$

where

Z_t = discrete time series,
s = seasonal length,
B = backward shift operator ($B \cdot Z_t = Z_{t-1}$),
a_t = random shock term; normally distributed, independent with zero mean and variance equal to σ_a^2,
$(1 - \phi_1 B - \phi_2 B^2 \ldots \phi_p B^p)$ = regular autoregressive process of order p,
$(1 - \phi_1 B^{1S} - \phi_2 B^{2S} \ldots \phi_N B^{NS})$ = seasonal autoregressive process of order N,
∇^d = regular differencing operator of order d,
∇_s^D = seasonal differencing operator of order D,
$(1 - \theta_1 B - \theta_2 B^2 \ldots \theta_q B^q)$ = regular moving average process of order q, and
$(1 - \Theta_1 B^{1S} - \Theta_2 B^{2S} \ldots \Theta_n B^{nS})$ = seasonal moving average process of order n.

Model Identification

Visual examination of the time-series plot (Figure 2) reveals

1. A linear trend component;
2. Seasonality, as indicated by the periodic peaks (repeating every 12 months); for example,

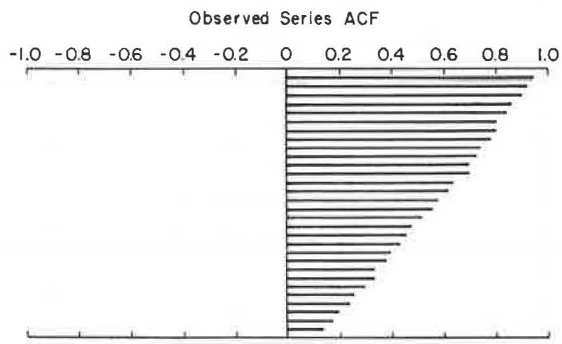

FIGURE 4 The ACF graph of original monthly series, Z_t.

there is a peak every August, indicating high travel period, followed by a periodic sharp drop in September. Another periodic peak occurs in March, preceded by a periodic drop in February.

The ACF graph in Figure 4 shows that the autocorrelations decreased linearly, suggesting a nonstationary process. Subsequently, several orders of regular and seasonal differences of the original series were computed and the respective ACF graphs were examined. Figures 5 and 6 show the ACF and PACF graphs of the first order regular and 6-month seasonally differenced series ($\nabla \cdot \nabla_s^6 \cdot Z_t$); this series satisfies the stationarity requirements. The peak at lag 6 in the PACF graph (Figure 6) suggests a seasonal AR term of the order 6 in the initial model. The coefficients of this model were estimated and found to be significant. The graphs of the ACF and PACF of the residuals showed significant peaks at lags 18 and 24. After different models were considered and the required diagnostic checking had been performed, the best ARIMA model was found to be of the following form:

$$\nabla \cdot \nabla_s^6 \cdot (1 - \Phi_6 B^{6s} - \Phi_{18} B^{18S} - \Phi_{24} B^{24S}) \cdot Z_t = (1 - \Theta_6 B^{6S} - \Theta_{17} B^{17S}) \cdot a_t.$$

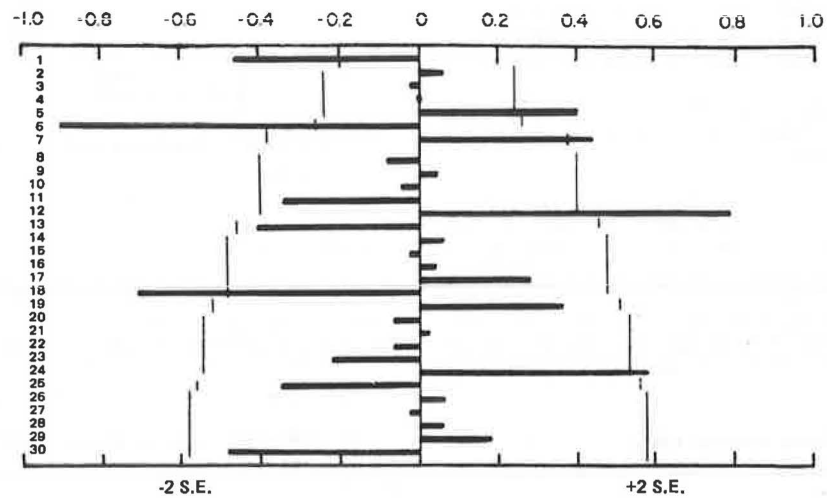

FIGURE 5 ACF graph of the first order regular and 6 month seasonally differenced series.

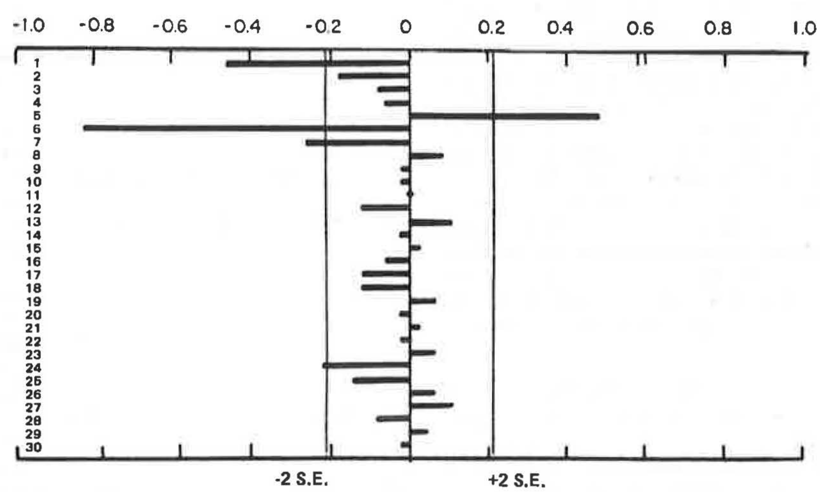

FIGURE 6 PACF graph of the first order regular and 6 month seasonally differenced series.

The ACF graph of residuals is shown in Figure 7 and shows no significant autocorrelation. Similarly,

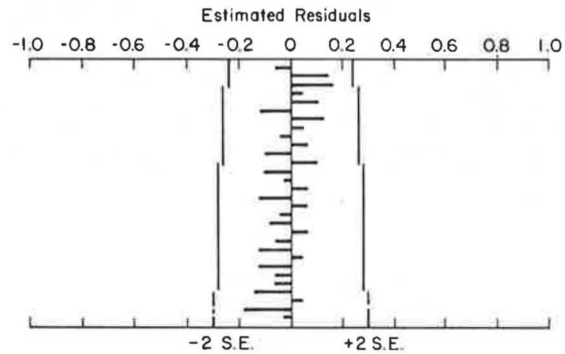

FIGURE 7 ACF graph of residuals.

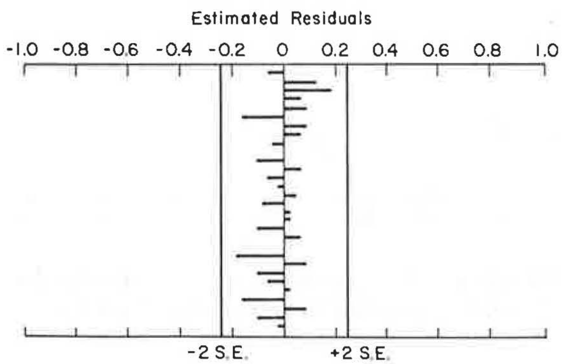

FIGURE 8 PACF graph of residuals.

the PACF graph (Figure 8) of the residuals indicates only white noise. The chi-square statistic (χ^2) is 17.290 with 25 degrees of freedom, which leads to acceptance of the null hypothesis of white noise at the 10 percent significance level.

Model Estimation

The estimated values of the parameters and their 95 percent confidence intervals are given in Table 1. Figure 9 shows the plot of the original series and the corresponding estimated series. The time-series plot (Figure 2) also indicated a possible nonhomogeneity in variance, so a log transformation of the original data was also considered. No appreciable improvement in the fit of the data was obtained. Further transformations were not considered in this study.

Application of Regression Models

It was also desired to develop predictive equations based on annual data. Because of the limited number of observations, the Box-Jenkins approach could not be applied to the annual airline passenger data (Figure 1). Regression techniques were therefore used to develop predictive equations.

Economic and Socioeconomic Factors

To develop regression equations based on past historical data for annual airline passengers, the nature of the variables that have influenced and will continue to influence travel demand must be

TABLE 1 Estimated Parameters of Box-Jenkins ARIMA Model

				95 Percent Confidence Interval	
Parameter No.	Seasonal Parameter Type	Parameter Order	Estimated Value	Lower Limit	Upper Limit
1	Autoregressive	6	-.8002	-1.0009	-.5995
2	Autoregressive	18	-.7889	-1.0471	-.5306
3	Autoregressive	24	-.6947	-.9716	-.4179
4	Moving average	6	.3539	.1060	.6019
5	Moving average	17	-.4604	-.7191	-.2016

Note: Residual sum of squares = 2.270; number of residuals = 67; residual mean square = 3.661; residual standard error = 6050.875.

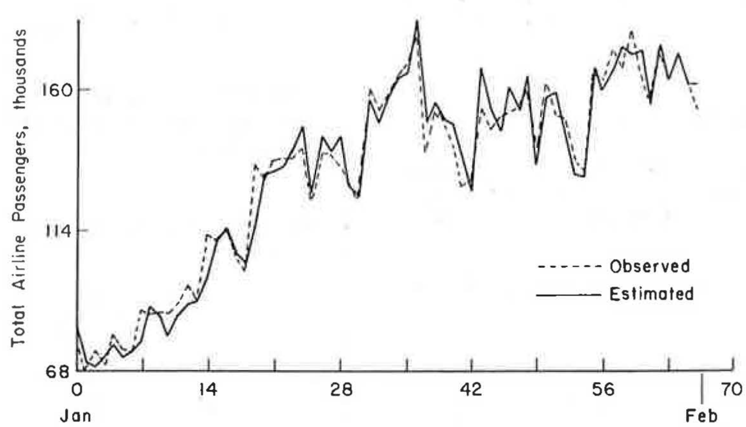

FIGURE 9 Plots of the original series and estimated series of ARIMA model.

considered. Several economic, socioeconomic, and other factors related to industrial and urban growth were considered for investigation:

1. Population (in thousands),
2. Per capita income,
3. Electricity consumption,
4. Water consumption,
5. Bank clearings,
6. Civilian work force, and
7. Sales tax revenue.

Historical annual data for all these variables were collected from the city of Austin. Figure 10 shows an exponential growth in sales tax revenue. Other variables also showed a similar growth pattern.

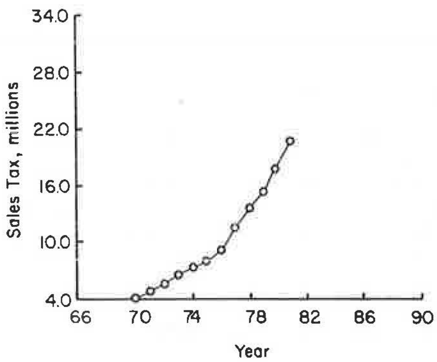

FIGURE 10 Annual sales tax revenue data, Austin.

Summary of Results

Table 2 gives predictive equations that define the relationships between annual airline passengers and some significant predictors. Equation 1 in Table 2 was developed by using the multiple linear regression technique to identify the most significant explanatory variables. This equation contains the nonzero intercept term, which is difficult to justify physically. The value of this term can be made zero by forcing the regression equation through the origin. Equation 2 was developed by using this option. The annual airline passenger plot in Figure 11 is nonlinear, and Equation 3 in Table 2 presents a nonlinear regression model. The estimated series is plotted in Figure 11. As noted in Table 2, all regression equations are associated with high R^2 values. The regression coefficients are statistically significant.

FORECASTING AIRLINE PASSENGER DEMAND

The equations discussed in the preceding section were used to forecast annual airline passenger traffic. The basic assumption underlying the forecasts is that the process and the estimated parameters are time invariant. In the regression models (Equations 1 and 2), forecasts of annual airline passenger totals were made by using the projected values for sales tax revenue and population. The forecasts of airline passengers using all three equations are shown in Figure 12. A summary of future annual airline passenger demand is given in Table 3. The forecast performed with the Box-Jenkins model was based on monthly passenger data taken from January 1976 to May 1982. The methods described by Box and Jenkins (1) for obtaining forecasts were used in this study.

TABLE 2 Estimated Parameters of Regression Models of Annual Airline Passenger Data

No.	Equation	R^2-Value
1	PAX = 2071959.8 + 0.1809(STR) - 6.2428(POP)	0.987
2	PAX = 0.1081(STR)	0.991
3	Log_n(PAX) = 249.79123 - 466193.63 (1/yr)	0.96

Note: PAX = total yearly airline passengers; STR = sales tax revenue, yearly ($); POP = population (thousands); and R^2 = explanatory power of a regression equation and is desired to be a value between 0.9 and 1.

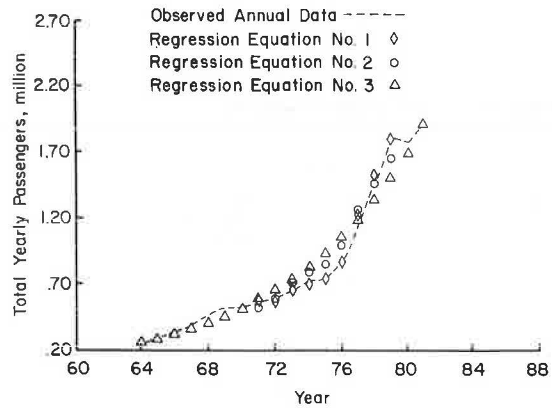

FIGURE 11 Annual airline passengers at Robert Mueller Municipal Airport, Austin—observed and estimated series.

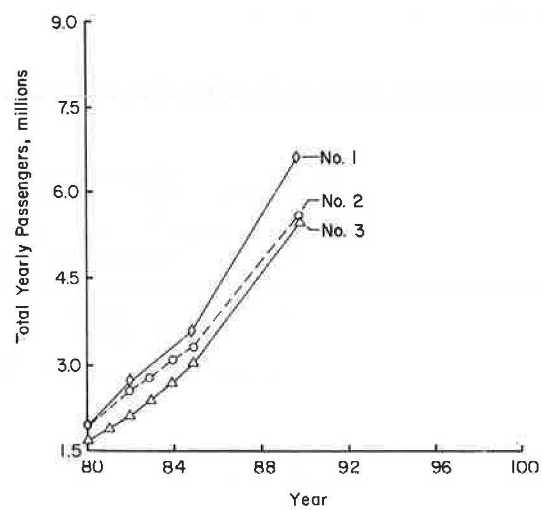

FIGURE 12 Comparison of forecasts—annual airline passenger demand at Robert Mueller Municipal Airport, Austin.

TABLE 3 Comparison of Forecasts

Year	Equation 1	Equation 2	Equation 3	Box-Jenkins Model
1982[a]	2,701,928	2,552,165	2,142,513	2,208,899
1983[b]	-	2,801,273	2,412,337	2,390,654
1984	-	3,107,252	2,715,813	-
1985	3,590,808	3,312,896	3,057,102	-
1990	6,657,828	5,634,766	5,515,484	-

Source: Directorate of Aviation, Austin, Texas.

[a] Actual number of arriving and departing airline passengers during 1982 at Robert Mueller Municipal Airport is 2,207,519.

[b] Actual 1983 count is 2,500,621.

Figure 13 shows forecasts and their 95 percent confidence intervals for lead times up to 10 months.

Forecasts made for 1982 and 1983 and compared with the actual figures (Table 3) obtained from aviation authorities at the Robert Mueller Municipal Airport in Austin indicate the reasonable predictability of Equations 2 and 3 and the ARIMA model.

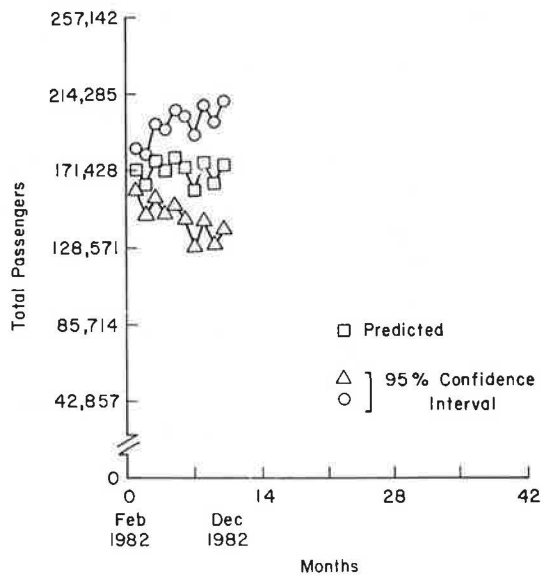

FIGURE 13 Application of ARIMA model to forecast in lead times.

ASSESSMENT OF AIRPORT FACILITIES EXPANSION

A report (4) was published that contained the results of forecasts, assessments of present facilities and future needs at the Robert Mueller Municipal Airport in Austin, and economic consequences of delaying a much needed, long-term planning program. The reaction in the community as well as among local aviation officials was very positive (5). The assessment of expansion needs is not meant to be very precise. The results of this study were reported (4) as a service to the local community.

Generally, air-travel-related facilities are designed to handle the expected number of airline passengers. These facilities include

1. Aviation facilities, such as runways, taxiways, aprons, and navigational aids for aircraft movements;
2. Terminal areas and automobile parking facilities to serve the air travellers and accompanying visitors; and
3. Adequate airspace.

The following sections outline the projected space requirements and the available facilities at the Robert Mueller Municipal Airport in Austin (6,4).

Ground Facilities and Parking Space

The terminal building of the airport and other structures, such as the traffic control tower and the concourse for the six gate positions, cover an area of 135,000 ft². A typical peak hour passenger (TPHP) flow of 0.04 percent of the annual flow and 24,200 ft² of space per 100 TPHP flow, as recommended by the FAA (7) for a domestic terminal facility, were used for the projection. The requirement projected for the 1990 estimated passengers is 484,000 ft². Adequate parking is an important consideration in the design of modern airports. If forecast demand is realized, the parking space required by 1990 will be about three times the present capacity, as shown in Figure 14.

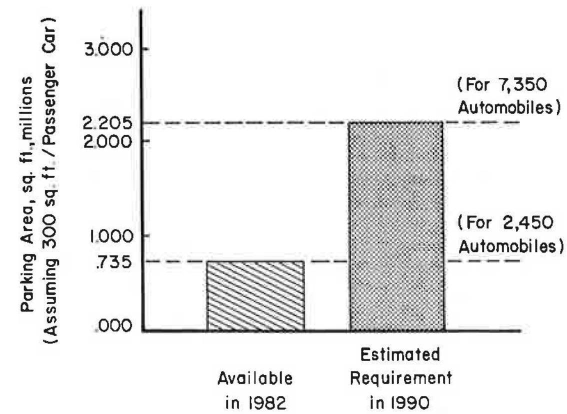

FIGURE 14 Projected automobile parking space needs at airport.

Other Aspects

Consideration must also be given to the future requirements for runway, taxiway, apron, and gate facilities. The level of passenger traffic projected will require an instrumented secondary runway suitable for air carrier operations in order to provide additional capacity and for emergency use. This implies more taxiways and apron space. These expansions will not be possible using the runway configuration at the present site. Thirty gate positions are projected for 1990 based on an approximation of five gate positions per 1 million airline passengers. The airspace requirement is a vital part of any airport planning. The existence of Bergstrom Air Force Base near the municipal airport limits the full utilization of available airspace at the present time. The proximity of Tims Airpark and the proposed plans for its expansion and instrumentation will further complicate the airspace issue.

Noise Impact and Land Requirement

A large part of Austin's urban area is directly under the approach and departure paths of the Robert Mueller Municipal Airport and Bergstrom Air Force Base. The impact of aircraft operations results in an objectionable noise level for the communities near the airport, which is a function of the duration and number of operations and the time of day. The projected increased number of aircraft will bring a larger area within the limit of objectionable noise contours. The land requirement projected for 1990 (1) is 3,000 acres, which is substantially higher than the 700 acres available at the existing site.

CONCLUSIONS AND RECOMMENDATIONS

In this paper the historical data on airline passengers at the Robert Mueller Municipal Airport in Austin, Texas, were examined, and the various economic, socioeconomic, and other factors, such as urban and industrial growth, were investigated to assess their impact on future air travel demand. Statistical models of the total airline passenger series were developed and used to make forecasts. The important findings of the research include the following:

1. The predictive models predict reasonably accurate forecasts. By 1990, the annual airline passenger demand will be around 5.5 million.
2. The present site does not provide sufficient room for long-term expansion. A large expansion in the number of gate positions, terminal facilities, and automobile parking space will be required.
3. A decisive factor in the selection of any future site for the airport should be the availability of extensive areas for land use planning and control.

The Austin City Council has formed a task force that is extensively studying all available options for the future of the Robert Mueller Municipal Airport (8), keeping in view the projections of annual airline passengers.

ACKNOWLEDGMENT

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Determination of the Appropriate Number of Taxicabs to Serve an Airport

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ABSTRACT

Airport managers constantly receive complaints from airline passengers about the suspected overcharging, poor service, and uncleanliness of taxicabs that serve the airport. Unfortunately, many airport officials find it politically and practically difficult to adequately supervise the airport curb services being offered by taxicab companies and individuals. In addition, airport taxicab groundside access has been increasingly aggravated in many U.S. cities by the relatively recent deregulation of taxicab firms and their operations. Many of these problems are directly related to the total number of taxicabs permitted to serve the airport. In the short run the demand for airport taxicab service is relatively fixed, and thus allowing too many cabs encourages overcharging and deteriorating vehicles as operators find it difficult to maintain financial viability. On the other hand, permitting too few vehicles results in excessively attractive taxicab incomes and passenger inconvenience through long delays on busy holidays and peak travel periods. In the analysis that follows, actual operation statistics and data from the Detroit Metropolitan Airport complex are used. It is demonstrated how a typical airport taxicab system can be simulated to provide a reasonable and practically defensible answer to the question of how many taxicabs are needed to serve the airport. The approach used involves a specially designed computer program entitled TAXISIM to simulate the capabilities of various cab fleet sizes to handle present and future taxicab demands. The optional number of cabs is then balanced with an economic business analysis of the cab fleet's earning potential, given past operational performance. Taken as a unit, this approach yields a simplistic method for determining an adequate size of taxicab fleet that can accommodate expected airport passenger demand and make a reasonable return on invested time and capital while paying the airport a fair concession fee. Results of this approach are easily transferable to other airports and even to cities in which a fixed number of taxicab permits is the preferred mode of operation.

Airport managers have become increasingly aware of the need to supervise and direct improved airport ground site access. Taxicab services have been the source of major complaints in terms of suspected overpricing, poor services, and unkempt, or unclean vehicles. Typically, a decision must be made to determine how many taxicab vehicles will be permitted to serve the airport in order to provide adequate service to airline traveling passengers, but yet limit the number of providers so that the total taxicab fleet can earn a reasonable return on its investment of time and capital.

The purpose of this paper is to provide a systematic approach to this managerial decision by using data from the Detroit Metropolitan Airport complex, which has been used in making recommendations concerning the appropriate taxicab fleet size for airport service. The following discussion includes a description of the airport taxicab situation at Detroit Metropolitan Airport and the analysis used to recommend the number of taxicabs required to serve the airport. The objectives of the study were to provide a number of taxicabs in service at Detroit Metropolitan Airport that would

1. Provide an adequate number so that airline passengers using taxicab service would have no delay or minimal delay,
2. Provide an adequate return on investment for time and capital used in taxicab services, and
3. Permit the airport authority to charge a reasonable concession fee to cab operators to defray the fixed and variable cost of assets used in the provision of taxicab ground site services.

PRESENT SITUATION

Deplaning passenger taxicab services at the Detroit Metropolitan Airport are provided exclusively by taxicab operators that have applied for and have been issued a permit by the Detroit Metropolitan Airport Board to provide services. Currently, there is a moratorium on the number of permits issued, which is now 127. Taxicab operators are required to pay a total monthly fee of $40--recently reduced from $55 per month through rescheduling of the monthly fee to a quarterly fee. Thus, on an annual basis, the airport board has recently reduced charges to the 127 taxicab operators by $22,860. In addition, the board has also been asked and has been given permission to eliminate the age restriction on vehicles as long as they continue to pass taxicab vehicle inspection criteria.

The poor economic condition of the taxicab operations at Detroit Metropolitan Airport is obvious. In the short run, due to the lack of demand caused by a downturn in the number of airline passengers requiring taxicab services, taxicab vehicles and incomes of operators have deteriorated seriously. The Detroit Metropolitan Airport Board had little choice in the short term but to reduce its requirements for fees and to eliminate age requirements for vehicles.

Given these circumstances, the Detroit Metropolitan Airport administration requested that a much more in-depth, detailed analysis of the financial condition of the taxicab operation be conducted and that recommendations to improve the financial viability of this needed ground transportation service be made. Thus, detailed information was gathered on taxicab operations for the past 3 years. A single driver's log book, which was verified through observation and discussion with other taxicab operators, was used as a data base for the years 1981, 1982, and 1983. A summary of these data is given in Table 1 and Figures 1 through 5.

As shown, the average taxicab and its driver at the Detroit Metropolitan Airport work a very long day (nearly 14 1/2 hr), travel approximately 250 miles per day, and average $67.13 per day in fare income. It should be noted that the average revenue per day has declined by nearly 15 percent from the June 1981 average. On an hourly basis, the typical operator receives somewhat less than $5 per hour from fares and probably receives from $8 to $12 per day in tips. The 127 taxicabs operating at the airport average approximately 3.31 trips per day or a total of slightly more than five passengers per day.

As can be readily understood, such a condition cannot continue for any length of time. The average number of trips per day is simply insufficient to sustain operations other than on a marginal basis. Currently, taxicab operators have used the capital in their vehicles and are not replacing them, but are running the vehicles on used engines and deteriorating bodies. Their inability to replace vehicles results from a lack of capital. The situation, if allowed to continue, appears to be one that will deteriorate further.

NUMBER OF CABS NEEDED

In determining the most appropriate number of taxicabs to be authorized to pick up passengers at the Detroit Metropolitan Airport, two conflicting goals must be considered. First is the need to have an adequate supply of taxicabs available to meet the immediate transportation needs of deplaning passengers. Second is the need to limit the supply of taxicabs so that those operators servicing the airport's needs will be utilized adequately. Attempts to determine a single best number of taxicabs are frustrating, because raising the total will increase the extent to which the first goal is met, but doing so will also diminish achievement of the second goal. Conversely, lowering the total will have the opposite effect. In the end, it is necessary both to

TABLE 1 Taxi Summary of All Computations

1983 MONTH	DATE	TIME STARTED WORK	LENGTH WORKDAY	MILES TRAVEL	TOTAL DAILY REVENUE	REVENUE PER MILE	REVENUE PER HR	TIMES BETWEEN PICK-UP & DROP OFF (V-U) (F-E)	(J-I)	(N-M)	(R-Q)	PLUS ALL OTHERS	ROUND TRIP REV / TV HR	# PUP'S	# PASS
JAN AVG------)		9.40	14.60	178	66.97	0.37	4.59	0.51	0.41	0.45	0.37	0.40	23.78	3.23	4.83
MAR AVG------)		9.39	14.61	229	72.70	0.32	4.96	0.42	0.41	0.42	0.42	0.88	23.70	3.71	5.71
APR AVG------)		9.26	14.74	211	58.52	0.29	3.98	0.43	0.48	0.41	0.38	0.34	23.07	2.96	4.85
MAY AVG------)		9.17	14.83	234	70.33	0.31	4.76	0.47	0.41	0.42	0.42	1.01	24.19	3.34	4.79
AVG OF AVERAGES---)		9.30	14.70	213	67.13	0.32	4.57	0.45	0.43	0.42	0.40	0.66	23.68	3.31	5.05
1982 MAY AVG------)		9.26	14.74	181	74.63	0.40	5.06	0.54	0.42	0.43	0.56	0.48	22.34	3.69	5.59
AVG-JUNE 81--)		9.97	13.77	224	78.80	0.36	5.74	0.43	0.45	0.46	0.45	0.64	21.76	4.10	5.86
AVERAGE OF ALL AVG----)		9.41	14.54	215.73	71.00	0.34	4.90	0.46	0.43	0.43	0.45	0.67	23.01	3.56	5.36

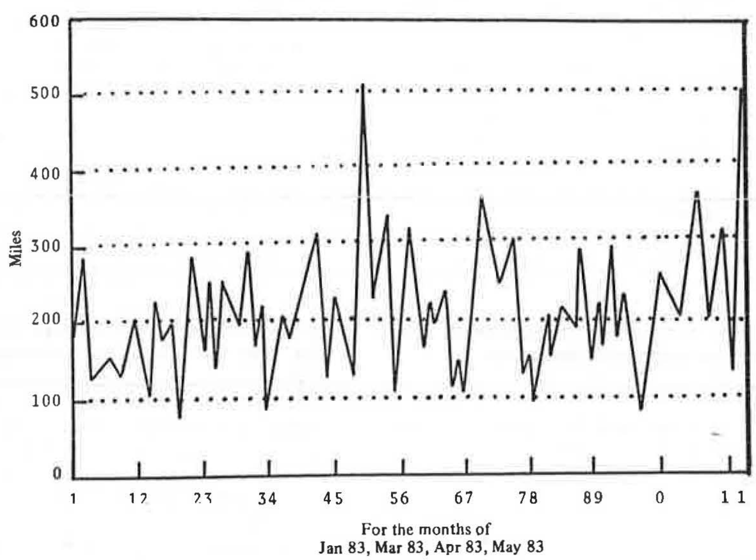

FIGURE 1 Number of miles traveled by day.

assure an adequate supply of taxicabs to meet passengers' needs and to make certain that the supply is limited sufficiently to enhance the chances of financial viability for individual taxicab operators.

Therefore, this study attempts to provide some insight into the number of taxicabs that are actually needed to meet the transportation needs of deplaning passengers. The approach used was to customize TAXISIM (a computer-based simulation model of taxicab operations) to the operating situation at the Detroit Metropolitan Airport and to simulate taxicab activity assuming several realistic levels of passenger demand for taxicab service. Given a particular level of demand, TAXISIM indicates the actual number of taxicabs that would be in service at any given time. Then, the maximum number of taxicabs needed can be determined by observing the magnitude of this figure over time. Finally, the application of an adjustment factor to this number for taxicabs to reflect a certain proportion that will be out-of-service at any given time will result in an estimate of the most appropriate number of taxicabs to be authorized to operate at the airport.

Four major steps were considered in this study:

1. Detailed physical description of taxicab operations at Detroit Metropolitan Airport,
2. Application of TAXISIM,
3. Interpretation of results, and
4. Analysis of policy implications.

Each step will be discussed separately.

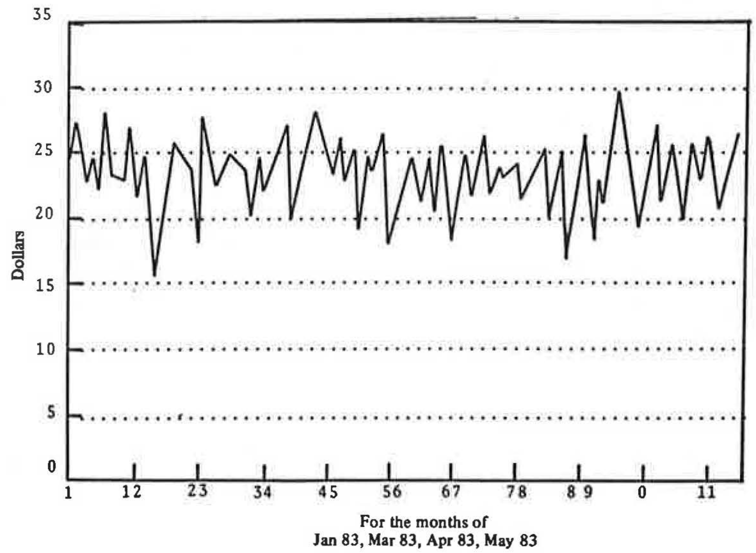

FIGURE 2 Revenue per travel-hour.

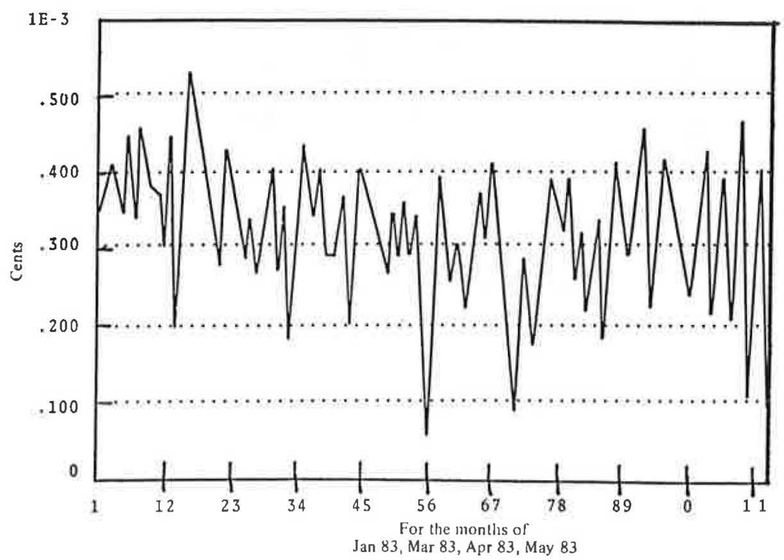

FIGURE 3 Revenue per mile.

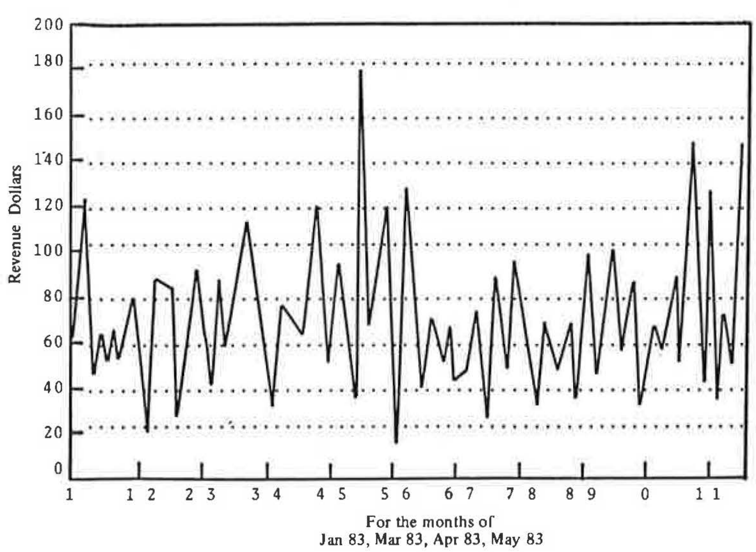

FIGURE 4 Total daily revenue.

TAXICAB OPERATIONS AT DETROIT METROPOLITAN AIRPORT

Figure 6 is a schematic of the principal components of the taxicab operating system at Detroit Metropolitan Airport. Passenger demand for taxicab service occurs either at the north terminal pickup point (PU) or at the south terminal pickup point. The need to provide such service for deplaning passengers at the international terminal was considered, but was not included in this analysis because of the low volume of such demand and because demand occurs at relatively discrete points in time (in contrast to being continuous).

When a passenger is in need of a taxicab service, the taxicab moves forward from a short dispatch line in the vicinity of each terminal area. The dispatch line at the south terminal accommodates approximately three vehicles at a time, while the dispatch line at the north terminal is somewhat longer and accommodates seven to nine vehicles. The supply of taxicabs in each of the short dispatch lines is replenished directly from the supply of taxicabs in the holding area by the use of a dispatcher at both the north and south terminals.

After each taxicab picks up its passenger(s) at the terminal area, the passenger is transported to his destination, and the taxicab then returns to the holding area. Although in actual practice a taxicab may not always return directly to the airport for a number of possible reasons, this assumption simpli-

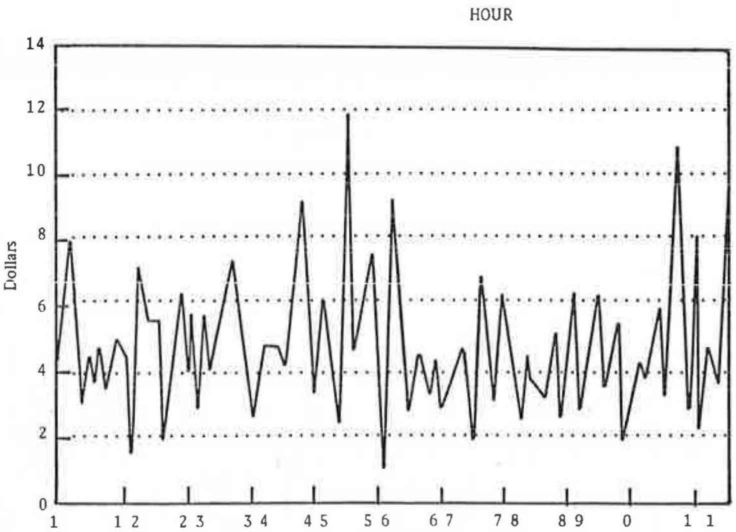

FIGURE 5 Revenue per shift hour.

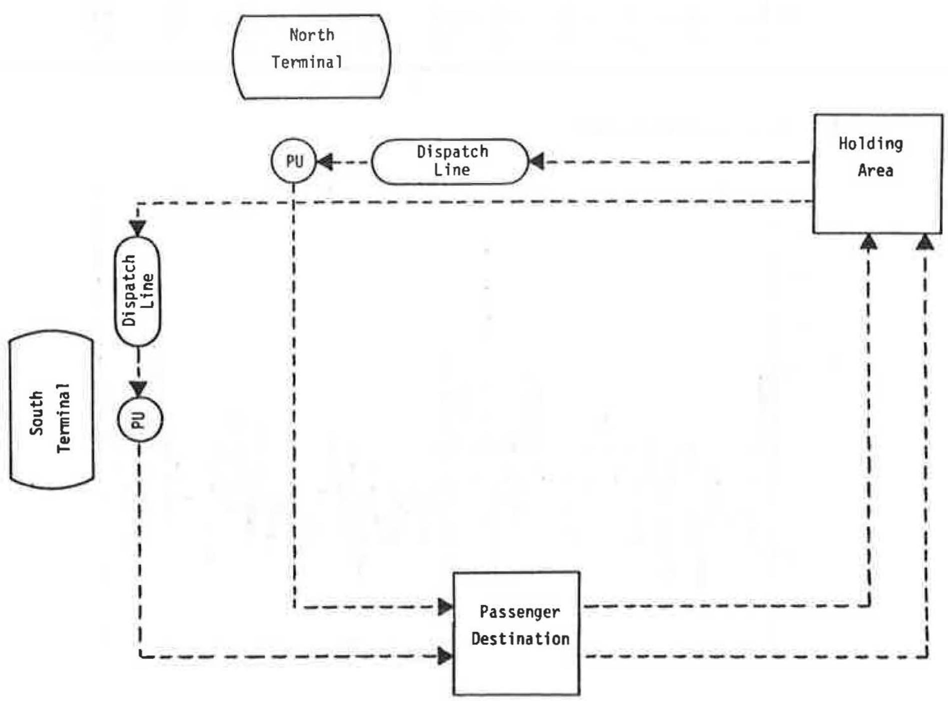

FIGURE 6 Taxicab system: schematic.

fies, but does not compromise, the validity of the simulation approach.

The data in Table 2 indicate the magnitudes of various time factors that must be considered in the attempt to understand the time sequence of various taxicab operations at Detroit Metropolitan Airport. The data in Table 2 were developed following a visual observation of taxicab operations at the airport at several different times and from a comprehensive set of log-book entries made by one of the taxicab drivers.

Activity 1, as identified in Table 2, is that of deplaning passengers requesting taxicab service. An analysis of available records suggested that it would be useful to consider four levels of demand for service, which were expressed in terms of passenger interarrival times, or the times between successive passenger requests for service. The most intense level of demand is that indicated by interarrival times that average 48 sec and that may vary by ± 15 sec. An interarrival time of 48 ± 15 sec translates to a demand per hour equal to 75 requests and a demand per 14-hr day of 1,050. In order of declining intensity, the other demand levels measured in terms of interarrival times are 60 ± 20 sec (60 requests per hour; 840 per day), 80 ± 30 sec (45 requests per hour; 630 per day), and 200 ± 50 sec (18 requests per hour; 252 per day).

Actually the analysis of passenger demand patterns for any individual day would conclude that demand fluctuates somewhat over various time periods. Thus, it is highly unlikely that any single demand rate would be maintained in a continuous fashion over a lengthy period of time. Also, it should be noted that with regard to the four levels of demand identified here, the 60 ± 20 sec interarrival time is representative of currently existing peak demand times, and the 200 ± 50 sec interarrival time is representative of exceptionally slow periods. The 80 ± 30 sec interarrival time is somewhat of an average or typical figure, and the 48 ± 15 sec interarrival time represents a super-peak level that is experienced only rarely. If passenger request activity were to increase significantly, however, it is possible that the peak level of interarrival times could be represented accurately by 48 ± sec.

Activity 2 is that of taxicabs moving from the holding area to the respective terminal areas, and the times concerned in this activity are approximately 120 ± 20 sec to the north terminal and 150 ± 20 sec to the south terminal. The time spent in the short dispatch lines (Activity 3) will depend on the location of the line (i.e., north versus south terminal) and the passenger interarrival times (demand rate) taking place. Thus, for each terminal, the data in Table 2 identify four estimates of time spent in the dispatch line.

Next, Activity 4 is that of advancing from the dispatch line to the passenger pickup point, and this is accomplished in approximately 10 sec, irrespective of terminal. Activity 5 is that of actually picking up the passenger(s), and the time factor for either terminal is 20 ± 10 sec.

Finally, Activity 6 consists of leaving the airport property, taking the passenger(s) to the destination, and then returning to the holding area. Logbook studies indicated that the average time elapsing from passenger pickup to return to the holding area was 51 min; thus a time factor of 3,060 ± 900 sec was used for this activity.

Although the actual time necessary to accomplish any of the foregoing activities may vary considerably from the average or expected value, the time factors given in Table 2 should provide an adequate representation of the system under study.

APPLICATION OF TAXISIM

TAXISIM is a generally applicable, computer-based simulation model of taxicab operations. It is sufficiently flexible to be helpful in analyzing a wide range of fixed-base ground transportation systems. As a result, it proved to be quite capable in terms of its ability to gain insight into taxicab operations at Detroit Metropolitan Airport.

The initial step in the use of TAXISIM was to incorporate all of the operating characteristics and time factors discussed in the preceding section. Once this was accomplished, a number of computer simulations were conducted, each with a differing level of passenger demand, as measured in terms of interarrival times. In a realistic sense, the taxicab operating system responds directly to individual passenger demands for service, and the TAXISIM simulation is driven entirely by the occurrence of passenger demands. It should be noted that the various levels of passenger demand listed in Table 2 are for both terminals combined and that TAXISIM assumes that approximately one-half of the demand occurs at the north terminal and the other half occurs at the south terminal. However, this could vary substantially and produce no significantly different results.

TABLE 2 Taxicab System: Time Factors (in seconds)

Activity	North[a] Terminal	South[a] Terminal
Passenger interarrival times (times in seconds between successive requests for service)		
Four levels of demand (both terminals combined)		
48 ± 15		
60 ± 20		
80 ± 30		
200 ± 50		
Advance taxicab from holding area to terminal area	120 ± 20	150 ± 20
Wait in (short) dispatch line at terminal area (depends on passenger interarrival times)		
48 ± 15	384 ± 60	96 ± 20
60 ± 20	480 ± 80	120 ± 30
80 ± 30	640 ± 120	160 ± 45
200 ± 50	1,600 ± 200	400 ± 75
Advance to passenger(s) pickup point	10	10
Pick up passenger(s)	20 ± 10	20 ± 10
Leave airport; take passenger(s) to destination; return to holding area	3,060 ± 900	3,060 ± 900

[a]Approximately one-half of the passenger demand occurs at the north terminal; the other half occurs at the south terminal.

INTERPRETATION OF RESULTS

Table 3 gives a summary of the principal results from the application of TAXISIM to the taxicab operating system at Detroit Metropolitan Airport. The first line of the table indicates that when passengers were arriving at a rate of 48 ± 15 sec apart (i.e., equivalent to 75 passengers per hour, or 1,050 passengers per 14-hr day), the maximum number of taxis in use at any given time was 82, and the average number was 63. "In use" status refers to the time that elapses between the time a taxicab exits the holding area to the time it returns to the holding area subsequent to providing transportation for a passenger. The last figure given in the average time column indicates that the average "in use" time per taxicab was 3,539 sec, or 58.98 min. The remaining lines in Table 3 can be interpreted similarly. Figure 7 shows an interesting comparison of the maximum number of taxicabs in use as related to the levels of passenger demand measured on a per hour basis.

The single most important figure in Table 3 is the 82 taxicabs, which was the maximum number in use at any time when demand was at the very intense level indicated by the first line of data. Although this demand rate was characterized earlier as the super-peak level, it is interesting to compare the TAXISIM result of a maximum of 82 taxicabs in use with the existing 127 taxicabs authorized to service the airport's needs. Even if an additional adjustment factor of, for example, 20 percent is added to the 82, the resulting 97 taxicabs (1.20 times 82) falls far short of 127. The implication is that the number of taxicabs could be reduced from 127 to 97 with no loss in the ability to meet super-peak levels of demand. Thus, a reduction of 24 percent (127 to 97) in fleet size would not compromise the ability of the taxicab fleet to meet the transportation needs of deplaning passengers.

TABLE 3 Taxicab System: Results of Study

Demand per Day	Demand per Hour	Interarrival[a] Time	Maximum Taxis in Use	Average Taxis in Use	Average Time[a]
1,050	75	48 ± 15	82	63	3,539
840	60	60 ± 20	64	51	3,521
630	45	80 ± 30	53	41	3,628
252	18	200 ± 50	26	21	4,295

[a]All times shown above are in seconds.

ANALYSIS OF POLICY IMPLICATIONS

As shown by the analysis, there is an oversupply of permitted taxicabs servicing the Detroit Metropolitan Airport. This has resulted in loss of revenue not only to the Detroit Metropolitan Airport, but also to the 127 permittees currently providing service. During the past 2 years, the capital equipment of the taxicab fleet and the incomes of those operators currently in the system have seriously deteriorated. Increasing taxicab rates would be one solution, but rates are already comparable to the higher ranges of taxicab rates for other major cities, and an increase in rates would only appear to be "gouging" airline traveling passengers.

Clearly the cause of the problem is underutilization of taxicabs that are in service for less than 4 hr out of a 15-hr work day for an approximate utilization factor of 25 percent. Comparing this utilization factor with taxicab operations in general, such utilization is appallingly low. This explains the low incomes and deteriorating equipment. Were it not

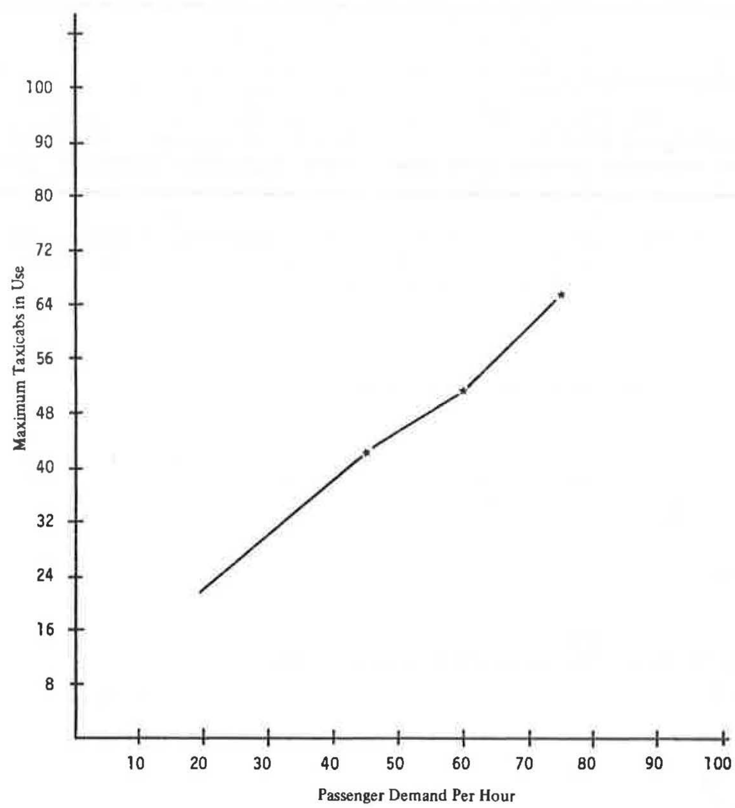

FIGURE 7 Taxicab system: maximum taxicabs in use versus passenger demand per hour.

for the very high unemployment rate experienced by the Detroit metropolitan area over the past 2 years, it is suspected that there would have been a natural decline in the number of taxicab operators at the airport. It appears that most operators are simply "hanging on" with a hope that an upturn in passenger activity will again bring profitability to their operations. As shown by the foregoing analysis, even with a steady increase in airline passenger traffic, it would be a long time before a sufficient volume of taxi demand was generated to fully use 127 permits. Thus, in order to restore profitability to the taxicab operation and to provide a financial framework so that taxicabs can pay their fair share for use of airport facilities, the total number of permits needs to be reduced.

TAXICAB FLEET REDUCTION OPTIONS

As stated earlier, a reduction of approximately 24 percent in the number of permits allocated to taxicab operations at Detroit Metropolitan Airport would not be detrimental to the level of service provided by the taxicab fleet. By decreasing the number of taxicabs and increasing the profitability of remaining taxicabs, new equipment could be purchased and thus increased utilization of the taxicab fleet could be effected.

Several mechanisms could be used to reduce the number of taxicab permits to the recommended level of 97: (a) refuse to grant the right of transferal of permits from one operator to another; (b) refuse to reissue permits as they expire; and (c) coordinate the purchase of 30 permits by the Detroit Metropolitan Area Taxicab Association. Each of these will be discussed in more detail.

The initial mechanism of refusing to grant transferal of permit operating authority would be a passive way of allowing the number of permits to be gradually reduced to the recommended level of 97 or lower, if such were desired. It would, however, place a hardship on those operators seeking to cease business operations and recover whatever investment they had made in their taxicab or purchase of the taxicab and permit if such had been the case. It has been common practice among permit holders to effectively sell their permit by selling their operating license and vehicle to a prospective buyer. It is estimated that the "street" value of a taxicab permit at the Detroit Metropolitan Airport is $4,000. This includes the taxicab, which, in essence, is what legally is being sold to the prospective buyer. Even at these rates, there appears to be a lack of interest in purchasing such operating authority. Thus, inability to sell a permit and a desire to discontinue daily operations would, over time, force a number of operators from the current group of 127.

The second alternative, that of refusing to renew permits as they expire at the 6-year limit, has the added benefit of probably being a faster method to reduce the number of taxicabs and to restore financial health to the entire system. However, this alternative would be somewhat discriminatory in that those operators who had originally purchased taxicab permits and had been in service the longest would be the first to be eliminated from the proposed system.

Purchase of approximately 30 permits by the Detroit Metropolitan Area Taxicab Association would probably be the most equitable and financially sound proposition to restore financial health to the overall taxicab operation. As previously mentioned, the street value of a current Detroit Metropolitan Airport taxicab permit is somewhere between $4,000 and $5,000. Thus, the purchase price of approximately 30 permits would result in a capital investment of as much as $150,000. As indicated in Table 4, the reduction of 30 taxicab permits would permit the remaining operators to achieve on the average one more pickup per day or an additional $20.73 per day in revenue.

Subtracting an estimated marginal cost of providing this additional service would mean an added income of $10.88 per day per vehicle. If $5.00 per taxicab per day were used in a loan repayment fund, $485 per day would be generated by the 97 participating taxicabs. Multiplied by 365 days per year, the fund would generate $177,025, which is more than enough to pay off a $150,000 short-term loan at 15 percent interest. Also the $5.88 additional daily income over expenses received by the taxicab operators would generate a $2,146 marginal increase in revenue per taxicab. Thus, it is further recommended that, after the first year and after the loan repayment has been completed, the $15 per month administrative charge by the Detroit Metropolitan Airport be reinstituted along with the requirement on vehicle age.

It is only through such a reduction in the number of taxicabs serving the airport that a sound financial program for the remaining vehicles can be developed. By reducing the number of taxicabs by approximately 24 percent, financial health will be restored to the taxicab system and the taxicabs will once more be able to pay a fair share for their use of the airport facility.

In the second and subsequent years, it is recommended that additional charges be assessed for upgrading the main holding area for taxicab operations. Currently, the small building that houses restroom facilities in the holding area appears to be inadequate for the number of individuals who use it. Consideration in future years should be given to levying special assessments on the taxicabs for the construction of a new facility that would house a limited number of vending machines and provide a minimum amount of space so that drivers could gather while they were not on call or waiting in line. Self-assessment financing by the taxicab owner-driver themselves should guarantee the nondestructive use of these facilities.

TABLE 4 Financial Analysis of Association Buy Out of 30 Vehicles

Average	Current Taxicab System (127 taxicabs)	Proposed Taxicab System (97 taxicabs)	Changes Under Proposed System
Number of trips per day	3.31	4.33	+1.02
Mileage per day	213.00	278.64	+65.64
Revenue per day ($)	67.18	87.91	+20.73
Variable cost per day (@ $.15/mile)	31.95	41.80	+9.85
Contribution to overhead and average profit per day (exclusive of gratuities) ($)	35.23	46.11	+10.88

SUMMARY

The foregoing analysis has shown how computer simulation in taxicab fleet operation serving major U.S. airports can assist airport policy officials in setting the appropriate number of taxicabs to serve their airport. Airport officials have the responsibility to ensure safe, economical, and dependable taxicab service and should manage this service. Concession agreements that limit the number of taxicabs to those that are economically viable to serve adequate airport passenger demand are simply an extension of good managerial practice on the part of the airport authority.

Through such mechanisms the actual taxicab fare or rate is secondary when the productivity factor of the taxicab fleet is taken into consideration. Objectives of a fair taxicab driver income, good quality service, and adequate compensation to the airport facilities dedicated to taxicab services can be met through operational simulation of the fleet by simple computer programs such as TAXISIM and straightforward business cost analysis. The tools are simple and other airport managers are encouraged to consider their use.

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Comments on Airport Survey Methods Using Schiphol Airport in Amsterdam as an Example

WOLFGANG BLECHINGER, WERNER BRÖG, and H. W. B. MESSELINK

ABSTRACT

Airport surveys are necessary to collect the data needed to analyze and forecast air travel. In this paper Schiphol Airport in The Netherlands is used as an example to demonstrate that it is important to occasionally study and review both the methods used to conduct such surveys and the execution of the surveys themselves. The Schiphol Airport study showed that sampling procedures can cause considerable misrepresentations in the results of a survey. If the so-called last minute passengers are not adequately represented in the sample, for example, the number of persons making private trips is automatically overrepresented. Although it is difficult to interview these last minute passengers, this study shows that it is possible. If the proper methods are used, last minute passengers can be correctly represented in the sample and it is also possible to get them to answer the questions that are most important to the survey. Furthermore, the Schiphol Airport study proved that for normal airport surveys, self-administered questionnaires are not only less expensive than personal interviews, but that passengers also prefer this method of data collection and the results are more accurate.

The growth of air traffic in the late 1960s and early 1970s made the thorough investigation of the need for, and the impact of, a second national airport a matter of vital concern to the Dutch Civil Aviation Authority. It appeared that the Schiphol Airport would soon no longer be able to handle existing volumes of traffic. One of the major problems for researchers working on the project was the lack of adequate data.

Consequently, in 1972 surveys of flight passengers at Schiphol Airport were commenced to collect data on airline passengers. These surveys were conducted under the auspices of a steering group that represented KLM (the national airline), the airport authority, and the civil aviation authority.

These surveys were conducted over the long term; five surveys were conducted every 2 years. Each survey covered a period of 1 week; 20 percent of all departing passengers were interviewed.

At first, all of the groups concerned were satisfied with the results of the surveys. As time passed, however, and it became possible to compare the Schiphol Airport data with other data sources (e.g., household surveys on vacation trips made by plane), the validity of the results of the Schiphol surveys was viewed with growing skepticism.

Increasing computerization, which allowed a much more detailed analysis of the data, reinforced these doubts. It was decided, therefore, that a thorough examination of the existing survey methods was necessary and that a new survey design would have to be developed, on the basis of the most recent developments in survey techniques.

ANALYSIS OF SURVEY METHODS USED TO STUDY VACATION TRAVEL IN THE NETHERLANDS

The vacation travel behavior of persons living in The Netherlands had been studied and analyzed by a number of different research institutes, some of which have been collecting data on vacation travel for many years. The results of these studies, however, varied considerably--especially for some of the important key data variables. [This is also the case in the Federal Republic of Germany (1).] This created a particular problem because when data on the status quo are not accurate, the forecasts based on such data are quite precarious.

The Dutch Ministry of Transport, which was well aware of the problematic nature of the data being supplied, subsequently decided to initiate an evaluation of the ongoing studies (2). The goal of the evaluation was to

- Critically review the survey methods used,
- Evaluate the survey results,
- Show ways to correct biased data, and
- Summarize the steps (still) necessary to provide data that could be used for forecasting.

Surveys Analyzed

In The Netherlands, there are three important empirical studies on vacation travel behavior:

- Vacation Survey conducted by the Central Bureau of Statistics (CBS).
- Continuous Vacation Survey conducted by The Netherlands Research Institute for Vacation and Tourism (NRIT) and the Institute for Social Psychological Surveys and Market Research (PANEL).
- Airport Survey commissioned by the Ministry of Transport (AIR).

The survey methods used in these studies and the goals of the studies varied greatly and cannot be directly compared. Nevertheless, it was surprising--and unsatisfactory to the users of the data--that the basic data on vacation travel in The Netherlands varied so significantly.

The CBS study is the classic study on vacation travel behavior in The Netherlands. In this survey, 4,000 (net) inhabitants of The Netherlands are personally interviewed each year. For 13 years, the contents of this survey have remained basically unchanged. The survey deals exclusively with vacation trips of at least 4 nights' duration.

The PANEL study, which has been in operation since 1980, deals with past vacation trips of at least 4 nights' duration, short vacation trips of 1 to 3 nights, and planned (short) vacation trips. Furthermore, four times during the year (once during each quarter), PANEL does postal surveys that include about 5,000 inhabitants of The Netherlands. The nonrespondents are replaced once a year by some of the (approximately) 15,000 persons included in the entire panel. The persons who are interviewed in the vacation PANEL are also interviewed up to eight times a year on other topics.

The AIR survey of airport passengers deals with all passengers embarking in Holland--most of them at Schiphol Airport. This survey is conducted two or three times a year for periods of one week at a time. Every fifth passenger is personally interviewed in the waiting area after check-in. In 1981 about 75,000 people were interviewed in this way. Although this survey does not represent vacation travel behavior overall, the results are very important for air travel. In this respect it differs from the CBS and PANEL studies.

Differences in the Data Collected by the Various Surveys on Vacation Flights

The comparison of the surveys that follows deals only with those vacation trips made by plane. This is done not only because all three surveys dealt with this type of trip, but also because the impact of the use of different survey methods can be observed particularly clearly for these trips.

A comparison of the results of the three surveys makes it clear that the data vary radically (as can be observed from the following table). If AIR is used as the basis for the number of vacation trips made by plane, the PANEL survey registers only 60 percent of the actual number of trips, and the CBS survey registers only 75 percent. In other words, for every five vacation flights, PANEL had two too few, or AIR had two too many flights. A comparison of the results of the three surveys, based on figures for 1981, is as follows:

	CBS	PANEL	AIR
Vacation flights (in millions)	1.08	0.86	1.44

PROBABLE REASONS FOR DIFFERENCES IN THE RESULTS

It is impossible to explain the considerable differences in the results satisfactorily. Nevertheless, as a result of the experiments that have been performed recently using different survey methods (3), it is possible to estimate the type and extent of errors that cause inaccurate survey results (4). The CBS and PANEL surveys are discussed briefly next, and the AIR survey is discussed in more detail later.

The CBS and PANEL surveys underestimate the number of vacation trips made by plane. In the CBS surveys, the main reasons for this underestimation are as follows:

- The data are not weighted--either sociodemographically (by age and sex, for example) or spatially (e.g., relative to community size);
- Because the effect of nonresponse is not estimated, it is likely that the number of trips reported is too low. People who travel frequently are, naturally, seldom at home, and it is more difficult for the interviewer to contact these people (5).
- It is natural for some people to forget some of the trips they made in the past 12 months (6). This should be taken into account when a survey is conducted.

In the PANEL surveys, most of the inaccuracies in the data were caused by nonresponse and by problems arising from the nature of the panel itself. Because the PANEL survey used both sociodemographic and spatial weighting, and because the reporting period was only 3 months, it is much less likely that the respondents forgot trips that had taken place. Current research on survey methods, however, shows that whenever a panel is used, the panel itself has a specific impact on the survey results (7), although it is almost impossible to estimate satisfactorily the direction and extent of this impact.

In the AIR study, three factors of varying importance caused the number of vacation flights to be somewhat overrepresented. The first, which is the least important and easiest to control, is the fact that the AIR studies include all persons living in The Netherlands, including foreigners. The other surveys only include citizens of The Netherlands; therefore the AIR survey naturally has more trips.

The second important factor is the sampling procedure. In the following section an explanation is given about how this causes the number of vacation trips to be overestimated.

The third factor relates to the qualitative improvement of the results. In the section titled Survey Design Used, the advantages of using self-administered questionnaires rather than personal interviews are discussed.

Sample Design of the AIR Survey

It is possible to determine the actual number of airline passengers because this figure is available from the airline ticket statistics. Figures on passengers become problematical only when subgroups (such as vacation travelers) are being reviewed because the statistics do not differentiate between travel for different purposes. If data on specific groups of passengers are needed, therefore, it is necessary to conduct surveys of the airline passengers.

The overrepresentation of air trips appears to be caused by nonresponse, and the nonresponse problem is a result of the sample design. To make this clear, it is necessary to describe more precisely how the airport passenger surveys are conducted.

In the AIR survey, every fifth flight passenger is interviewed. This quota is always the same, irrespective of the type of flight, that is, whether it is a vacation charter or a scheduled flight, an intercontinental or a European flight, a flight with 30 passengers or 300. This quota system causes a number of problems, not all of which can be solved--meaning that the resulting data are somewhat biased.

Three examples help to demonstrate some of the problems arising from the quota system:

- For charter flights to vacation destinations, all passengers have to be at the airport early. It is easy, therefore, to select a representative sample, and the results of the survey are likely to be correct.
- For regularly scheduled flights with frequent connections--for example, Amsterdam to London--passengers more frequently appear at the gate shortly before departure. This means that when a survey is being conducted, a relatively high number of passengers have to be interviewed in a very short time. It is generally hectic at this time, with both passengers and personnel becoming somewhat anxious in the last minutes before boarding, and it is difficult to organize a survey in which enough interviewers are available during this time. Consequently, it is difficult to interview a representative sample, and the final sample is also unlikely to be representative. An attempt is often made to counteract this problem by sampling an overproportional number of passengers who arrive early, meaning that those passengers who arrive (very) late are generally underrepresented.
- The foregoing problem is aggravated for flights with many passengers, for example, on jumbo jets from Amsterdam to New York. Thus, for these flights, it is even more difficult to obtain a representative sample.

These three examples show that passengers on charter flights tend to be fairly accurately sampled, and the last minute passengers (LMP) (those persons who arrive at the gate just before departure) tend to be underrepresented, whereas those passengers who arrive early for their flights tend to be overrepresented. The LMPs are usually the passengers who fly most frequently, and a large proportion of these persons are business travelers, whereas many of the other passengers are traveling for personal reasons. Thus, it is obvious that the vacation travelers are overrepresented in the trip purpose structure of that AIR survey.

Survey Design Used

As in many other airports, personal interviews are used in the Schiphol Airport surveys. The interviewers are responsible for selecting the sample and conducting the interviews (approximately 3 min each). After close observation of this interview situation, it is doubtful that this approach can produce valid results.

When the interviewers arrive at the gate to begin their interviews, the passengers quickly register what is about to take place. Because only every fifth passenger is interviewed, the interviewer is forced to select those persons to be interviewed. Persons who would gladly be interviewed (because they are bored or curious) are frequently not interviewed, whereas persons who resent being interviewed are asked to answer questions. This means that the general atmosphere in which the interviews are conducted is somewhat tense.

Furthermore, it is natural that the interviewers select those passengers whom they believe will be relatively easy to interview. This also causes the sample to be slanted toward the leisurely vacation traveler, who appears more pleasant to interview, and away from the harried business travelers who are occupied with their papers.

Finally, in airport interviews, as in any interviews, the interviewer might (unintentionally) influence the interviewee's responses. Because the interview is relatively short and very standardized, however, this impact is likely to be minimal.

TESTING A NEW DESIGN

As discussed previously, the surveys that were conducted at Schiphol Airport were not totally satisfactory. The individuals responsible for commissioning these surveys wanted to determine whether the methods used to conduct the surveys at the airport could be improved. The major problem was, naturally, the sample design--especially the LMP problem and the survey method that should be used.

In the following sections, the experiences reported can be applied to other airports, as well as to Schiphol Airport. Those problems that were specific to Schiphol Airport, and that were sometimes difficult to solve, will be discussed elsewhere.

GENERAL EXPERIENCE GAINED FROM THE AIRPORT SURVEY TEST

Self-Administered Survey

The tests that used the self-administered survey technique proved that this method was accepted positively by most passengers. The majority of passengers (many of whom had nothing to do anyway) were willing to carefully fill out the questionnaires in the relaxed atmosphere of the airline terminal.

Certain prerequisites are necessary, however, to ensure the success of this method:

• The interviewers should briefly contact the passengers in a friendly and motivating manner.
• Writing materials, as well as a writing board, should be supplied.
• The questionnaires should be appealing, not too long, and easy to understand.
• The questionnaires for normal and transfer passengers should be identical; the appropriate filter questions should be used.
• The questionnaires should be in the mother tongue of the respondent.
• One contact persons should be present to answer any possible questions and to collect the questionnaire.

The tests showed that one major advantage of using written questionnaires instead of personal interviews was that, within the same period of time, fewer personnel could handle a much larger number of respondents. Furthermore, as has already been repeatedly demonstrated (8), when the respondents fill out the questionnaires, the results are more valid. This is primarily because the respondents have more time to consider their answers, all the respondents have an identical questionnaire, and the interviewer cannot introduce bias into the responses. Moreover, the respondent is not put under direct psychological pressure by the interviewer; therefore, the entire process is more harmonious--a fact that is evident even to external observers.

Sample Design

When the survey is conducted in written form, one important technical problem is already solved. The tests showed that the same number of personnel can handle many more respondents. Also, the quota system was not necessary because all passengers could be included in the survey. The only remaining problem was the problem of the LMPs. It was necessary to treat these passengers specially.

The LMP survey had to be conducted by using personal interview techniques, and the number of questions asked had to be reduced to a minimum. The interviewers used the normal written questionnaire forms, but asked the passengers to answer only the first four or five questions. If there was enough time, the interviewer asked as many of the questions used in the normal questionnaire as was possible. However, this was not to be done if it meant that other LMPs arriving at the gate would be overlooked.

As departure time approaches, it becomes increasingly difficult to interview the LMPs because these last passengers, as well as airline personnel, tend to become anxious. During the test it became evident that this problem could be dealt with if the interviewers approached the passengers as far away from the gate as possible and personally interviewed the passengers on their way to the gate. The airline's ground personnel also had no objections to these interviews because they caused no delays.

Importance of the Interview Team

Finally, the importance of the interview team used for such surveys must be stressed. A special type of interviewer is needed to deal with the relatively sensitive target group at the airport.

It proved useful to divide into teams with one supervisor for every one to five interviewers. The supervisor was in charge of organizing the survey with the main task of leading the team and giving interviewers instructions when necessary. The supervisor is especially important at the point when the written questionnaires are no longer used and the LMPs have to be personally interviewed. It is important that the team (i.e., the supervisor and the interviewers) be able to work together smoothly and that all persons on the team know what is expected of them.

The interviewer is especially important when written questionnaires are used instead of personal interviews. It is more difficult to interact with a large number of passengers for a short period of time than to spend more time personally interviewing only a few passengers. Even if the interviewers are under the direction of the supervisor, it is important that they be able to think independently; supervisor and interviewers need to form a smoothly functioning team.

CONCLUSION

An analysis of surveys on vacation travel behavior in The Netherlands has shown that the basic data from different surveys varies considerably. This was also the case for vacation trips made by plane. The Ministry of Transport wanted the results of the airport passenger survey to be critically and objectively reviewed.

It was possible to show that the sample design that was being used to determine the number of passengers making vacation trips resulted in an overrepresentation of these trips. The charter and vacation passengers, who usually arrive well in advance of their departure time, are easily interviewed, whereas passengers who arrive late (last minute passengers), and who are frequently either passengers who fly often or business travelers, can only be interviewed with great difficulty. This results in overrepresentation of travelers making vacation or other private trips.

By treating specially last minute passengers (using short personal interviews), it is possible to correctly represent this group. It was also shown that for normal airport surveys the use of self-administered questionnaires is preferable to personal interviews for a number of reasons. Written questionnaires are more economical, more pleasant for the respondents, and the results are more valid.

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Helicopters and Urban Communities

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ABSTRACT

The principal beneficiary of helicopter services is the urban community, and the growing presence of helicopters in metropolitan areas, now a factor in the management of urban land and airspace resources, has elicited controversy. The benefits and the social costs of helicopter operations in urban communities are addressed, and the steps taken to enhance the benefits and minimize the costs are identified. Three issues are examined: (a) heliports are far less obtrusive in the urban environment than has been believed; (b) the helicopter's benefit to communities is principally transmitted through businesses; and (c) the issue of land use, particularly the allocation of land resources to heliports, is widely misunderstood. Specifically addressed are the two familiar costs of community helicopter operations, noise and anxiety; and a third, less obvious social cost, that of foregone opportunity. Steps taken by members of the helicopter community to enhance benefits and minimize costs are described. These steps involve both technology and communications. In the longer run, however, these improvements go beyond the amelioration of social costs--they reflect understanding between helicopter operators and the communities they serve, and they reflect a convergence of their objectives.

Although helicopters have been produced and sold since 1939, the modern-technology civil helicopter, as such, is largely the result of technology transfer from the Vietnam War period. The acceleration of civil helicopter technology since 1970 is analogous to that of fixed-wing technology after World War II--marked by quantum improvements in performance, reliability, and cost, which combine to clothe rugged military aircraft in the amenities and economics of commercial aviation.

This evolution has been accompanied by a dawning realization that the principal beneficiary of helicopter services is the urban community. Helicopters have provided unique, essential, and often dramatic services in rescue, air taxi, medical evacuation, police work, high-rise construction, and even the rapid clearing of financial paper. All of these services contribute meaningfully to the preservation and even the enhancement of the increasingly compromised amenities of urban life. This unique service value to the community is perceived by urban political and business leaders, whose demand for helicopter services has drawn helicopters to metropolitan areas in growing numbers.

In the past 20 years, the number of helicopters in major metropolitan areas has grown at an annual rate of about 15 percent--twice the rate for the country as a whole. The presence of helicopters has now become a factor in the management of urban land and air-space resources, and like other resource users, helicopters and their necessary heliports have elicited controversy. Most community leadership, mindful of overriding benefits, considers helicopters a necessity--not unlike factories and freeways--whose inherent inconveniences are an acceptable part of the metropolitan equation. Others, however, consider helicopters as potentially noisy and intrusive and either do not understand or do not accept their necessity. The issue is one of perception: the external costs of urban helicopters (e.g., noise) are obvious; the benefits are not always obvious, because they are generally indirect.

Both the benefits and the social costs of helicopter operations in urban communities are addressed in this paper, and the steps taken to enhance the benefits and minimize the costs are identified.

BACKGROUND

The genesis of this analysis was a continuing investigation by helicopter manufacturers and operators, independently and under the aegis of the Helicopter Association International (HAI), into the economic and social functions of their products. An extensive benefit-cost analysis was begun in 1982, and early results of that work were presented at the HAI Annual Meeting in February 1983.

A major premise of that study was that heliports provided significant direct financial benefits, specifically municipal revenues, to their communities. The first tentative conclusion of the 1982 analysis, however, was that the premise was not well-founded. A survey of major public-use heliports produced evidence that direct financial benefits were not well-perceived and were either marginal or nonexistent, except for the four public-use heliports in New York City.

At the same time, three other conclusions that led to further analysis were reached in the 1982 study. First, heliports were far less obtrusive in the urban environment than had been believed. Second, notwithstanding the obvious considerations of public services, the helicopter's benefit to communities is principally transmitted through businesses. Third, the issue of land use, particularly the allocation of land resources to heliports, is widely misunderstood.

EXAMINATION OF MAJOR ISSUES

Heliports Are Generally Considered Innocuous

Benefit-cost analysis must rest on actual experience, and a survey of heliports was conducted over a period of 18 months by telephone, mail, and personal visit. The survey covered the 17 public-use heliports in cities of more than 250,000 population. The heliports are rarely elaborate. Many are only sidelines to larger business operations, and only five enjoy the services of a full-time, fixed-based operator. A summary of the character of these heliports is given in Table 1.

There was no difficulty in rationalizing the social value of the four heliports in New York City because they contribute significantly to municipal revenues. Representatives of the remaining 13 heliports had difficulty explaining their value in terms that could be quantified, but their arguments rested on three basic principles.

First, heliports are not obtrusive politically or financially. They require small outlays, much of which can be federally funded. They are easily established and just as easily disestablished if the initial development proves unsatisfactory or inappropriate. Unlike buses or taxis, they add no regulatory burden to the community; and on the air side they operate outside of existing traffic and are not directly competitive with municipal airports as revenue producers.

Second, heliports provide exceptionally good comparative value as a public utility. For example, a study of investments undertaken by the Port Authority of New York and New Jersey concluded that the four New York heliports had drawn less than $3 million in all costs since their implementation, compared with $1.5 billion for the West Side Bus Terminal and $3.5 billion for JFK Airport. When compared with the annual traffic through these facilities, the heliport system is twice as productive in investment cost-per-passenger as the bus terminal and nearly 10 times as productive as JFK.

But the dominant theme in the heliport survey was one of indifference. Few public-use heliports provide municipal revenues at all, and fewer serve the general public (as opposed to business and government interests); but three-fourths of them report no community opposition, and none of them report a serious community threat to present operations. No serious objections to a heliport had been filed once the heliport had been established. Some of these heliports have been in operation for more than 20 years.

Community Benefits Are Transmitted Through Businesses

This issue rests on the value of the helicopter to business and the value of business to its community. An interesting perspective on the emergency of the modern business helicopter is its evolution from

TABLE 1 Metropolitan Public-Use Heliports[a]

City	Annual Traffic Operations	Location	Maximum Landing Fee ($)	Heliport Development Funds	Profitable
Baltimore	520	Waterfront	2	Public	Yes
Cincinnati	20	Downtown rooftop	25	Private	No
Cleveland	2,200	Waterfront	2.50	Public	Yes
Columbus	120	Downtown ground level	15	Private	Yes
Denver	900	Downtown ground level	10	Public	Even
Detroit	75	Convention center rooftop	6	Private	No
Indianapolis	3,000	Downtown ground level	None	Public	No
Memphis	200	Waterfront	None	Private	No
Miami	5,000	Island	None	Private	Yes*(sic)*
New York *(3)*	114,000	Waterfront	40	Public	Yes
Newark	400	Waterfront	None	Public	No
Philadelphia	1,800	Waterfront	15	Private	No
Pittsburgh	300	Waterfront	4	Public	No
Toledo	50	Downtown rooftop	25	Private	No

Source: Aerospace Industries Association Heliport Directory and personal interviews.

[a]Not including heliports on fixed-wing airports.

convenience to routine and then to essential. Today's business environment demands productivity, and the inevitable involvement of business with the urban complex makes productivity in its transportation a difficult challenge. The helicopter provides this productivity by reducing the travel time not only of chief executives but also of the growing number of professional and managerial workers for whom mobility is a primary job characteristic. The value of that travel time is a hard number to determine. Efforts have been made to tie it to company sales and to executives' positions in their companies, and these result in a range of time values between $10,000 and $50,000 per hour (sic) for the management of hundred-million-dollar firms.

Whether this enigmatic value can ever be determined is not really important: the value to a company of its management and professional employees is far greater than their salaries, and that value deteriorates when they are trapped in traffic and unable to perform their professional functions. The rapidly growing number and sophistication of business helicopters is evidence of the importance of vertical mobility in this environment. This has not gone unnoticed by corporate location analysts, who increasingly reject prospective plant sites that do not provide for helicopter access. That need arises from the character and function of "the new corporate headquarters," analyzed recently by The Conference Board (1), whose helicopters free them from the confines of congested cities while maintaining their necessary linkage to financial and commercial centers.

Examples of helicopter-assisted management productivity abound. Prudential Insurance Company, operating from the public-use heliport in Newark, New Jersey, logged 195 hr of executive travel in 1983, compared to nearly 700 hr of equivalent trip time by car. The company saved 500 hr, roughly one-fourth of a working year. Union Carbide Corporation's 1978 move of 1,100 employees from Manhattan to new headquarters in Danbury, Connecticut, was contingent on approval of its heliport, from which Union Carbide inaugurated a helicopter shuttle of three daily flights to Manhattan and the New York airports (2).

Thus, the large corporation must be in two places at the same time: at the metropolitan periphery, where it lives and manufactures; and in the center, where it does its financial maneuvering and decision making. This leads to an expensive network of cross-hauling that is the classic urban transportation problem, and that leads to inefficiencies in the linkage between corporate operations and corporate headquarters. It is these inefficiencies that have motivated so many corporations to abandon urban centers for suburbs that appear (at least superficially) to satisfy their locational requirements. But the central city still does best those activities that depend on rapid communication and face-to-face contacts; and, despite its high labor costs and crowded land--or perhaps because of them--the resource potential of the urban core remains great. Access to the core from the new corporate hinterlands requires the vertical mobility of the helicopter. And this is not exclusively a megacompany phenomenon--the billion-dollar corporations that make up the Fortune 500 account for less than 7 percent of today's business helicopter fleet.

This leads to the discussion of the importance of business itself to its own community, an oddly elusive bit of data. It was clear in the preliminary study that very little work had been done to estimate the importance to a community of the kinds of activities that make the most use of helicopter transportation. These again are largely corporate headquarters functions, which are not generally the subject of community based studies. The study group itself therefore undertook to analyze the effect on community economic welfare of such corporate headquarters' activity.

The method of analysis and detailed conclusions are available in an unpublished report titled Corporate Headquarters Relocation: The Analysis of the Economic Impact on a Community. Most interesting were the effects of corporate headquarters on property values and the multiplied benefits of the corporate payroll. A study of the grand list (or total value of real property) of a number of southern Connecticut communities shows disproportionately large increases in the valuation of real property in the towns of Danbury, Fairfield, Greenwich, and Stamford during the last 15 years. The responses of those four towns to the relocations of Union Carbide Corporation, General Electric Company, American Can Company, and other Fortune 500 companies is clear and dramatic (see Figure 1). Between 1965 and 1982, grand lists of corporate cities in Connecticut increased by more than 500 percent, more than twice the increase for all other neighboring cities with comparable populations. In general the study concluded that the value of corporate headquarters' relocation to a host community averaged $100 million in annual sales, $1 million to $3 million in annual property taxes, 3,500 secondary jobs, and intangibles such as senior executive participation in community planning and management.

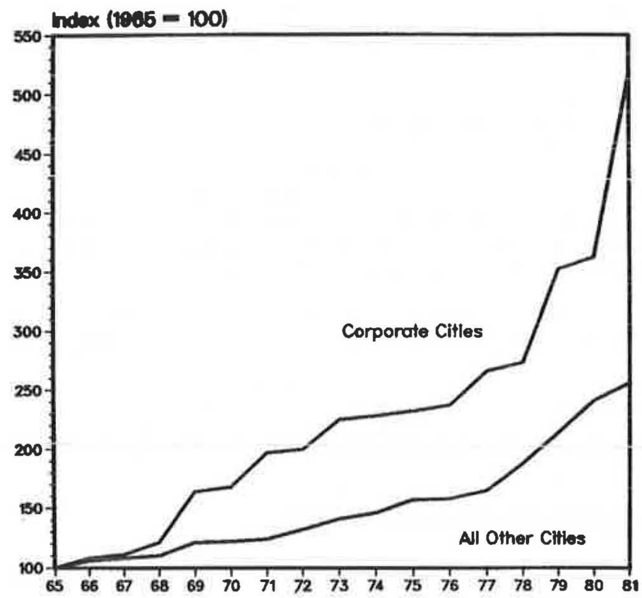

FIGURE 1 Grand list of corporate cities in Connecticut.

The Fundamentals of Sensible Land Use

The traditional battles over the allocation of urban land to transportation, and particularly to heliports, have been fought over the preservation of privacy and the security of residential property. There should be no controversy here, because it is clearly unreasonable to preempt residential land for heliports. But more important, heliports can best serve urban communities when located away from residential land. They should be on or contiguous to commercial or industrial land, which generates the predominant share of their traffic. Moreover, industrial land, with its inevitable rail lines, waterways, and circumferential highways, means clear areas for aircraft approaches and departures as well as a natural masking of whatever noise may be generated at the heliport itself. This confluence of rail, water, and highways also suggests transportation centers through which the helicopter can contribute to intermodal synergy.

Surprisingly, the land use controversy now surrounds the allocation to helicopter operations of what should be noncontroversial land, which reflects a serious ambiguity in urban planning.

The most provocative example of this misunderstanding is a disturbing tendency to reserve highly productive harbor real estate for parks, playgrounds, high-rise apartments, and restaurants. Without denying the right of these activities to suitable real estate, and without even denying the necessity for esthetically pleasing facilities for urban living and recreation, the fundamentals of effective land use are undeniable, and the preempting of essential haborfront activities is counterproductive at best and dangerous in the long run. The situation is exacerbated by the eventual inability of these esthetic and recreational activities to coexist compatibly with modern commercial heliport facilities, which by their nature are necessarily noisy and intrusive within the fairly well-defined perimeter of their activity. But it is intuitively known that harbor sites can be reserved for both kinds of activities if both of them are carefully planned and carefully contained.

Going beyond intuition, Stokes (3) and his staff at the Urban Management Institute have been able to quantify the value of harbors to America's cities, and Stokes' recent study of 11 major U.S. waterfront cities has quantified the effect of heliports on harbor productivity. His conclusions are that harbors are far more productive and far more critical to the prosperity of major cities than had been believed, and that the tendency to shift their function from commerce to esthetics is potentially damaging. He concludes further that harbors are essentially comfortable with heliports, their attributes being compatible and consistent with the commercial function of the harbors themselves. Specifically, an analysis of the dimensions of harbor activity and the impact of additional investment on harbor productivity indicates that a heliport investment of $1 million would increase commercial activity by about 1 percent and would add 18 jobs equivalent to annual wages of about $350,000 a year to the community. Although these numbers are not very large, neither is the initial investment. The heliport investment in a harbor environment would generate wages equal to the initial investment in less than 3 years--clearly more productive than alternative investment in recreational facilities.

SOCIAL COSTS

An inventory of social benefits should be compared with concomitant costs in one way or another. The two most familiar costs of community helicopter operations are noise and anxiety. These are euphemistic terms, because the issues really relate to the community's perception of intrusion into its privacy and compromise to its safety. More fundamentally, even the issues of privacy and safety are only skirmishes in the real battle--the battle for the allocation of scarce urban resources. (It is interesting that noise and safety arguments are typically raised against proposals for new heliports, but once the land use issue is resolved, whether for or against the heliport, these arguments are rarely raised again.) These are not new issues in transportation--any transport innovation carries with it a real or perceived threat to privacy and safety, even to those who stand to benefit the most. The history of transportation in urban communities is in fact a history of volatile hearings, environmental impact arguments, and exaggeration of the issues on both sides. But the issues are real, if only because they are perceived to be real by the public.

A third and somewhat less obvious social cost is opportunity cost. The impact of opportunity cost on heliport development is significant, because it is difficult for political leaders who must be accountable to an electorate every 2 or 4 years to set aside near-term revenue opportunities for admittedly needed heliport facilities whose payback is either long term or intangible. In one recent case, for example, the last barrier to setting aside downtown real estate for a heliport with obvious long-term benefits was the city's reluctance to part with smaller but immediate revenues from parking meters that occupied the site.

UPGRADING THE EQUATION

It was a premise of this discussion that helicopters and heliports are increasingly perceived as an essential part of the metropolitan equation. Like other systems of metropolitan transport, they carry a cargo of costs and benefits. The growing demand for private helicopters and urban access suggests that the benefits outweigh the costs.

Yet steps have been taken by the helicopter community to further enhance the benefits and minimize the costs. These steps involve both technology and communications.

On the aircraft side, technology advances of the last few years have addressed the primary social costs. Significant noise reduction has been achieved through aerodynamic changes that eliminated the notorious slap of the two-bladed rotor and dramatically softened the noise signature even of conventional rotors. Changes in gear design have reduced the whine of helicopter transmissions and engines. Helicopter safety and reliability, never as great a horror as might be inferred from the publicity, and actually better than comparable fixed-wing general aviation, is a continuing concern of the manufacturers. Component redundancy, better materials and tougher testing, and especially the large-scale shift to twin engines tend to eliminate public anxieties about urban helicopter operations.

These technological advances carry with them substantial reductions in manufacturing and operating costs, and further advances now on the boards will reduce costs even more dramatically--perhaps by as much as 30 percent by the end of the decade. In addition, the cruise speed of the 1990 helicopter will exceed 180 knots, and the effect of the increased speed and reduced costs could cut seat-mile costs by one-half. At that time intercity helicopter service, now beyond the economics of any existing rotorcraft, could significantly expand the value of helicopters and heliports in urban communities.

At the same time, the Federal Aviation Administration (FAA) has now stepped forward to lead the integration of helicopters and heliports into the national transportation system. As a result there has been rapid improvement in all-weather operating capabilities, accelerated development of exclusive and safe helicopter airways, and improved, uniform guidelines for heliport location and construction.

Perhaps most important in upgrading the equation, the helicopter operating industry has begun to police itself. Like fixed-wing aviation before it, and the trucking industry before that, helicopter operators have come a long way from the barnstormers of the 1960s. They have become increasingly sophisticated, responsible, and sensitive to the inescapable relationship between financial success and community acceptance, and through the Fly Neighborly program, helicopter operators have imposed a discipline on themselves.

Fly Neighborly is a voluntary noise-reduction program for all types of civil, military, and government helicopter operations. Through broadly sponsored regional seminars, the program makes pilots aware of the noise they might generate and trains them to minimize it through better operating techniques and route planning. It stresses openness, speaking to the community about what the helicopter is and what is is not, and listening to the community's concerns. The result of this new dialogue is the accommodation of helicopters to acceptable community standards of noise and intrusiveness and the informed accommodation of communities to helicopters.

In the longer run, these improvements go far beyond the amelioration of social costs--they reflect an understanding between helicopter operators and the communities they serve, and they reflect a convergency of objectives that can make their achievement a reality.

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