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# INDICATORS OF GENERAL AVIATION ACTIVITY FOR PLANNERS OF SMALL COMMUNITIES

Thesis for the Degree of M. U. P.

MICHIGAN STATE UNIVERSITY

John T. Smith

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ABSTRACT

INDICATORS OF GENERAL AVIATION ACTIVITY
FOR PLANNERS OF SMALL COMMUNITIES

by John T. Smith

The value of an airport and aviation to a community has long been recognized by those who have a financial or aeronautical interest in aviation. Community planners and city officials, however, often have not given adequate recognition to the value of the airport to the community. This is especially true for smaller cities where general aviation activity (i.e., all civil air traffic except scheduled airlines) may be the only aviation activity. The basic problem, then, beyond that of increased awareness of the value of general aviation, is one of determining the potential general aviation activity of existing or possible airports so that more adequate and realistic plans can be made.

This thesis points out first what general aviation is and the part it plays in the total air transportation system. Examples of general aviation activity are given as well as its effect on the growth of a specific southern community. Various studies are reviewed which outline in considerable detail the characteristics of the people who fly,

i.e., their income, education, and occupation. Covered last is general aviation use by different industries.

In an approach to the problem of determining potential general aviation activity, a study of the characteristics of forty-eight Michigan cities within the population range of 2,500 to 50,000 was undertaken. All characteristics were based on data published in the U.S. Census of Population: 1960. The objective of the study was to determine what, if any, community characteristics relate to general aviation activity. Two separate methods of analysis were used to determine which characteristics were related to general aviation activity. The related characteristics were then tested on certain cities with known activity levels as a check on their degree of accuracy.

It was found that nine of the twenty-eight characteristics considered, when used together, could be useful in determining potential general aviation activity. Indicators relating to the agriculture and finance industries proved most related to general aviation activity as did the indicators related to agriculture and management occupations. Examples are given of how the indicators might be of use to community planners and aviation agencies when studying a given community.

# INDICATORS OF GENERAL AVIATION ACTIVITY FOR PLANNERS OF SMALL COMMUNITIES

By

John T. Smith

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are made for the cooperation and understanding shown by all who gave assistance to this undertaking, not the least of whom were Ward J. Mayrand, Donald A. Krueckeberg, Charles A. Hansen, and my wife.

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# INTRODUCTION

> Plaintiff argues that the acquisition of an airport or landing field is not a city purpose, even if a public one, and that the bonds, if issued, will be void. We think the purpose to be served is both public and municipal. A city acts for city purposes when it builds a dock or a bridge or a street or a subway. Its purpose is not different when it builds an airport. Aviation is today an established method of transportation. The future, even the near future will make it still more general. The city that is without the foresight to build the ports for the new traffic may soon be left behind in the race of competition. Chalcedon was called the city of the blind because its founders rejected the nobler site of Byzantium lying at their feet. The need for vision of the future in the governance of cities has not lessened with the years. The dweller within the gates, even more the stranger from afar, will pay the price of blindness.[1]

The value of an airport and aviation to a community has long been recognized by those who may have a financial or aeronautical interest in aviation. This value has also been recognized by the courts. Nearly forty years ago Justice C. J. Cardozo of the New York Court of Appeals, in ruling for the city of Utica, New York, handed down the above statement as part of his ruling that the city had a

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[1] Hesse v. Rath et al., 164 Northeastern Reporter, p. 342, December 7, 1928. Reprint obtained from Piper Aircraft Corporation, Lock Haven, Pennsylvania.

right to issue corporate bonds to purchase land on which to establish an airport.

Community planners and city officials, however, often have not given adequate recognition to the value of the airport to the community. This is particularly true in the smaller cities where general aviation activity (i.e., all civil air traffic except scheduled airlines) may be the only aviation activity. The words of Justice Cardozo are even more timely today because of the advancements made in the field of aviation, and particularly general aviation, than when they were written in 1928.

This thesis attempts to point out in the first chapter what general aviation is today. Special attention is given to the magnitude of general aviation and how it has effected people and business. A specific example of its effect on a community is related to help point out the importance of this segment of the air transportation system. Various studies are then reviewed concerning the people who fly--who they are and why they fly.

The second chapter is based on a study of the characteristics of forty-eight Michigan cities within the population range of 2,500 to 50,000. The objective of the study was to determine what, if any, community characteristics relate to general aviation activity. Two separate methods of analysis were used to determine which characteristics were related to general aviation activity. The related

characteristics were then tested on certain cities with known activity levels as a check on their degree of accuracy.

The final chapter combines the findings of the study of Michigan cities with the nature of general aviation as outlined in the first chapter in order to arrive at some indicators of general aviation activity. Examples are given of how the indicators might be used by community planners and aviation agencies when studying a given community. It is hoped that the indicators will be of value in better understanding and evaluating the value of airports in small communities.

# CHAPTER I

## GENERAL AVIATION TODAY

In the last sixty years aviation has developed from virtually nothing to its present position as one of the most important components of the national transportation system. To many persons and many communities, however, aviation is thought of only in terms of the scheduled airlines or air carriers. Often overlooked is the largest segment of aviation, commonly called "general aviation." The term "general aviation," as widely used by aviation agencies and the aviation industry, may be defined as all air traffic except that of the military and scheduled airlines.

A few areas of comparison between general aviation and scheduled airlines will help point out the importance of general aviation in the area of air transportation. Of the 90,935 active aircraft registered with the Federal Aviation Agency at the beginning of 1965, general aviation accounted for 88,742, air carriers only 2,081.[2] Of the 9,490 airports on record at the beginning of 1965, 8,791 were general

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[2] FAA Statistical Handbook of Aviation (Washington, D.C.: U.S. Government Printing Office, 1965), pp. 53-54, 77.

aviation airports and only 709 were airports with regular airline operations.[3] The charts on the following page show the percentages of planes in the air and hours flown for the three types of aviation activity.

As suggested above, this prominent role of general aviation is too often not realized by those in a position to capitalize upon it most, namely, the community officials, leaders, and planners. As pointed out in a report by the Eastern Region of the Federal Aviation Agency, "community officials all too frequently have failed to recognize that the airport, and the business it generates, is an economic asset that should be afforded every protection possible to assist in maintaining economic flexibility of the communities which it serves."[4] They go on to say that "failure on the part of a community to incorporate its airports into the community development plan can be attributed to ignorance of the importance of aviation in the scheme of transportation."[5] With this in mind, it is important that planners obtain a better understanding of aviation, and general aviation in particular, so they will be able to recognize the impact of general aviation upon future community growth and then

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[3] Ibid., p. 5.

[4] General Aviation and Its Relationship to Industry and the Community (Jamaica, New York: Federal Aviation Agency, Eastern Region, Airports Division, 1964), p. 4.

[5] Ibid., p. 5.

Chart 1. Planes in the air*

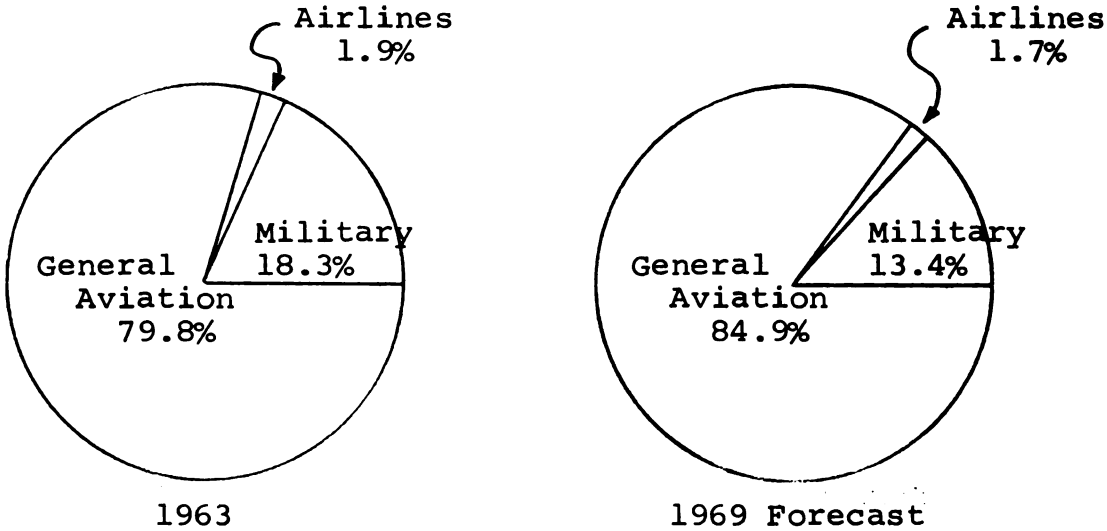
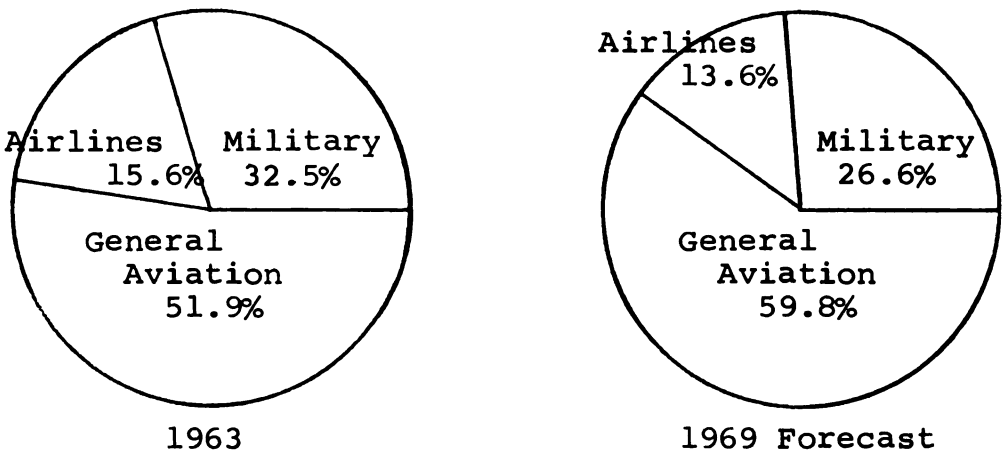



Chart 2. Hours in the air*




*Source: General Aviation--Today and Tomorrow.

prepare a development plan which is more realistic and that better serves the needs of the community.

## General Aviation

General aviation may be broken into four basic categories or types of flying. They are business flying, commercial flying, flight instruction, and personal or pleasure flying. Business flying covers the use of private aircraft as a means of transportation in the conducting of some business enterprise. During 1962, a business fleet of approximately 34,000 airplanes flew a total of 5.5 million hours.[6] Flying for business purposes accounts for about thirty-seven per cent of the total general aviation hours flown.[7]

Commercial flying includes the use of private aircraft to perform a service for hire. Examples of this type of use are air taxi and charter flying. This type of flying amounts to about twenty-one percent of the total general aviation hours.[8]

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[6]Joseph T. Geuting, Jr., "General Aviation: What It Is and Why Important to You," Speech given at NAEC Annual Meeting, Miami Beach, Florida, July 10, 1963, p. 6. (Mimeographed.)

[7]Robert L. Parrish, "General Aviation 1966," The AOPA Pilot, IX (March, 1966), 28.

[8]Ibid.

The smallest segment is that of flight instruction. It accounts for about eighteen percent of the total general aviation hours.[9]

The last group, personal or pleasure flying, covering those persons who fly strictly for the fun of flying, accounts for about twenty-four percent of the total hours.[10] This is the fastest growing type of flying and in the last five years has increased more than fifty percent.[11]

From these four categories it is easy to see that general aviation covers a broad range of aviation activity. Specifically, it might be worth elaborating on some of the ways private aircraft are used. As Senator Proxmire read into the Congressional Record, "so conglomerate is the mixture of people, business, aircraft and activities, that while the term 'general aviation' is hardly descriptive, it is about the only one that describes it all."[12]

The use of general aviation aircraft has done much to improve farming and ranching. Nearly every kind of crop can be treated in some manner with the use of aircraft, from

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[9] Ibid.

[10] Ibid.

[11] Geutling, "General Aviation: What It Is and Why Important to You," p. 6-7.

[12] William Proxmire, "Significance of General Aviation to the National Economy," U.S., Congressional Record, Senate, 1962. Reprint obtained from Piper Aircraft, Lock Haven, Pennsylvania, p. 1.

seeding and fertilizing a new crop to weeding a more mature crop. Ranchers inspect fences and pastures from the air as well as note livestock movements.

Forestry has been effected much the same way as agriculture. Of primary importance is forest preservation, ranging from fire spotting to fire fighting with the dropping of men and equipment by parachute.

The airplane has even had its influence on real estate development. A new subdivision in Fresno, California, provides for the aircraft to be taxied from the landing strip right up to the owner's residence and parked under his planeport next to the house.[13]

The use of private aircraft has effected the recreation and pleasure patterns of many people. Many dude ranches, hunting and fishing lodges, and resorts of all kinds have put in landing strips for their guests. Boyne Mountain ski lodge is but one example here in Michigan of a resort, with an airstrip adjacent, which attracts many pilots.

Aircraft are widely used in politics and government, too. Few are the candidates aspiring to a major political office who don't make use of private planes in some manner in meeting their tight campaign schedules. Various levels of government use the personal airplane, from transporting

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[13]"An Aviation Subdivision," Urban Land, XXIV (February, 1965), 9.

the President or the Governor, to highway patrol and aerial survey work.

Not only has general aviation had a tremendous effect on other business activity, as evidenced from many of the examples above, but it has spawned a whole host of enterprises just to serve itself. Different manufacturers produce a wide variety of equipment necessary for aircraft operation, including engines, tires, and radio and electronic equipment. At most any airport can be found all sizes of businesses which repair and maintain the aircraft, train pilots and mechanics, as well as provide special services such as air taxi, charter flying, and crop dusting.

Most of the examples cited thus far relate to those persons who already fly or are aware of the value of general aviation. Not to be overlooked is the effect the airport has on those who do not fly. A recent article in The AOPA Pilot[14] gave an example, which is worth repeating here, of the value of an airport to a community.

The people of Cartersville, Georgia, were seeking to attract a branch plant of the Oster Company with a potential employment of five hundred to six hundred people. The city did not yet have an airport even though it had one planned. In deciding for Dayton, Tennessee, over Cartersville, the

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[14]Charles Spence, "Airports Are for People Who Don't Fly," The AOPA Pilot, IIX (September, 1965), 28.

vice president in charge of manufacturing wrote the mayor of Cartersville: "I feel quite certain that had Cartersville had an airport adjacent to the town, our decision probably would have been in favor of Cartersville. Unfortunately, we cannot wait until an airport is built before opening our next facility."[15]

The United States Chamber of Commerce has estimated that for every one hundred new factory jobs there is $710,000 more annual personal income. This means $331,000 more in retail sales, $229,000 more in bank deposits, 97 more automobiles, 3 new retail businesses, 65 new non-manufacturing jobs, and a population increase of 359.[16] It is not too hard for the people of Cartersville to figure out what over one-and-a-half million dollars a year in retail sales would mean to their community.

This is not just one community in Georgia, though. This is repeated over and over each year in communities everywhere, even in Michigan. And it is not just any airport over no airport, either. A well-kept airport with adequate facilities, one which the people are proud of, means much more than the run-down airport with weeds growing all around.

Another major benefit of the airport is bringing transient money into the community. The Michigan Aviation

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[15] Ibid.

[16] Ibid.

Fact Finder Survey, which studied aviation activity at Michigan's licensed airports in 1962, found that the average expenditure for a non-resident general aviation pilot was $15.44 while for non-resident general aviation passengers the amount was $21.34.[17] This amounted to about fifteen thousand dollars to twenty thousand dollars annually for some of the less active airports to well over five hundred thousand dollars annually at some of the more active airports. And this is just by general aviation pilots and passengers, not airline passengers.

The reason aviation and an airport can mean so much to a community is more easily understood when looking at the people who fly and their reasons for flying. Their use of the airplane gives a better idea of the potential at some communities as well as pointing out those to whom it has the greatest importance.

Looking first at new pilots, why do they learn to fly and what are some of their characteristics? A recent survey from Time gives some of the necessary information from those who obtained a private pilot license in 1963.[18] Fifty-seven percent of those surveyed listed pleasure as their main reason for flying, while forty percent combined

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[17] Michigan Aviation Fact Finder Survey (Lansing, Michigan: Michigan Department of Aeronautics, 1963), p. 7.

[18] New Pilots, A Survey of the Individuals Obtaining Pilot's Licenses in 1963, Research Report 1301 (New York: Time Marketing Information, 1964).

business and pleasure. They felt the most important benefits of flying were that it was fun and enjoyable, was stimulating and challenging, saved time (convenience), and was a safer method of travel.

The new pilots were well educated, with seventy-five percent having gone to college. Their median family income was $10,110 a year. They were a fairly young people, having an average age of 31.6 years. The largest area of employment was listed as business, accounting for sixty-seven percent of the total. Among the professional, those persons in medicine were the most apt to fly.

Since business was the largest category for the new pilots, it was broken into type and job title. Manufacturing lead the list, followed by Construction/Engineering/Architecture, Transportation/Communication/Public Utilities, Retail, Service, and Finance/Real Estate/Insurance. As to the position within the business of the new pilots, Top Management accounted for thirty-one percent; Middle Management, and Professional and Technical, each twenty-one percent; Other White Collar, eleven percent; and Blue Collar, fifteen percent. Tables 1, 2, and 3 show the personal characteristics, occupation, and employment capacity of the new pilots along with that of two other pilot groups discussed later.

Table 1. Personal characteristics

| | New Pilots | AOPA Profile | New Plane Purchasers |
|---|---|---|---|
| Average Annual Income | $10,110 | $18,499 | $33,333 |
| Education | | | |
| College graduate or beyond | 42% | 47% | 42% |
| Attended college | 33% | 26% | 26% |
| High school graduate | 20% | 20% | 22% |
| Some education but not high school graduate | 5% | 7% | 10% |
| Average Age | 31.6 yr | 41.9 yr | 43.4 yr |

Table 2. Occupations

| | New Pilots | AOPA Profile | New Plane Purchasers |
|---|---|---|---|
| | (%) | (%) | (%) |
| Business | | | |
| Manufacturing | 24 | 20 | 21 |
| Wholesale | 4 | 3 | 4 |
| Retail | 6 | 8 | 9 |
| Service | 5 | .. | 3 |
| Finance/Real Estate/ Insurance | 5 | 5 | 6 |
| Transportation/Communication/Public Utilities | 7 | 8 | 11 |
| Farming/Agriculture | 2 | 5 | 14 |
| Construction/Engineering/Architecture | 13 | 21 | 9 |
| Other business | 1 | .. | 1 |
| | 67 | 70 | 78 |
| Professional | | | |
| Medicine | 3 | 6 | 8 |
| Dentistry | 1 | 1 | 2 |
| Education | 2 | 4 | 1 |
| Clergy | 1 | 1 | .. |
| Law | 1 | 2 | 3 |
| Other professional | 3 | .. | 2 |
| | 11 | 14 | 16 |
| Other (includes Armed Forces, Government, Student, Housewife, Retired, etc., and not stated) | 22 | 22 | 6 |
| Total | 100 | 106* | 100 |

*Exceeds 100% because of multiple mentions.

Table 3. Employment capacity*

| | New Pilots | AOPA Profile | New Plane Purchasers |
|---|---|---|---|
| | (%) | (%) | (%) |
| Top Management (includes Owners, Partners, Presidents & Other Corp. Officers, General Mgrs., etc.) | 31 | 37 | 70 |
| Middle Management (includes Managers and Dept. Heads, Superintendents, etc.) | 21 | 13 | 14 |
| Professional & Technical (includes Engineers, Chemists, Other Technicians, etc.) | 21 | 34 | 6 |
| Other White Collar (includes salesmen, clerical, etc.) | 11 | 3 | 2 |
| Blue Collar (includes skilled, semi-skilled & unskilled, farmers, etc.) | 15 | 4 | 7 |
| Not stated | 1 | 9 | 1 |
| Total | 100 | 100 | 100 |

*Capacity of those engaged in Business, Table 2.

In 1964, the FAA Statistical Handbook of Aviation indicated that 378,700 general aviation pilots flew a total of 15 million hours. Of these totals, the 110,000 AOPA members/PILOT readers flew over 11.9 million hours. In other words, twenty-nine percent of the licensed pilots flew over seventy-nine percent of the general aviation hours.[19] This information is given as a base for a survey of AOPA members/PILOT readers and published as Profile of Flying & Buying.[20] It is probably most representative of general aviation today in that its number accounts for such a large percentage of the total hours flown. The following information points out the main characteristics of the pilots most likely to bring business and money to the community.

AOPA members/PILOT readers were well-to-do persons, having an average annual income of $18,499. Nearly seventy percent had an annual income of $10,000 or more. They were a fairly well-educated group, with seventy-three percent having attended college or beyond. Their average age was about forty-two, or ten years older than that of the new

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[19] Profile of Flying and Buying (Washington, D.C.: Aircraft Owners and Pilots Association, 1965), p. 1.

[20] AOPA (Aircraft Owners and Pilots Association) is the world's largest organization of civil airplane pilots and owners. It was founded primarily to stimulate the growth of general aviation in the United States. The PILOT (The AOPA Pilot) is the monthly magazine published by the association.

pilots mentioned earlier. Table 1 shows the personal characteristics of the AOPA group.

Like new pilots, seventy percent of the AOPA members/ PILOT readers listed some type of business as their major occupation. Construction/Engineering/Architecture ranked slightly ahead of Manufacturing, followed in turn by Transportation/Communication/Public Utilitiies, and Retail. Of the professions listed, medicine again ranked first. Table 2 gives the percentages in each category. Table 3 shows the capacity of employment within business, lead by Top Management. Eighty-four percent of the group were in the three areas of Top Management, Middle Management, and Professional and Technical.

A third group of interest is those who buy new private airplanes. A recent study of new airplane buyers[21] produced some results that generally fit the pattern established by the two studies already described. About sixty-eight percent of the new plane buyers had attended college. Their average age of 43.4 years was slightly higher than that of the AOPA group and considerably above that of the new pilots. The greatest difference, however, was in annual income. New plane purchasers had an average income of over

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[21] The Men Who Buy New Private Airplanes, Research Report 1302 (New York: Time Marketing Information, 1964).

$33,000. A comparison of this group with the other two groups is shown on Table 1.

Occupation distribution of new plane buyers varied little from that of the other two groups. The most significant change was in the rise of Farming/Agriculture to second place following Manufacturing in the business ranking. Also of note is that nearly twice the percentage of new plane purchasers were in Top Management when compared to the other two groups of new pilots and AOPA members/PILOT readers.

In summary then, and as shown in Tables 1, 2, and 3, it can be said that the average or typical general aviation pilots and plane owners are well-educated, financially well-off, and between thirty and forty-five years old. The majority of the pilots are in business with most of them being in a management capacity.

Turning now to a look at the industries, rather than the people and their occupations, we can get a deeper insight into the uses of private planes. A report of the National Business Aircraft Association points out the relationship between active corporations, by major industrial group, and the number of plane-owning firms in the United States. Of the approximately 1.1 million active corporations, just over one percent were identified as plane-owning firms.[22]

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[22] Business Flying, Special Report 66-4 (Washington, D.C.: National Business Aircraft Association, Inc., 1966), p. 6.

Table 4, taken from the National Business Aircraft Association report, shows the numbers and percentages for each industrial group.

From the above mentioned table, it is easy to see that Manufacturing firms lead the list in plane-owning firms, followed by Retail, Transportation, Construction, Services, Wholesale, Agriculture, Finance, and Mining. Of equal importance, however, is the fact that of the percentage of plane-owning firms in any given industry to the total firms in that industry, the order is quite different. Agriculture leads the list, followed by Transportation, Mining, Construction, Manufacturing, Services and Wholesale, Retail, and Finance last.

Since Manufacturing is one of the most important groups in both listings, a breakdown of the different types of manufacturing is useful. A study by Cessna Aircraft Company found that of the manufacturers maintaining their own aircraft, the largest users were the manufacturers of metal products and the manufacturers of machinery other than electrical. Following these were manufacturers of miscellaneous products, electrical machinery, transportation equipment, lumber and wood products, paper products, petroleum products, textiles, stone-clay-glass, and primary metals.[23]

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[23] The Fly-In Concept, A Reference Study by Industrial Development and Manufacturers Record (Atlanta, Georgia: Conway Research, Inc., 1965), p. 16.

Table 4. Relationship between active corporations and plane-owning firms by major industrial groups for the United States

| Industrial Group | Active U.S. Corporations | | Identified Plane-owning Firms | | Plane-owning Firms of Total Corps. | Aircraft Owned | | Aircraft Per 10,000 Employees |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | % | No. | % | No. |
| Agriculture | 17,139 | 1.6 | 842 | 6.7 | 4.9 | 2,323 | 9.7 | 4.7 |
| Mining | 13,017 | 1.2 | 442 | 3.5 | 3.4 | 667 | 2.8 | 10.5 |
| Construction | 72,332 | 6.6 | 1,496 | 11.9 | 2.1 | 1,697 | 7.1 | 5.7 |
| Manufacturing | 165,862 | 15.0 | 2,635 | 21.1 | 1.6 | 3,716 | 15.4 | 2.2 |
| Transportation | 43,852 | 4.0 | 1,660 | 13.2 | 3.8 | 4,865 | 20.2 | 12.4 |
| Wholesale | 117,437 | 10.6 | 1,382 | 11.0 | 1.2 | 2,100 | 8.7 | 6.7 |
| Retail | 217,269 | 19.7 | 1,822 | 14.6 | 0.8 | 4,633 | 19.3 | 5.3 |
| Finance | 334,338 | 30.3 | 786 | 6.3 | 0.2 | 1,163 | 4.8 | 4.1 |
| Service | 121,024 | 11.0 | 1,466 | 11.7 | 1.2 | 2,882 | 12.0 | 3.5 |
| Total | 1,102,320 | 100.0 | 12,531 | 100.0 | 1.1 | 24,046 | 100.0 | 4.6 |

Any study of general aviation in relation to community development presupposes a certain importance of one element in regard to the other. In the case of this thesis, the importance of general aviation's influence upon community development is assumed. This chapter, in effect, attempted to justify that assumption by giving background information supporting and describing the importance of general aviation today.

# CHAPTER II

## A STUDY OF COMMUNITY CHARACTERISTICS OF MICHIGAN CITIES

Community leaders and decision makers, urban planners and planning consultants, as well as federal, state, and local airport agencies and authorities, are faced with the problem of determining the potential of existing or possible airports if they are to adequately and realistically plan for them. Most airport planning and development in the past has related more to solving existing problems and meeting existing needs and demands than to meeting future needs and demands. Much community planning has either ignored the airport or only given passing recognition to it. If in the future we are to have airports and an air transportation system which does not conflict with other elements of the urban community, we must plan for it now.

The general aviation segment of air transportation was chosen for this thesis because, as pointed out in the first chapter, it is the largest segment and because it does not include the scheduled airlines. It is in the smaller cities, many of which are without airline service, that general aviation often plays its most important role. It

is also the smaller cities that most often overlook their general aviation activity. This may be explained for the most part, as suggested previously, by the fact that most people equate air transportation with airline service.

The objective of this chapter is to identify and examine community characteristics in an attempt to find some which might serve as indicators or guidelines of general aviation activity. These indicators would then be useful to urban planners and to aviation agencies in more effectively planning and coordinating aviation activity and growth with community growth. In order to have some common source of measurement, while at the same time increasing the scope of usefulness, the U.S. Census of Population was used as the source of community characteristics.

As mentioned earlier, small cities are most prone to overlook general aviation activity because of a lack of airline service or scheduled activity. To cover most of the smaller cities, and at the same time keep the project within workable limits, a population range of 2,500 to 50,000 was selected. The lower limit was determined by a population breaking point used by the Census Bureau in categorizing cities and in giving community characteristics. The upper limit of 50,000 was based on a requirement for federal planning assistance. The Urban Planning Assistance Program, as authorized by Section 701 of the Housing Act of 1954, as ammended, provides for federal funds for the planning of

incorporated areas less than 50,000 population.[24] The population limits give a workable range for an intitial search of indicators.

From the U.S. Census of Population: 1960, all Michigan cities within the selected population range were listed. Since the objective was to establish indicators of general aviation activity, it was necessary that all cities studied have an airport. Accordingly, cities within the population range and without airports were rejected.

Second, in order to relate a given city to activity at a given airport, it was necessary to eliminate as many outside influences as possible. All cities with more than one airport were rejected, as were two or more adjacent cities served by only one airport. Cities having their own airport but which were adjacent to or suburbs of a larger city were also rejected because of the difficulty in relating the general aviation activity to the particular city. Table 5 lists the forty-eight cities selected for study.

The Michigan Department of Aeronautics, in its aviation survey for 1962,[25] studied the aviation activity at all 137 of the licensed airports in the state. The forty-eight cities selected for this study were ranked according to their

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[24] "Policies and Requirements for Local Public Agencies" (Book III), Urban Renewal Manual (Washington, D.C.: Housing and Home Finance Agency, Urban Renewal Administration, 1960), Pt. 40, chap. 2, sec. 1.

[25] Michigan Aviation Fact Finder Survey.

Table 5. Forty-eight selected cities

| City | 1960 Population | City | 1960 Population |
|---|---|---|---|
| Adrian | 20,347 | Iron Mountain | 9,299 |
| Allegan | 4,822 | Ironwood | 10,265 |
| Alma | 8,978 | Lapeer | 6,160 |
| Alpena | 14,682 | Ludington | 9,421 |
| Bad Axe | 2,998 | Manistee | 8,324 |
| Big Rapids | 8,686 | Manistique | 4,875 |
| Blissfield | 2,653 | Marine City | 4,404 |
| Boyne City | 2,797 | Marshall | 6,736 |
| Cadillac | 10,112 | Mason | 4,522 |
| Caro | 3,534 | Midland | 27,779 |
| Charlevoix | 2,751 | Milan | 3,616 |
| Charlotte | 7,657 | Mt. Pleasant | 14,875 |
| Cheboygan | 5,859 | Munising | 4,228 |
| Chesaning | 2,770 | Niles | 13,842 |
| Coldwater | 8,880 | Rogers City | 4,722 |
| Dowagiac | 7,208 | Romeo | 3,327 |
| Escanaba | 15,391 | St. Ignace | 3,334 |
| Fenton | 6,142 | Sault Ste. Marie | 18,722 |
| Fremont | 3,384 | South Haven | 6,149 |
| Gaylord | 2,568 | Sparta | 2,749 |
| Grand Haven | 11,066 | Sturgis | 8,915 |
| Hastings | 6,375 | Tecumseh | 7,045 |
| Howell | 4,861 | Three Rivers | 7,092 |
| Ionia | 6,754 | Traverse City | 18,432 |

Total General Aviation Operations as listed in the Fact Finder Survey.[26] The cities with their total operations rank (TO) are shown in Table 6.[27]

In a study making a comparison of general aviation activity at cities of different sizes, it may be expected that to a certain extent the size of the city itself will influence the amount of activity. For example, in a study comparing Lansing, Michigan, to Detroit, Michigan, part of any difference in activity could be explained on the basis of population difference alone. The same would hold true for a comparison of one of the selected cities of this study with 3,000 population compared to one of 25,000 population. In order to minimize this population difference influence when comparing cities, a ranking of operations per person (O/P) was figured by dividing the Total General Aviation Operations at each city by the population of that city. This ranking is shown in Table 6 along with the total operations ranking.

As mentioned earlier, the U.S. Census of Population was used as the source for community characteristics. From the Michigan census report on "General Social and Economic Characteristics," figures for occupation and industry were

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[26] Ibid., pp. 10-14.

[27] The term "operation" in aviation basically refers to an aircraft landing or take-off. Total operations is the sum of all landings and take-offs over a given period of time.

Table 6. Selected cities and rankings

| City | Rank* TO | Rank* O/P | City | Rank* TO | Rank* O/P |
|---|---|---|---|---|---|
| Adrian | 1 | 13 | Iron Mountain | 32 | 38 |
| Allegan | 36 | 34 | Ironwood | 24 | 30 |
| Alma | 28 | 31 | Lapeer | 14 | 10 |
| Alpena | 7 | 17 | Ludington | 30 | 33 |
| Bad Axe | 13 | 3 | Manistee | 18 | 20 |
| Big Rapids | 2 | 6 | Manistique | 41 | 39 |
| Blissfield | 46 | 43 | Marine City | 34 | 29 |
| Boyne City | 44 | 37 | Marshall | 20 | 21 |
| Cadillac | 37 | 45 | Mason | 26 | 16 |
| Caro | 29 | 15 | Midland | 3 | 26 |
| Charlevoix | 31 | 14 | Milan | 8 | 2 |
| Charlotte | 23 | 27 | Mt. Pleasant | 9 | 18 |
| Cheboygan | 45 | 46 | Munising | 38 | 35 |
| Chesaning | 43 | 36 | Niles | 16 | 25 |
| Coldwater | 12 | 12 | Rogers City | 42 | 42 |
| Dowagiac | 11 | 7 | Romeo | 6 | 1 |
| Escanaba | 33 | 44 | St. Ignace | 21 | 11 |
| Fenton | 47 | 47 | Sault Ste. Marie | 5 | 22 |
| Fremont | 39 | 32 | South Haven | 4 | 4 |
| Gaylord | 27 | 8 | Sparta | 19 | 5 |
| Grand Haven | 15 | 19 | Sturgis | 25 | 28 |
| Hastings | 48 | 48 | Tecumseh | 35 | 40 |
| Howell | 17 | 9 | Three Rivers | 22 | 24 |
| Ionia | 40 | 41 | Traverse City | 10 | 23 |

*TO - Total General Aviation Operations; O/P - General Aviation Operations per Person.

taken for each city. Three additional characteristics concerning number, income, and education of the population were also considered for a total of twenty-eight characteristics.

Characteristics relating to occupation were based on the employed male civilian labor force. Male employment was used rather than total employment because it was listed separately in the census and because of the fact that approximately ninety-seven percent of all licensed pilots are males.[28] The occupation characteristics are listed in Table 7. The figures for each characteristic used in the analysis represent the percentage of employed males.

Industry characteristics were based on the combined employed civilian labor force of both sexes. The figures used in the analysis represent the percentage of total employment. These characteristics are also listed in Table 7.

Three other characteristics were selected for consideration. Two were based on a study for the Michigan Aeronautics Commission which found that the number of aircraft based in a community could be expressed as a function of the population over twenty-five years with some college education, or as a function of disposable income.[29] Census information most closely corresponding to these findings were

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[28] FAA Statistical Handbook of Aviation, pp. 65, 67.

[29] Interview with Edward A. Mellman, Statistician, Michigan Aeronautics Commission, June 21, 1966.

Table 7. Characteristics considered

Selected Characteristics

1. Population (number)
2. Percent persons 25 yrs old and over who completed 4 years High School or more
3. Families median income

Occupation Characteristics

4. Professional, technical, and kindred workers
5. Farmers and farm managers
6. Managers, officials, and proprietors, except farm
7. Clerical and kindred workers
8. Sales workers
9. Craftsmen, foremen, and kindred workers
10. Operatives and kindred workers
11. Private household workers
12. Service workers, except private household
13. Farm laborers and farm foremen
14. Laborers, except farm and mine

Industry Characteristics

15. Agriculture, Forestry and Fisheries
16. Mining
17. Construction
18. Durable Goods Manufacturing
19. Nondurable Goods Manufacturing
20. (total manufacturing)*
21. Transportation, Communication, and Other Public Utilities
22. Wholesale and Retail Trade
23. Finance, Insurance, and Real Estate
24. Business and Repair Services
25. Personal Services
26. Entertainment and Recreation Services
27. Professional and Related Services
28. Public Administration

*This characteristic not listed as such in Census report but used in this study by combining values for Durable Goods and Nondurable Goods Manufacturing.

percentage figures for persons twenty-five years old and over who completed four years of high school or more, and the median income of families expressed in dollars. The third characteristic of city population was selected to see if in fact there is the relationship between general aviation activity and city size which was assumed earlier and which served as the basis for the second ranking of the cities studied.

Two methods were used in attempting to identify certain characteristics that might relate to general aviation activity. The first method, referred to as Top 12-Bottom 12 (T-B 12), considered only the twelve most active cities and twelve least active cities from both rankings. The second method, which was to figure the coefficient of correlation (C of C) for each characteristic, considered all forty-eight cities selected. Both methods were applied to each ranking of the cities and are discussed separately below.

## Top 12-Bottom 12 Method

In the Top 12-Bottom 12 (T-B 12) method, the average value for each characteristic was computed based on all forty-eight cities. The characteristic value for each city of the twelve most active and twelve least active cities on each ranking (TO and O/P) was compared to the average value of that characteristic. A tabulation was made of the cities with characteristic values above the average and below the

average of that characteristic. Characteristic values equal to the average were figured as one-half above and one-half below the average. In combining the values of the top twelve cities with those of the bottom twelve cities, an x value representing the sum of the above average figure for the top cities and the below average figure for the bottom cities was determined for each characteristic. Out of a total possible twenty-four, the characteristics with x values closest to zero or twenty-four were considered most related to general aviation activity. Tables showing the x values of the characteristics are given in Appendix A.

As an example of the above procedure, take the population characteristic in Appendix A. The average population of all forty-eight cities was 7,919. Of the twelve most active cities ranked by total operations, eight had a population above the average while four had a population below the average. Of the twelve least active cities, one was above the average while eleven were below. The x value for population in this ranking (19), relating population to general aviation activity, was determined by combining the above average figure (8) for the top cities with the below average figure (11) for the bottom cities. This procedure was repeated to determine the x value for each characteristic on each ranking.

The mean of x values for the twenty-eight characteristics was then figured for each ranking (TO = 12.32; O/P = 12.34). Assuming a normal distribution around the mean for the x values of the twenty-eight characteristics, the standard deviation for each ranking was figured (2.82 for both TO and O/P). Characteristics with x values in a range covering the central seventy-five percent of the possible x values were excluded as having no significant relation to general aviation activity. Accordingly, only characteristics with an x value equal to or less than nine, or equal to or greater than sixteen were considered. The characteristics accepted by this method as being related to general aviation activity are shown in Table 8 for both rankings.

The characteristic value of indicators found by the T-B 12 method, as described above, was based on the combination of above average and below average figures for the twelve most active and twelve least active cities. The farther the x value from the mean, the greater the relationship to general aviation activity. x values of sixteen or larger have a direct or positive (+) relation to general aviation activity, while x values of nine or less have an inverse or negative (-) relation to aviation activity. The x value and relation to general aviation activity are shown in Table 8 for the accepted characteristics. Values for all twenty-eight characteristics are shown in Appendix B.

Table 8. Top 12-Bottom 12 indicators

| Total Operations | | |
|---|---|---|
| Characteristic | Value | Relation* |
| Population | 19 | + |
| Operatives | 6 | - |
| Professional & Related | 18 | + |
| Managers & proprietors | 8 | - |
| Finance & Insurance | 8 | - |

| Operations/Person | | |
|---|---|---|
| Characteristic | Value | Relation* |
| Operatives | 6 | - |
| Agriculture, Forestry, & Fisheries | 18-1/2 | + |
| Farmers & farm managers | 16-1/2 | + |
| Entertainment | 8-1/2 | - |
| Professional & Related | 16 | + |
| Managers & proprietors | 9 | - |

*+ = direct relation; - = inverse relation.

## Coefficient of Correlation Method

Coefficient of correlation is a mathematical analysis to determine the degree of relationship between two variables. The coefficient of correlation value is expressed as $r$ and tells the strength of the linear relation between the two variables considered. Values of $r$ may range from +1 to -1. An $r$ close to zero would indicate a very weak or nonexistant relationship, while a value close to +1 or -1 is indicative of a strong relationship. If one variable tends to increase as the other increases, there is said to be positive correlation and $r$ will have a positive (+) sign. If one variable tends to decrease as the other increases, there is negative correlation and $r$ will have a negative (-) sign.

In using the coefficient of correlation method, the forty-eight cities were listed in order of general aviation activity and in order of characteristic value for each of the twenty-eight characteristics. Using the Spearman formula for rank correlation,[30] $r$ values for each characteristic were figured. Values of $r$ for characteristics ranked by total operations ranged from +.424 to -.385. The range under operations per person was somewhat smaller, being from

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[30] John E. Freund, Modern Elementary Statistics (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960), pp. 346-348; Murray R. Spiegel, Theory and Problems of Statistics (New York: Schaum Publishing Co., 1961), p. 246. The Spearman formula for rank correlation is

$$r = \frac{1 - 6\sum d^2}{n\,(n^2 - 1)} .$$

+.375 to -.395. All characteristics with an $r$ value greater than +.300 or -.300 were considered to have enough correlation with general aviation activity to be termed indicators. These indicators, along with their value and relation, are shown in Table 9. Values for all twenty-eight characteristics under each ranking are shown in Appendix C.

Table 9. Coefficient of correlation indicators

| Total Operations | | |
|---|---|---|
| Characteristic | Value | Relation* |
| Population | .424 | + |
| Operatives | -.385 | - |
| Managers & proprietors | -.378 | - |
| Farm laborers | .324 | + |
| **Operations/Person** | | |
| Characteristic | Value | Relation* |
| Operatives | -.395 | - |
| Farm laborers | .375 | + |
| Agriculture, Forestry, & Fisheries | .314 | + |

*+ = direct relation; - = inverse relation.

## Application of Methods

The above discussions set forth the methods used in arriving at community characteristics considered to be related to general aviation activity. The resulting characteristics were termed "indicators" of general aviation activity and are proposed as guides for use in study and planning of general aviation facilities in communities within the population range of 2,500 to 50,000 used in this study. Application of the indicators is described below.

The relation of each indicator to general aviation activity is shown by a plus (+) or minus (-) sign. A plus sign means there is a direct relation between that characteristic and general aviation activity. In other words, a city with considerable general aviation activity should have a value for that particular characteristic above (+) the average characteristic value for other cities in the same class. A minus sign, showing inverse relation, means that a city with considerable general aviation activity should have a value for that particular characteristic below (-) the average characteristic value for other cities in the same class. The average value figures constitute the base from which measurements for each city are taken. The relation, by method and ranking, along with the average or base figures for each indicator, are shown in Table 10.

Table 10. Selected indicators and relation to general aviation activity

| Indicator | Relation* T-B 12 TO | T-B 12 O/P | C of C TO | C of C O/P | Average of 48 Selected Cities |
|---|---|---|---|---|---|
| Operatives | - | - | - | - | 23.7% |
| Managers & proprietors | - | - | - | | 13.8% |
| Farm laborers | | | + | + | 0.6% |
| Agriculture, Forestry, & Fisheries | | + | | + | 1.2% |
| Population | + | | + | | 7919 |
| Professional & Related | + | + | | | 15.4% |
| Farmers & farm managers | | + | | | 0.4% |
| Entertainment | | - | | | 0.7% |
| Finance & Insurance | - | | | | 3.1% |

*+ = direct relation; - = inverse relation

To test the results, each of the nine indicators was applied to the six most active cities appearing on both rankings and the six least active cities appearing on both rankings. A plus sign was given to a characteristic value above the average and a minus sign to a value below the average. Signs for the characteristics of each city were compared to the sign it should have according to the indicator and the city's known rank by general aviation activity.

(See Appendix D, Tables 1 and 2.) The accuracy of the indicators applied to the most active cities ranged from a low of 33.3 percent to a high of 77.8 percent with the average being 63 percent. For the least active cities the range was 55.6 percent to 88.9 percent with an average of just over 74 percent. Applied to the twelve cities the indicators averaged 68.5 percent accuracy.

Various other measurements were made concerning the accuracy of the indicators when applied to the specific cities. In figuring ratios and percentages of the combined accuracy of the indicators, extra weight was given to those indicators which appeared more often than did others (i.e., Operatives appeared four times but Entertainment only once; see Table 10). The weighted average accuracy for the most active cities was nearly 65 percent to over 73 percent accuracy for the least active cities. The weighted average for the twelve cities was 69 percent, only 0.5 percent higher than the non-weighted average. Accuracy of individual indicators ranged from 33.3 percent to 100.0 percent. (See Appendix D, Table 3.)

Using the nine indicators, there proved to be very little difference in accuracy based on the two methods of analysis used in the study (68.9 percent for T-B 12, 69.0 percent for C of C). Accuracy based on ranking was somewhat different, however. The ranking by total operations was

over 70 percent accurate, while the operations per person ranking was less than 68 percent. (See Appendix D, Table 4.)

An additional comment relating to the study and overall accuracy might be warranted at this point. Normally when comparing two variables, an $r$ value of about $\pm.600$ or larger is considered necessary in order to have a moderate or strong correlation between the variables. In this study it was necessary to use a value of $\pm.300$ or larger in order to establish a relation between variables. While the accuracy of measuring general aviation activity approached seventy percent, the inclusion of those indicators found or reinforced by the coefficient of correlation method was based on a fairly weak correlation between the characteristic and general aviation activity. Additional study in the area of determining aviation activity, using the indicators found here and other methods of analysis, such as multiple correlation, may provide stronger indicators of general aviation activity. This does not, however, detract from the value of this study in providing initial indicators and a base for additional study.

# CHAPTER III

## INDICATORS OF GENERAL AVIATION ACTIVITY

What do the indicators found by the characteristic study of Michigan cities really mean, and do the indicators really relate to general aviation activity? How might the indicators be used by community planners, aviation agencies, and other interested persons or groups? This chapter points out the relationship between the indicators found in Chapter II and the nature of general aviation as outlined in Chapter I, concluding with an explanation of the proposed use of the indicators.

Of the twenty-eight community characteristics studied, nine showed a considerable relation to general aviation activity. The nine indicators included four related to occupation, four related to industry, and one of the selected characteristics. The relation of each indicator to general aviation activity, along with the base value of that indicator, is shown in Table 11.

As somewhat of a cross check on each of the indicators, it is interesting to note that for several areas there is multiple coverage. For example, the area of agriculture is covered by Farm laborers, and by Farmers and farm

managers under occupation, and by Agriculture, Forestry, and Fisheries under industry. There is also a definite relation between Managers and proprietors (occupation) and Finance and Insurance (industry). This comparison is relatively easy as the Census Bureau defines what is included in each category under both occupation and industry.

Table 11. Indicators of general aviation activity

| Indicator | Relation to Gen. Aviation Activity[1] | Base Value (Average of 48 cities) |
|---|---|---|
| Selected Characteristics | | |
| Population | + | 7,919 |
| Occupation Characteristics[2] | | |
| Farmers and farm managers | + | 0.4% |
| Managers, officials, and proprietors, except farm | - | 13.8% |
| Operatives and kindred workers | - | 23.7% |
| Farm laborers and farm foremen | + | 0.6% |
| Industry Characteristics[3] | | |
| Agriculture, Forestry, and Fisheries | + | 1.2% |
| Finance, Insurance, and Real Estate | - | 3.1% |
| Entertainment and Recreation Services | - | 0.7% |
| Professional and Related Services | + | 15.4% |

[1] + = direct relation; - = inverse relation.

[2] Figures are percentage of employed male civilian labor force.

[3] Figures are percentage of total employed civilian labor force.

A composite of the general aviation users by occupation and industry, based on Chapter I, is given in Table 12. Comparing the indicators with the general aviation users is more difficult because of the lack of standard definitions. However, because of the similarity of some terms with those used by the Census Bureau, and with some general knowledge of the fields associated with the terms, it can be assumed that there is a relation where there is a similarity in terms.

Table 12. General aviation users by occupation and industry

| Occupation | Industry |
|---|---|
| 1. Manufacturing | 1. Transportation |
| 2. Professional | 2. Manufacturing |
| 2. Construction/Engineering/ Architecture | 3. Agriculture |
| 4. Transportation/Communication/ Public Utilities | 4. Construction |
| 5. Retail | 5. Retail |
| 6. Farming & Agriculture | 6. Services |
| 7. Finance/Real Estate/Insurance | 7. Mining |
| 8. Service | 8. Wholesale |
| 9. Wholesale | 9. Finance |

In comparing the indicators (Table 11) to the composite of general aviation users (Table 12), it is apparent that the indicators do have some relation to the users. For example, there is a definite relation under occupation between the indicator Managers and proprietors and the Retail, Service, and Wholesale users. This is especially true when it is remembered that over fifty percent of the users are employed in a management capacity. Farming and Agriculture users are covered by the indicators Farm laborers, and Farmers and farm managers.

The relationship between users and indicators under industry is not quite so evident. The most obvious relationships are in the fields of agriculture and finance. Based again on the high ranking of persons employed in a management, professional, or technical capacity, it seems reasonable that there would be an industrial relation between the indicator Professional and Related Services, and Manufacturing users.

To summarize the community characteristics as they relate to general aviation activity, it might be said that a community with a high percentage of employment in agriculture occupations and agriculture and professional industries is more likely to have a high level of general aviation activity. Communities with a low percentage of employment in proprietary and operative occupations and in finance and entertainment industries are also more likely to have a high

level of general aviation activity. According to this study then, communities with these combined characteristics would, in all probability, have a significant amount of general aviation activity or potential activity and should have adequate consideration given to general aviation and its effect on their future development.

Recognizing that there is some relation between the indicators and known general aviation users, we turn now to an explanation of how the indicators might be applied to various cities. Each indicator has a base value and a sign showing its relation to general aviation. A positive sign shows that the indicator is directly related to general aviation, and the value of a corresponding characteristic for a given community should be above the base value in order to have potential general aviation activity. Conversely, a negative sign shows that the indicator is inversely related to general aviation, and the value of a corresponding characteristic should be below the base value in order to have potential general aviation activity in the city.

Table 13 gives four hypothetical cities and characteristic values corresponding to the indicators. Cities A and B will serve as examples of the use of the indicators to community planners. City A presently has an airport but little or no present aviation activity. In applying the indicators to the city, there is nearly eighty-nine percent accuracy, indicating a potential general aviation activity

Table 13. Application of indicators

| Indicator | Base Value | Relation | City A Value | City A Sign | City B Value | City B Sign | City C Value | City C Sign | City D Value | City D Sign |
|---|---|---|---|---|---|---|---|---|---|---|
| Population | 7,919 | + | 7,000 | - | 5,200 | - | 11,300 | + | 18,200 | + |
| Farmers & farm managers | 0.4% | + | 0.5% | + | 1.2% | + | 0.5% | + | 0.5% | + |
| Managers & proprietors | 13.8% | - | 12.3% | - | 15.5% | + | 13.2% | - | 12.9% | - |
| Operatives | 23.7% | - | 18.2% | - | 33.7% | + | 23.5% | - | 23.8% | + |
| Farm laborers | 0.6% | + | 0.7% | + | 1.4% | - | 0.7% | + | 0.9% | + |
| Agriculture, Forestry, & Fisheries | 1.2% | + | 1.5% | + | 2.4% | + | 1.7% | + | 1.3% | + |
| Finance & Insurance | 3.1% | - | 3.0% | - | 4.8% | + | 2.7% | - | 2.5% | - |
| Entertainment | 0.7% | - | 0.6% | - | 0.8% | + | 1.1% | + | 0.9% | + |
| Professional & Related | 15.4% | + | 16.1% | + | 11.3% | - | 22.1% | + | 19.8% | + |
| Accuracy | | | 88.9% | | 22.2% | | 88.9% | | 77.8% | |

exists. Since the planner would probably be concerned only with his city, population would be a factor only to the extent that it is increasing or decreasing. If it is rapidly increasing, and may soon be over the base value of the indicator, the total accuracy would improve to one hundred percent (assuming no changes in the other characteristics). If the planner knew of trends changing the composition of the city, he would also know if the potential was increasing or decreasing.

City B, on the other hand, is quite different, being like City A only in the fact that it too has an airport and little present activity. The indicators applied to it show an accuracy of only twenty-two percent, indicating little potential activity. Here again, the planner or planning consultant, knowing the changing trends of the city, would be able to estimate what influence general aviation might have on airport and community growth.

Cities C and D help point out possible use of the indicators by an aviation agency, such as a state aeronautics commission. They have the problem of allocating funds in such a manner as to best serve aviation. If two cities appear on the surface to be equal in all respects, yet there are funds only for the improvements at one, the use of the indicators may help determine which city should have the funds first.

Application of the indicators to Cities C and D produce an accuracy of approximately eighty-nine percent and seventy-eight percent, respectively. At first glance it would appear that the money should go to City C as it has the greater accuracy or potential. On closer examination, however, the accuracy difference lies primarily in the value of the operatives characteristic. City D is only one-tenth of one percent from the indicator base value and three-tenths of one percent from the value of City C. Disregarding operatives as an indicator in this particular case, the two cities would have the same level of accuracy. Since population is also an indicator, and benefit to most people may be a criteria for spending state money, City D might get the nod as it is considerably larger than City C and farther from the indicator base value.

It may be concluded then, that the indicators of general aviation activity arrived at in this thesis are related to general aviation users. Other considerations, not within the scope of this present study, however, should not be overlooked. Such factors as travel time and distance of the airport from the center of population, and the rate of change of a characteristic value from one year to the next may also be important and helpful in determining potential general aviation activity.

As the examples in this chapter point out, the indicators could be useful to community planners and to aviation agencies when used in the manner described. Of greater importance, however, is the hope that this study may re-emphasize an area largely ignored by planners, and in doing so serve as a base for an improved method of studying and relating aviation activity and growth to the planning of our cities.

# APPENDICES

## APPENDIX A

## X VALUES OF CHARACTERISTICS--T-B 12 METHOD

| | | Population | 25 yr & over 4 yr H.S. | Family income | Professional & technical | Farmers & farm managers | Managers & proprietors | Clerical | Sales | Craftsmen | Operatives | Household | Service | Farm labor | Other labor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Operations | Top 12 above average | 8 | 6 | 6 | 5 | 4 | 5 | 7 | 5 | 5 | 3 | 5 | 6 | 6 | 7½ |
| | Top 12 below average | 4 | 6 | 6 | 7 | 8 | 7 | 5 | 7 | 7 | 9 | 7 | 6 | 6 | 4½ |
| | Bottom 12 above average | 1 | 5 | 7 | 5 | 5 | 9 | 5 | 7 | 5 | 9 | 5 | 5½ | 3 | 4 |
| | Bottom 12 below average | 11 | 7 | 5 | 7 | 7 | 3 | 7 | 5 | 7 | 3 | 7 | 6½ | 9 | 8 |
| | Combined 24 X | 19 | 13 | 11 | 12 | 11 | 8 | 14 | 10 | 12 | 6 | 12 | 12½ | 15 | 15½ |
| | Combined 24 Y | 5 | 11 | 13 | 12 | 13 | 16 | 10 | 14 | 12 | 18 | 12 | 11½ | 9 | 8½ |
| Operations/Person | Top 12 above average | 2 | 6 | 7 | 2 | 7½ | 5 | 7 | 8 | 8 | 3 | 5 | 6 | 5½ | 6 |
| | Top 12 below average | 10 | 6 | 5 | 10 | 4½ | 7 | 5 | 4 | 4 | 9 | 7 | 6 | 6½ | 6 |
| | Bottom 12 above average | 3 | 6 | 5 | 4 | 3 | 8 | 6 | 7 | 6 | 9 | 7 | 5½ | 2 | 3 |
| | Bottom 12 below average | 9 | 6 | 7 | 8 | 9 | 4 | 6 | 5 | 6 | 3 | 5 | 6½ | 10 | 9 |
| | Combined 24 X | 11 | 12 | 14 | 10 | 16½ | 9 | 13 | 13 | 14 | 6 | 10 | 12½ | 15½ | 15 |
| | Combined 24 Y | 13 | 12 | 10 | 14 | 7½ | 15 | 11 | 11 | 10 | 18 | 14 | 11½ | 8½ | 9 |

APPENDIX A--Continued

| | | | Ag., For., & Fisheries | Mining | Construction | D. Goods Mfg. | N.D.Goods Mfg. | (total Mfg.) | Transportation | Wholesale & Retail | Finance & Ins. | Bus. & Repair | Personal Serv. | Entertainment | Professional & Related | Public Admin. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Operations | Top 12 | above average | 6½ | 4 | 4½ | 6 | 2 | 7 | 4 | 7 | 3 | 5 | 6½ | 5 | 7 | 4 |
| | | below average | 5½ | 8 | 7½ | 6 | 10 | 5 | 8 | 5 | 9 | 7 | 5½ | 7 | 5 | 8 |
| | Bottom 12 | above average | 7 | 2 | 4 | 6 | 4 | 8 | 2 | 4 | 7 | 4 | 4 | 6½ | 1 | 6 |
| | | below average | 5 | 10 | 8 | 6 | 8 | 4 | 10 | 8 | 5 | 8 | 8 | 5½ | 11 | 6 |
| | Combined 24 | X | 11½ | 14 | 12½ | 12 | 10 | 11 | 14 | 15 | 8 | 13 | 14½ | 10½ | 18 | 10 |
| | | Y | 12½ | 10 | 11½ | 12 | 14 | 13 | 10 | 9 | 16 | 11 | 9½ | 13½ | 6 | 14 |
| Operations/Person | Top 12 | above average | 10½ | 2½ | 6 | 6½ | .. | 5 | 4½ | 8 | 5 | 4 | 7½ | 5 | 6 | 5 |
| | | below average | 1½ | 9½ | 6 | 5½ | 12 | 7 | 7½ | 4 | 7 | 8 | 4½ | 7 | 6 | 7 |
| | Bottom 12 | above average | 4 | 3 | 4 | 6 | 2 | 6 | 4 | 5 | 6 | 6 | 6 | 8½ | 2 | 7 |
| | | below average | 8 | 9 | 8 | 6 | 10 | 6 | 8 | 7 | 6 | 6 | 6 | 3½ | 10 | 5 |
| | Combined 24 | X | 18½ | 11½ | 14 | 12½ | 10 | 11 | 12½ | 15 | 11 | 10 | 13½ | 8½ | 16 | 10 |
| | | Y | 5½ | 12½ | 10 | 11½ | 14 | 13 | 11½ | 9 | 13 | 14 | 10½ | 15½ | 8 | 14 |

# APPENDIX B

## CHARACTERISTIC VALUES
(T-B 12 Method)

| TO Rank | Value | O/P Rank | Value |
|---|---|---|---|
| Population | 19 | Operating | 6 |
| Operatives | 6 | Ag.,For., & Fisheries | 18½ |
| Professional & Related | 18 | Farmers & farm mgrs. | 16½ |
| Managers & proprietors | 8 | Entertainment | 8½ |
| Finance & Insurance | 8 | Professional & Related | 16 |
| Other laborers | 15½ | Managers & proprietors | 9 |
| Farm laborers | 15 | Farm laborers | 15½ |
| Wholesale & Retail | 15 | Other laborers | 15 |
| N.D. Goods Mfg. | 10 | Wholesale & Retail | 15 |
| Public Admin. | 10 | N.D. Goods Mfg. | 10 |
| Sales | 10 | Public Admin. | 10 |
| Personal Services | 14½ | Business & Repair Serv. | 10 |
| Entertainment | 10½ | Professional & technical | 10 |
| Clerical | 14 | Household | 10 |
| Mining | 14 | Family income | 14 |
| Transportation | 14 | Craftsmen | 14 |
| Farmers & farm mgrs. | 11 | Construction | 14 |
| Family income | 11 | Population | 11 |
| (total manufacturing) | 11 | Finance & Insurance | 11 |
| Ag., For., & Fisheries | 11½ | (total manufacturing) | 11 |
| Education | 13 | Personal Service | 13½ |
| Business & Repair Serv. | 13 | Mining | 11½ |
| Professional & technical | 12 | Sales | 13 |
| Craftsmen | 12 | Clerical | 13 |
| Household | 12 | Education | 12 |
| D. Goods Mfg. | 12 | D. Goods Mfg. | 12½ |
| Construction | 12½ | Transportation | 12½ |
| Service | 12½ | Service | 12½ |

# APPENDIX C

## CHARACTERISTIC VALUES
(C of C Method)

| TO Rank | r | O/P Rank | r |
|---|---|---|---|
| Population | .424 | Operatives | -.395 |
| Operatives | -.385 | Farm laborers | .375 |
| Managers & proprietors | -.378 | Ag., For., & Fisheries | .314 |
| Farm laborers | .324 | N.D. Goods Mfg. | -.270 |
| Mining | .254 | Professional & Related | .252 |
| Clerical | .202 | Other laborers | .240 |
| Professional & Related | .159 | Managers & proprietors | -.210 |
| Service | .137 | Service | .198 |
| Professional & tech. | .137 | Farmers & farm mgrs. | .182 |
| Craftsmen | .129 | Personal Service | .178 |
| Other laborers | .126 | (total manufacturing) | -.159 |
| Household | .112 | Craftsmen | .142 |
| N.D. Goods Mfg. | -.110 | Mining | .134 |
| Finance & Insurance | -.108 | Population | -.131 |
| Farmers & farm mgrs. | .102 | Construction | .129 |
| Wholesale & Retail | .078 | Sales | .119 |
| Entertainment | -.067 | Entertainment | -.115 |
| Family income | .066 | Wholesale & Retail | .098 |
| Personal Service | .064 | Public Admin. | .094 |
| (total manufacturing) | -.054 | Transportation | -.082 |
| Education | .048 | Clerical | .077 |
| D. Goods Mfg. | -.045 | Business & Repair Serv. | -.060 |
| Construction | .031 | Professional & tech. | .058 |
| Public Admin. | -.031 | Education | .049 |
| Ag., For., & Fish. | .028 | Family income | .025 |
| Sales | -.020 | Finance & Insurance | -.021 |
| Business & Repair Serv. | -.003 | D. Goods Mfg. | -.011 |
| Transportation | -.001 | Household | .001 |

APPENDIX D

TABLE 1. SIX ACTIVE CITIES

| | Base Value | Relation T-B 12 TO O/P | | Relation C of C TO O/P | | Big Rapids | Romeo | Milan | South Haven | Dowagaic | Cold-water |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Operatives | 23.7% | - | - | - | - | $14.6^{-}$ | $20.7^{-}$ | $15.2^{-}$ | $26.7^{+}$ | $28.4^{+}$ | $21.8^{-}$ |
| Managers & proprietors | 13.8% | - | - | - | | $9.0^{-}$ | $9.0^{-}$ | $11.1^{-}$ | $13.3^{-}$ | $10.4^{-}$ | $14.4^{+}$ |
| Farm laborers | 0.6% | | | + | + | $1.6^{+}$ | $5.5^{+}$ | $0.4^{-}$ | $0.3^{-}$ | $2.1^{+}$ | $0.6^{-}$ |
| Ag., Forestry, & Fisheries | 1.2% | | + | | + | $1.9^{+}$ | $5.6^{+}$ | $0.7^{-}$ | $1.5^{+}$ | $2.7^{+}$ | $1.9^{+}$ |
| Population | 7919 | + | | + | | $8686^{+}$ | $3327^{-}$ | $3616^{-}$ | $6149^{-}$ | $7208^{-}$ | $8880^{+}$ |
| Professional & Related | 15.4% | + | + | | | $24.9^{+}$ | $17.2^{+}$ | $20.8^{+}$ | $10.6^{-}$ | $9.7^{-}$ | $21.1^{+}$ |
| Farmers & farm managers | 0.4% | | + | | | $0.4^{-}$ | $0.5^{+}$ | $...^{-}$ | $...^{-}$ | $0.5^{+}$ | $1.0^{+}$ |
| Entertainment | 0.7% | | - | | | $1.3^{+}$ | $1.1^{+}$ | $0.3^{-}$ | $1.1^{+}$ | $0.4^{-}$ | $0.5^{-}$ |
| Finance & Insurance | 3.1% | - | | | | $3.2^{+}$ | $2.4^{-}$ | $1.6^{-}$ | $2.5^{-}$ | $2.5^{-}$ | $2.8^{-}$ |
| Accuracy | | | | | | 66.7% | 77.8% | 55.6% | 33.3% | 66.7% | 77.8% |

TABLE 2. SIX NON-ACTIVE CITIES

| | Base Value | Relation T-B 12 TO | T-B 12 O/P | C of C TO | C of C O/P | Ionia | Rogers City | Bliss-field | Cheboygan | Fenton | Hast-ings |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Operatives | 23.7% | - | - | - | - | $24.8^{+}$ | $35.0^{+}$ | $28.3^{+}$ | $18.9^{-}$ | $26.2^{+}$ | $19.7^{-}$ |
| Managers & proprietors | 13.8% | - | - | - | | $15.4^{+}$ | $15.7^{+}$ | $18.2^{+}$ | $20.5^{+}$ | $7.9^{-}$ | $13.5^{-}$ |
| Farm laborers | 0.6% | | | + | + | $...^{-}$ | $...^{-}$ | $...^{-}$ | $0.7^{+}$ | $0.5^{-}$ | $0.5^{-}$ |
| Ag., Forestry, & Fisheries | 1.2% | | + | | + | $0.2^{-}$ | $0.2^{-}$ | $0.5^{-}$ | $1.8^{+}$ | $0.6^{-}$ | $1.8^{+}$ |
| Population | 7919 | + | | + | | $6754^{-}$ | $4722^{-}$ | $2653^{-}$ | $5859^{-}$ | $6142^{-}$ | $6375^{-}$ |
| Professional & Related | 15.4% | + | + | | | $15.9^{+}$ | $12.5^{-}$ | $14.3^{-}$ | $12.0^{-}$ | $14.2^{-}$ | $13.6^{-}$ |
| Farmers & farm managers | 0.4% | | + | | | $...^{-}$ | $...^{-}$ | $0.6^{+}$ | $0.3^{-}$ | $...^{-}$ | $1.1^{+}$ |
| Entertainment | 0.7% | | - | | | $1.0^{+}$ | $0.4^{-}$ | $0.8^{+}$ | $1.4^{+}$ | $0.7^{-}$ | $0.2^{-}$ |
| Finance & Insurance | 3.1% | - | | | | $3.8^{+}$ | $1.0^{-}$ | $3.6^{+}$ | $2.6^{-}$ | $3.4^{+}$ | $4.2^{+}$ |
| Accuracy | | | | | | 88.9% | 77.8% | 88.9% | 55.6% | 77.8% | 55.6% |

TABLE 3. ACCURACY OF INDICATORS APPLIED TO CITIES

| Indicators | Six Cities* (active) ratio | % | Six Cities* (non-active) ratio | % | Combined avg. % |
|---|---|---|---|---|---|
| Operatives | 16/24 | 66.7 | 16/24 | 66.7 | 66.7 |
| Managers & proprietors | 15/18 | 83.4 | 12/18 | 66.7 | 75.0 |
| Farm laborers | 6/12 | 50.0 | 10/12 | 83.4 | 66.7 |
| Ag., For., & Fisheries | 10/12 | 83.4 | 8/12 | 66.7 | 75.0 |
| Population | 4/12 | 33.3 | 12/12 | 100.0 | 66.7 |
| Professional & Related | 8/12 | 66.7 | 10/12 | 83.4 | 75.0 |
| Farmers & farm managers | 3/6 | 50.0 | 4/6 | 66.7 | 58.3 |
| Entertainment | 3/6 | 50.0 | 3/6 | 50.0 | 50.0 |
| Finance & Insurance | 5/6 | 83.4 | 4/6 | 66.7 | 75.0 |
| Weighted avg. of 9 Indicators | 70/108 | 64.8 | 79/108 | 73.2 | 69.0 |
| Non-weighted avg. of 9 Indicators | 34/54 | 63.0 | 40/54 | 74.1 | 68.5 |

*Accuracy of active cities measured by city's characteristic with sign corresponding to that of indicator; non-active cities measured by city having characteristic sign opposite that of indicator.

TABLE 4. ACCURACY OF INDICATORS BY RANK AND METHOD
(figures in percent)

Six Active Cities

| | | Rank | | Method | Combined |
|---|---|---|---|---|---|
| | | TO | O/P | | |
| T-B 12 | TO | 66.7 | | 66.7 | 64.8 |
| | O/P | | 66.7 | | |
| C of C | TO | 58.3 | | 61.9 | |
| | O/P | | 66.7 | | |
| wt. avg. | | 62.9 | 66.7 | | |

Six Non-Active Cities

| | | Rank | | Method | Combined |
|---|---|---|---|---|---|
| | | TO | O/P | | |
| T-B 12 | TO | 76.6 | | 71.2 | 73.2 |
| | O/P | | 66.7 | | |
| C of C | TO | 79.2 | | 76.2 | |
| | O/P | | 72.2 | | |
| wt. avg. | | 77.8 | 68.5 | | |

| | Rank | | Method | | Com- |
|---|---|---|---|---|---|
| | TO | O/P | T-B 12 | C of C | bined |
| Six Active Cities | 62.9 | 66.7 | 66.7 | 61.9 | 64.8 |
| Six Non-Active Cities | 77.8 | 68.5 | 71.2 | 76.2 | 73.2 |
| Combined 12 Cities | 70.3 | 67.6 | 68.9 | 69.0 | 69.0 |

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