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Sintering Characteristics of Lignite Ash

Merwin L. Odenbaugh

FEASIBILITY AND COST ANALYSIS
OF PRIVATE AIRCRAFT TRANSPORTATION
FOR THE UNIVERSITY OF NORTH DAKOTA

by

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This thesis submitted by John D. Odegard in partial fulfillment of the requirements for the Degree of Master of Science in the University of North Dakota is hereby approved by the Committee under whom the work has been done.

Chairman

Dean of the Graduate School

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ABSTRACT

The purpose of this study is to determine the feasibility of private aircraft transportation for the University of North Dakota and analyze the costs involved.

Safety of private aircraft transportation is discussed with emphasis on the added safety of flying in North Dakota. This additional safety factor is attributed to the low terrain, numerous airports and suitable flying weather in North Dakota.

Economic justification is determined by comparing total operating costs, which include aircraft operating costs, depreciation and "value per man hour", to transportation costs incurred while traveling by commercial airlines or by University Motor Pool automobile. Value per man hour puts a quantity cost on the lost time of the University employee, faculty or administrator.

Break-even analysis of the various transportation alternatives indicate a definite justification for the proposed private aircraft transportation. Based on the expected usage of a University aircraft, ownership, instead of lease or charter, would present optimum economy.

By acquiring a private aircraft for transportation, the University should increase its management effectiveness and produce a substantial savings in transportation costs.

CHAPTER I

THE GROWTH OF AIR TRANSPORTATION

Man has always been fascinated by flying. We know that the ancient Chinese made drawings of flying contraptions, the Greeks talked and wrote about aeronautics, and that the 15th century jack-of-all trades, Leonardo da Vinci, designed and made a small model helicopter which actually flew. In the 19th century, balloons were a craze; but man was still possessed by the dream of flying in a machine heavier than air. And, very early in that bright new century, the 20th, man achieved his dream. On the 17th day of December in 1903, which was a bleak, windy day at Kitty Hawk, North Carolina, the Wright Brothers made their historic flight. Orville modestly and precisely described it like this:

> This flight lasted only twelve seconds, but it was nevertheless the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, and sailed forward without reduction of speed, and had finally landed at a point as high as that from which it started.[1]

That historic flight was just a little over fifty years ago and was the keystone of the transportation industry

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[1]Federal Aviation Agency, Jennies to Jets (Washington: U.S. Government Printing Office, 1963), pp. 1-2

as we know it today. When Rudyard Kipling saw his first airplane, he remarked, "There is what we refer to as a flying machine. In it I see the opening verse of the opening page of a chapter that has no end. The subject is without limitation."[2] Aviation began to play a bigger role after we had entered the World War I; and, when the War ended, the Army and the Navy had over 6,000 planes with pilots who loved to fly; so the 1920's began with a craze for aviation.[3]

This early phase of aviation produced the thrill-seeking, fun-loving barnstormer and a reputation that the industry today still has not entirely outlived. World War II was another turning point for the aviation field and the source of thousands of pilots and fast, reliable aircraft. The aviation boom was here, and it continued to grow at a phenomenal rate. Every year produced new records in the number of pilots, aircraft, landings and takeoffs, and the volume of passengers carried. Many of the pilots of World War II were now in the corporate world and through their businesses were able to purchase aircraft for corporate use. The majority of the aircraft purchased were ex-military planes of various configurations and were far from economical business tools. In most cases, no actual costs were accumulated; and the planes were used for business but with a large emphasis on

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[2]Cessna Aircraft Company, Bridges to the Future, p. 2.

[3]Federal Aviation Agency, p. 4.

pleasure. Regardless of their motives, this was the start of corporate aviation.

It did not take long for the general aviation aircraft manufacturers to realize that ex-military aircraft could be efficiently replaced by smaller, more economical aircraft. Thus, a whole new market opened for the amazing new business tool, usually identified as the "company plane". It was discovered that most business machines are designed to increase the efficiency and productivity of factory workers, accountants, and technical personnel; whereas, the company plane is the first business machine designed to increase the efficiency, productivity, and money-making capacity of men and women at executive levels.[4]

The real turning point for general aviation, which is the entire aviation industry less military and common carriers, actually came only a few short years ago and was hastened by thousands of former World War II pilots reaching executive levels and applying principles of military mobility to widespread marketing operations. The competitive advantages of business flying have become so multiple and the cost so low in relation to the benefits that general aviation now exceeds the combined operations of all the country's commercial airlines. In fact, privately owned airplanes are transporting businessmen on more trips to more places, everyday,

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[4]Beech Aircraft Corporation, Answers to Nineteen Questions Most Frequently Asked About Business Flying (Wichita, Kansas), p. 3.

than all U.S. airlines put together.[5]

This new mode of transportation puts top men in the right places, at the right time, to do the right job, and to make the right decisions. These private planes travel four times faster than automobiles and to more than 8,000 airports not served by commercial airlines. In addition, these company airplanes can save valuable time as compared against modern jet airliners. Naturally, they cannot match coast-to-coast flight time; but they can save time on shorter round trips, multiple-destination flights, inter-line connections, and trips to airports without airline connections.[6]

General Aviation has grown until it is now the largest employer of any nonagrarian industry and has moved into a predominant position in the transportation field. This transportation industry alone accounts for one dollar out of every five dollars comprising the Gross National Product and employs fourteen per cent of the nation's total civilian employment.[7]

This media of transportation is presently non-existent at the University of North Dakota as the present University transportation system is composed mainly of a ten-car motor pool under the jurisdiction of the Auxiliary Services Department. Three of these automobiles are permanently assigned to the Athletic Department, one is restricted for local use only,

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[5]Beech Aircraft Corporation, Answers to Nineteen Questions Most Frequently Asked About Business Flying (Wichita, Kansas), p. 4.

[6]Ibid., p. 10.

[7]Cessna Aircraft Company, p. 3.

one is reserved for Civil Defense, and the other five may be used for miscellaneous trips either in or out of state. Personal automobiles and other modes of transportation may be used with proper authorization; however, all transportation is under the authority of the "State Travel Regulations" (Appendix A).

For travel outside of the State of North Dakota, an application for travel authorization must be completed one month prior to the desired trip and approved by the Dean of the College, President of the University, State Board of Higher Education, and the Governor of North Dakota. The media to be used is, of course, included in the application.

For travel inside the State, a "Report of Absence from Campus" form must be completed (Appendix A), which requires the approval of the Department Chairman and the Dean of the College. This also is under the authority of the State Travel Regulations which say, "Plane travel inside the State will be paid only if certain unusual circumstances make air travel necessary and if reasons are fully explained and justified on the voucher."

Reimbursement for use of personal automobile is at the rate of 8-½¢ per mile, and the mileage should be taken from state maps, not from the car's speedometer unless "vicinity" travel is approved and indicated on the voucher. The respective departments are charged for these reimbursements. If one of the University vehicles is used for a trip, either in or out of state, the department is indicated on the trip ticket and is charged 5¢ per mile for the trip.

The purposes of this thesis are to examine the area of private aircraft transportation for the University of North Dakota, analyze the costs involved, determine the actual feasibility, and give the writer's views on the desirability and profitability of incorporating this mode of transportation.

CHAPTER II

SAFETY OF PRIVATE AIRCRAFT TRANSPORTATION

Private aircraft transportation has a better safety record than most travel methods used by executives today. It is extremely difficult to produce accurate data which prove statistically the actual safety of aircraft transportation as too many estimates must be used. For example, no one knows exactly how many flights and hours were flown, how many people were carried, how far they went, or even how many private aircraft were involved in accidents. These accidents are normally included in the FAA general aviation category which includes the aeronautical activities of students, aerial applicators, air taxi pilots, pleasure and recreational flying, personal business flying, corporate/executive flying (by professional pilots), and even illegal flying by unlicensed pilots. Needless to say, there is a great difference between the professional business pilot and the student or non-licensed pilot. Naturally, combining their statistics will not yield an accurate, usable result. When attempting to draw a conclusion from statistics of this nature, a good rule to be remembered is: "Statistics are like bikinis . . . what they reveal is interesting . . . what they conceal is vital."[1]

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[1]William K. Lawton, "In Good Company," Flying, Vol. IV (October, 1965), p. 52.

The safety of private aircraft transportation is greatly affected by the superior design and precision of an aircraft engine which is unknown on other engine assembly lines. Every part of an aircraft engine and the components of the airplane itself are meticulously tested and inspected before they are installed in the airplane. In addition to the maximum safety design, any aircraft that is used for any commercial form of flying, is thoroughly inspected according to Federal Aviation Agency regulations after every 100 hours of flight. Any form of maintenance and every 100 hour inspection must be in accordance with FAA regulations and specifications. Logbooks for both the aircraft and engine must be maintained and inspected by FAA certified mechanics with entries made for any form of maintenance which is done to the engine or aircraft. Think of the increased safety if automobiles were required to maintain these standards and submit to these periodic inspections.

The pilots themselves also attribute to the safety of this transportation media, especially when considering the professional pilot and crew. The pilot flying executive aircraft will probably have a minimum of 1,000 hours of flying experience. He has completed hundreds of hours of studying and has passed, on the average, five very comprehensive examinations given by the FAA. The majority of these pilots are operating under FAA regulations for "Air Taxi and Commercial Operators of Small Aircraft," Part 135, which states:

> No person may act as pilot in command of an aircraft at night unless he has had at least 500 hours of flight time as pilot, including at least 100 hours of cross-country flight time, at least 25 hours of which were at night. No person may act as pilot in command of an airplane carrying passengers at night unless he holds an instrument rating.[2]

To further increase safety of flight operations under Part 135, the FAA has established "recent experience requirements" for the pilot in command of small multiengine aircraft and while operating in instrument conditions. This normally is referred to by the FAA as "operations under Instrument Flight Regulations."

> No person may act as pilot in command of a small multiengine airplane unless he has, within the preceding 12 calendar months--
>
> (1) Had at least 20 hours of pilot-in-command time in small multiengine airplanes, including at least 10 hours in the type of airplane in which he is to act as pilot in command; or
>
> (2) Passed a flight and oral check, given by the Administrator or an authorized check pilot; in the type of airplane to be used.[3]

> No person may act as pilot in command of an aircraft under IFR unless he has passed, within the preceding 6 months, the most recent check given to him by the Administrator or an authorized check pilot.[4]

These regulations and their enforcement help to point out that every effort is made by the FAA to help the pilot

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[2]Federal Aviation Agency, Federal Aviation Regulations, Part 135--Air Taxi Operators and Commercial Operators of Small Aircraft (Washington: U.S. Government Printing Office, April 1, 1965), p. 2.

[3]Ibid.

[4]Ibid.

and the aviation industry in general to operate as safely as possible.

Just how safe is this private aircraft transportation and how does it compare to commercial air carrier operations and to automobile transportation? It has already been pointed out that accurate statistics are not published by any governmental organization and that "guesstimates" must be made; however, National Business Aircraft Association has been doing extensive work in this area by compiling statistics and raw data from the U.S. Civil Aeronautics Board, Federal Aviation Agency, National Safety Council, Interstate Commerce Commission, Bureau of Public Roads, National Association of Motor Bus Operators, American Transit Association, and the Bureau of Safety. The comparison usually requested is between scheduled air carriers (airlines) to corporate flying. These accident rates are compared on a 100,000-hour base, but some of the operational differences should be understood before a side-by-side comparison is attempted.

The scheduled air carriers, which are flown by the unionized airline pilot, fly fixed routes which the pilot will fly repeatedly up to 85 hours per month. To help support these flight operations, the air carriers have professional dispatchers that aid in the pre-flight planning which sometimes even includes computerized flight plans. Baggage handling, loading, refueling, ground servicing, maintenance assistance, and food catering is all handled by additional personnel which in essence reduces the airline captain's responsibility to a single purpose--fly the aircraft safely to its destination.[5]

The corporate pilot, on the other hand, is usually responsible for the pre-flight activity, maintenance, catering, and all the operating functions of his airplane for each particular flight. In addition, while there may be a few fixed routes, destinations are more frequently dictated by the needs of the company or organization. He must remain extremely flexible and must adapt to the changing requirements and plan his flight accordingly. "The corporate aviation pilot is a professional and safety is paramount, but there is a substantially greater individual effort required in completing the flight to the satisfaction of the passengers."[6]

In Table 1, the safety records of the various sections of the aviation industry are compared by showing the estimated hours flown, total accidents, and the fatal accidents. Preliminary data was used for the 1965 statistics as complete data was available only through 1964. It is quite obvious that the safety record of general aviation with 3.2 fatal accidents every 100,000 hours does not compare very favorably to the safety record of certified air carrier operations with only 0.26 fatal accidents every 100,000 hours in 1964. It must

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[5] Business Flying, Special Report 67-6 (Washington: National Business Aircraft Association, Inc., 1967), p. 11.

[6] Ibid.

be remembered, as was mentioned earlier, the general aviation category includes the student pilot through the air taxi operator. The picture makes a drastic change when the certified air carrier operations are compared to the safety record of the corporate aircraft which are flown by professional pilots. It is, in fact, remarkable how similar the accident rates in 1964 are with the air carrier having 0.19 fatal accidents while corporate aviation shows only 0.14 fatal accidents per 100,000 hours. These statistics take on an added significance when due consideration is given to the operational differences between the two segments as was mentioned earlier. It is certainly obvious corporate flying is at least as safe as airlines, and apparently a little safer.

It is extremely difficult to compare the relative safety of highway travel and air transportation as they are so completely different and, for the most part, lack any common basis for comparison.

> Aircraft accidents are very personal and are very rarely caused by anyone but the pilot of the plane involved. On the other hand, automobile accidents may involve half a dozen cars with no one taking the blame. You can be the safest driver in the world, but if you're on a narrow, winding road with a drunken driver coming at you doing 70 MPH, you've had it.[7]

With the pilot almost totally responsible for accidents and

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[7]Robert L. Bornarth AOPA195093, "How Safe Is Private Flying?" AOPA Pilot, Vol. 7 (October 1964), p. 13.

TABLE 1

SAFETY RECORD FOR ALL GENERAL AVIATION[a]

Year	Est Flt Hr In Thousands	Total Accidents	Rates Per 100,000 Hr	Fatal Accidents	Rates Per 100,000 Hr
1962	14,500	4,840	33.4	430	3.0
1963	15,106	4,690	31.0	482	3.2
1964	15,738	5,070	32.2	504	3.2
1965*	16,733	5,250	31.4	516	3.1

SAFETY RECORD FOR AIR CARRIER AIRCRAFT (AIRLINES)

1962	3,887	63	1.62	5	0.13
1963	3,904	66	1.69	10	0.26
1964	3,774	59	1.53	11	0.26
1965*	4,071	65	1.59	8	0.19

SAFETY RECORD FOR CORPORATE AIRCRAFT (PROFESSIONAL PILOTS)

1962	3,954	80	2.02	10	0.25
1963	3,897	69	1.77	8	0.21
1964	3,688	84	2.02	14	0.36
1965*	3,416	60	1.75	5	0.14

Numbers of accidents presented have been provided by Bureau of Safety, CAB. All flight hours and rates based on FAA estimates of total flight activity in each-named operational area.

*Preliminary data.

[a]National Business Aircraft Association, Inc., Business Flying, Special Report, 67-6 (Washington: March, 1967), p. 12.

the lack of the "other guy", it is often hard to compare this information statistically; however, there is a common denominator--transportation accident death rates. Table 2 clearly shows, on the basis of 100,000,000 passenger miles, that there was an average death rate in 1965 of 2.40 people traveling in automobiles compared to 0.38 people traveling by scheduled air carrier. With the accident rate that has been preliminarily established for 1965, this would show a death rate of 2.40 for automobiles compared to approximately 0.35 for corporate aircraft. Roughly these statistics indicate you are about 685% safer in an airplane flown by a corporate pilot than you are in an automobile. This somewhate substantiates the feeling of most pilots that "the most dangerous part of any flight is the drive to and from the airport on crowded highways."[8]

There are, of course, many additional variables which affect the safety of air transportation, two of the most important being the typical weather patterns of a certain area and the type and elevation of the terrain over which you may be operating.

Weather is a very important consideration as the majority of all general aviation accidents are caused by weather. However, this is an indirect cause as the inability of the inexperienced general aviation pilot to control the airplane by

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[8]Robert L. Bornarth AOPA195093, "How Safe is Private Flying?" AOPA Pilot, Vol. 7 (Oc-ober 1964), p. 13.

TABLE 2

TRANSPORTATION ACCIDENT DEATH RATES, 1961 TO 1965[a]

Kind of Transportation	1965		
	Passenger Miles	Passenger Deaths	Death Rate per 100,000,000 Passenger Miles
Passenger Deaths in--			
Passenger automobiles and taxis*	1,370,000,000,000	32,700	2.40
Passenger automobiles on turnpikes . .	36,000,000,000	400	1.10
Buses	61,000,000,000	110	0.18
Intercity buses**	18,800,000,000	44	0.23
Railroad passenger trains	17,420,000,000	12	0.07
Scheduled air transport planes (domestic)	54,260,000,000	205	0.38
Corporate aircraft***			0.35

Source: Railroad data from Interstate Commerce Commission; airplane data from Civil Aeronautics Board; motor-vehicle data, approximation by National Safety Council based on data from state traffic authorities, Bureau of Public Roads, National Association of Motor Bus Operators, American Transit Association, and Interstate Commerce Commission.

*Drivers of passenger automobiles are considered passengers.

**Class I only, representing about four-fifths of total intercity bus passenger mileage.

***Interpolated from Illustration I.

[a]National Business Aircraft Association, Inc., Business Flying. Special Report, 67-6 (Washington: March, 1967), pp. 12-13.

reference to the aircraft instruments when operating in adverse weather conditions is the primary cause. Since our main consideration will be for the corporate type flying with professional pilots, our observation will be directed toward the "flyability" of the weather rather than the ability of the pilot.

The western and eastern coast line states are often plagued by fog and low stratus cloud conditions which restrict the aviation operations. These conditions are frequently below FAA minimums for either visual or instrument flight. Other parts of the country have weather problems which are also particular to their areas such as frequent severe thunderstorms in the spring and summer months in the west and southwest mountainous areas. North Dakota, with the exception of occasional extreme cold weather in the winter months, does not have any actual limiting weather factors.

The U.S. Weather Bureau did a monthly study of flying weather in Bismarck for six years and a similar study in Fargo for four years to classify the flying weather for North Dakota. The studies, which are summarized in Table 3, revealed that for Bismarck, on an annual average, 93% of the time the weather was suitable for contact flying which means the ceiling is 1,000 feet or higher and the visibility is 3 miles or more. Five per cent of the time the conditions were below contact but suitable for instrument flying which means the ceiling is 500 feet or higher and the visibility is under 1 mile. It appears the worst flying weather is in the month of March with contact conditions 85% in Fargo and 88% in Bismarck. The best weather appears to be in July with contact conditions 99% of the time in both Fargo and Bismarck. It is believed "that the averages for Bismarck and Fargo fairly represent the conditions within the state as a whole."[9] Therefore, weather is not actually a limiting factor and will seldom affect the scheduling of a trip. In fact, from September, 1966, through January, 1967, North Dakota State University had a contract with Flight Development, Inc., of Fargo, North Dakota, for 11 trips to Bismarck, Dickinson, Beulah, Minot, wait three hours and return via the same route all in the same day. The only trip delayed by weather was caused by a severe snowstorm that halted all transportation in the area. With that exception, they were usually home by 6 p.m.[10]

The terrain over which you are flying is another important factor to consider when analyzing the safety of air transportation. The danger of a forced landing or engine malfunction becomes greater in a high mountainous terrain than in low flat terrain. Also, the distance and accessibility of airports along proposed flight paths are of significance.

North Dakota and the proposed flight paths for the

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[9]Letter from Harold G. Vavra, Director, Aeronautics Commission, State of North Dakota, Bismarck, North Dakota, January 18, 1967.

[10]Interview with James Peterson, President of Flight Development, Inc., March 28, 1967.

TABLE 3

CLASSIFICATION OF FLYING WEATHER (Frequency Percentages)[a]

	Contact		Instrument		Closed	
	(BIS)	(FAR)	(BIS)	(FAR)	(BIS)	(FAR)
January	90	92	6	4	4	4
February	87	89	9	5	4	6
March	88	85	8	9	4	6
April	93	96	6	3	1	1
May	94	92	5	6	1	2
June	94	94	5	5	1	1
July	99	99	1	1	0	0
August	97	94	2	4	1	2
September	96	96	3	2	1	2
October	95	95	3	3	2	2
November	87	92	9	6	4	2
December	91	88	6	7	3	5
Annual Average (%)	93	92	5	5	2	3

(BIS)--Bismarck, North Dakota
(FAR)--Fargo, North Dakota

Contact--Ceiling 1,000 feet or more and visibility three miles or more.
Instrument--Either element below above minima, but not below 500 ft. ceiling and/or one mile visibility.
Closed--Ceiling below 500 feet or visibility below one mile.

[a]FAA Weather Bureau--Fargo & Bismarck, North Dakota.

University of North Dakota offer advantages in both directions. Table 4 indicates the typical flight path areas of operation. It should be noted that at no time, while on these proposed flight paths, are you more than 22 miles from an FAA approved airport. Assuming an average ground speed of 180 MPH, you are never more than 10 minutes from an airport. This is certainly an important safety factor when compared to flying in parts of the country in which you are over an hour from a usable airport.

The elevation of the terrain is also important because as you increase in altitude, the density of the air decreases and, accordingly, the performance of the aircraft will decrease. Increase in temperature and humidity will also decrease the density. Therefore, on a hot day and at a high elevation, the efficiency of an airplane will be greatly decreased; and, at extremely high temperatures and altitude, the airplane's service ceiling may be exceeded. This means the airplane is incapable of flight under those conditions. An example illustrating service ceiling and density altitude would be that a typical 4-place single-engine airplane with a service ceiling of 10,000 feet would have no trouble operating from Denver, Colorado, (elevation 6,000 feet) as the airplane should be able to fly almost 4,000 feet above the ground. However, on an extremely hot day and with a little extra humidity, the density altitude of Denver may be 12,000 feet; consequently, even with 15 miles of runway, the airplane

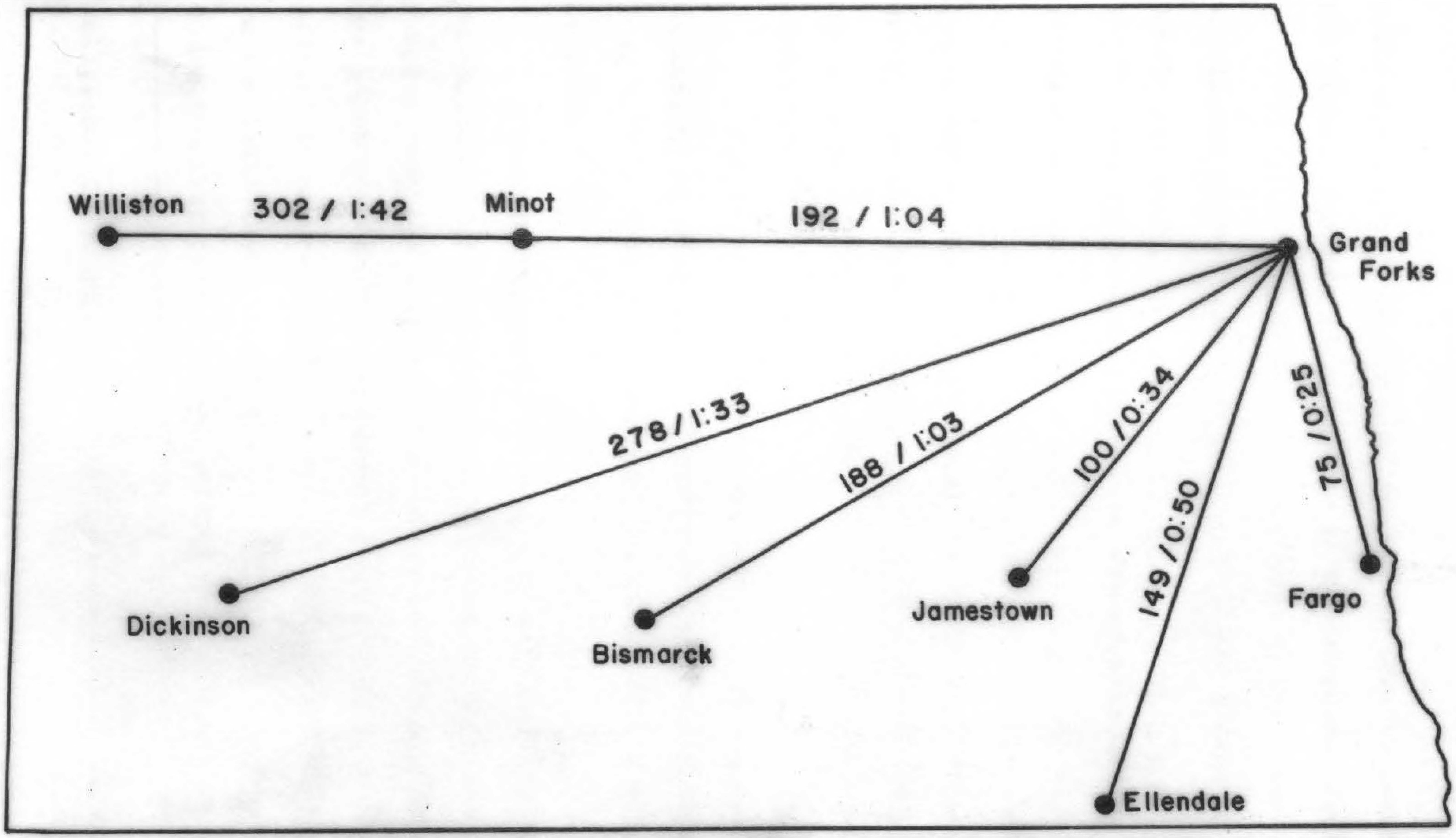
TABLE 4

TYPICAL TRAVEL AREAS FROM GRAND FORKS

To City	Distance (Statue Miles) (1)	Terrain (Above Sea Level)			Greatest En Route Distance from Any Airport (3)	Average Time En Route (4)	Longest Time to Closest En Route Airport (4)
		Highest (2)	Lowest (5)	Obstructions (2)			
Bismarck	188	2,130'	842'	2,413'	15 Miles	1:03	5 Min.
Williston	302	2,245'	842'	2,845'	20 Miles	1:42	6½ Min.
Minot	192	1,723'	842'	2,197'	15 Miles	1:04	5 Min.
Dickinson	278	2,707'	842'	3,556'	20 Miles	1:33	6½ Min.
Jamestown	100	1,498'	842'	1,985'	10 Miles	:34	3½ Min.
Fargo	75	900'	842'	1,338'	14 Miles	:25	4½ Min.
Ellendale	149	1,450'	842'	2,495'	22 Miles	:50	7½ Min.
Valley City	80	1,570'	842'	2,495'	22 Miles	:28	7½ Min.

(1) Measured on FAA Sectional Aeronautical Chart (airport to airport).
(2) Within a measured 10 statue miles of the course.
(3) Measured distance from any FAA approved airport while en route.
(4) Based on average 180 MPH ground speed.
(5) Grand Forks Elevation.

[a]Information obtained for Fargo, Minot, Miles City, and Williston Sectional Aeronautical Charts. U.S. Department of Commerce (Washington, D.C.: June 1966).



NUMERATOR IS THE DISTANCE FROM GRAND FORKS IN AIR MILES AS GIVEN BY THE FAA.
DENOMINATOR IS THE TIME FROM GRAND FORKS AT 180 MPH.

could not get off the ground. It can be seen in Table 4 that the highest terrain elevation along the proposed flight paths is 2,707 feet; therefore, the high density altitude factor should not present any safety hazards while flying over North Dakota prairies.

The final safety factor to consider is the twin-engine aircraft and its apparent safety. Although airplane engines have been refined to a high degree of reliability and an engine failure is rare, the possibility is still there. Naturally, the twin-engine provides additional safety, especially for the pilots who fly at night and under instrument conditions.[11]

Table 5 substantiates the apparent safety and desirability of multiengine aircraft as they have increased from 7.7% in 1958 to a projected 15.2% in 1971 of the general aviation fleet.

However, there are a couple of problems that should be explained. First, the light twin-engine airplane is more complex than the single-engine plane; and the proficiency of the pilot must accordingly exceed that of the single-engine pilot. If the twin-engine pilot is not sufficiently proficient in the light twin, the complexity of the aircraft could easily cause the risk factor to be greater than if you were flying

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[11]T. M. Smith, Multiengine Airplane Rating (North Hollywood, California: Pan American Navigation Service, 1964), p. 5.

TABLE 5

ACTIVE GENERAL AVIATION AIRCRAFT, 1958-71[a]

Year	Total Aircraft	Multiengine Aircraft	% Multiengine Aircraft
1958	65,289	5,036	7.7
1959	67,839	5,416	8.0
1960	68,727	6,034	8.8
1961	76,549	7,243	9.5
1962	80,632	8,400	10.4
1963	84,121	9,186	10.9
1964	85,088	9,695	10.2
1965	88,742	10,044	12.0
*1966	97,300	12,200	12.5
*1967	102,200	13,400	13.1
*1968	107,300	14,700	13.7
*1969	112,600	16,000	13.3
*1970	118,000	17,400	14.7
*1971	123,400	18,800	15.2

*Forecasted figures.

[a]Federal Aviation Agency, "Aviation Forecasts F4 1966-71," December 1965.

in a single-engine airplane. Historically, some older multi-engine pilots have said, "Two engines only mean twice the chance of engine failure." If you adopt this premise, you are still safe providing you have a capable pilot. However, with an incapable or inexperienced pilot at the controls, a single-engine airplane gliding to a forced landing is actually safer than a twin-engine with one engine out and a confused pilot. But there can be no doubt that with capable hands at the controls, the twin-engine aircraft is by far the safer of the two.

The second problem in twin-engine flying is the possibility of exceeding the aircraft limitations of single-engine service ceiling. Most light twin-engine aircrafts have a service ceiling of 18,000 to 20,000 feet with both engines operating. However, excluding any discussion on density altitude and its effects, many of these airplanes have a single-engine service ceiling in the 5,000 to 6,000 foot range. This means if the airplane were to have an engine failure and continue flying on one engine, it would be able to maintain altitude up to its single-engine service ceiling. The problem arises when operating in higher elevation areas that exceed the single-engine ceiling. Take, for example, a typical light twin with a single-engine ceiling of 5,000 feet operating out of Denver on a mountain flight; if this plane should have an engine failure, the maximum altitude it could maintain on one engine is 5,000 feet. The problem, of course, is that the ground elevation is higher than 5,000 feet so the airplane must land. There is, however, an advantage to a slow controlled descent with some power rather than the much faster, no-power descent you would have with an engine failure in a single-engine airplane.

The increased safety of this twin-engine operation in North Dakota is substantial because of the low terrain elevation. Even with the lowest single-engine ceiling twin, it would be possible to lose an engine over Bismarck, climb to 5,000 feet above sea level, and fly back to Grand Forks. This is definitely much safer than losing an engine over Colorado or Wyoming and also much safer than a single-engine airplane.

CHAPTER III

OPERATIONAL COST ANALYSIS

Operational costs, much like statistics, offer no easy interpretation and can be used to prove a number of contradictory conclusions. However, skillfully handled and derived, they can provide valuable information which, when compared under standardized and identical conditions, will yield a meaningful analysis.

However, it must be remembered that the purpose of this thesis is not to recommend any particular aircraft but to analyze the operational costs of private aircraft transportation in general and to establish the feasibility of its operation at the University. Therefore, three groups of airplanes were used for the study and were selected and grouped according to their comparability of speed, price, operational costs, seating capacity, and the historical operating data available. The selected groups are as follows:

Group I TWIN ENGINE (OVER 200 MPH)
1. Piper Aztec PA-23 (203 MPH)
2. Beech Baron B-55 (220 MPH)
3. Cessna 310 (221 MPH)

Group II SINGLE-ENGINE (180 MPH)
1. Piper Commanche PA-24 (176 MPH)
2. Beech Debonair B-33 (180 MPH)
3. Cessna 210 (190 MPH)

Group III SINGLE-ENGINE (160 MPH)
1. Mooney M21 (168 MPH)
2. Cessna 182 (159 MPH)

Naturally, the actual cost per hour of aircraft operation for a non-profit organization like the University will differ considerably from profit-seeking business organizations because of the depreciation factor alone. Business organizations are able to apply investment credit and accelerated depreciation methods and receive tax advantages which are considered in their total hourly operational costs. The University, being a non-profit entity, would only be concerned with the actual decline in resale value or increase in replacement cost of the aircraft. For this reason an equitable method of depreciation was determined by analyzing historical declines in resale values for the past five years.

The total depreciation for five different models from one to five years old was divided by the sum-of-the-years involved giving a weighted average depreciation in resale value per year (see Appendix B). For example, the total depreciation for the five Piper Aztec models is $98,150; divided by 15 (sum-of-the-years), it equals a $6,543 weighted average depreciation in resale value. This annual depreciation rate is considerably higher than a straight-line depreciation for five years and about equal to a straight-line rate for three years. This depreciation is then applied on a 300-, 500-, and 700-hour basis of annual operation to determine the depreciation rate per hour. The average rate per hour for each group was used in the actual cost analysis as shown in Table 6. It should be noted that the decline in resale value or increase in replacement cost is dependent on numerous variables such as the maintenance history, hours flown, type of usage, type and amount of original equipment, and the area purchased and resold. In addition, the depreciation rate used is very liberal as aircraft are seldom purchased for full retail price, which was used in determining the depreciation rates. It should be concluded that the depreciation rate used in this study to determine the total cost per hour is the maximum decline the University should experience in operating a private aircraft for transportation.

The estimated operating costs, which exclude this depreciation factor, for each of the aircraft considered are illustrated in detail in Appendix C on the basis of 300, 500 and 700 hours of operation per year. This information was determined from manufacturer's recommendations, specifications, national averages, and known Grand Forks area costs. These operating costs were computed in two groups:

Direct Operating Costs Per Hour:
- a) Gasoline
- b) Oil
- c) Inspection, Maintenance, and Propeller Overhaul
- d) Engine Exchange Allowance

Indirect Operating Costs:
- a) Hangar Rental
- b) Insurance
- c) Pilot Salary

The majority of these costs are very accurate and in some cases exact; however, the last indirect operating cost mentioned, pilot salary, should be discussed. In the event

TABLE 6

DEPRECIATION ANALYSIS (RESALE VALUES)

	Weighted Average (Per Year)*	Depreciation Per Hour 300	500	700
GROUP I				
Twin-Engine (Over 200 MPH):				
Piper Aztec (203 MPH)	$6,543	$21.81	$13.09	$9.35
Beech Baron (220 MPH)	6,143	20.48	12.29	8.78
Cessna 310 (221 MPH)	6,630	22.10	13.26	9.47
GROUP II				
Single-Engine (180 MPH):				
Piper Commanche (176 MPH)	1,920	6.40	3.84	2.74
Beech Debonair (180 MPH)	2,468	8.22	4.94	3.53
Cessna 210 (190 MPH)	2,803	9.34	5.61	4.00
GROUP III				
Single-Engine (160 MPH):				
Mooney M21 (168 MPH)	1,920	6.40	3.84	2.74
Cessna 182 (159 MPH)	2,240	7.47	4.48	3.20

Average Depreciation Rates To Be Used In Cost Analysis:	Annual	300	500	700
GROUP I (Twin-Engine)	$6,439	$21.46	$12.87	$9.20
GROUP II (Single-Engine)	2,397	7.99	4.79	3.24
GROUP III (Single-Engine)	2,080	6.93	4.16	2.97

*Weighted Average depreciation determined by dividing the total depreciation of resale value by the sum-of-the-years involved (see Appendix B.).
Example: Piper Aztec:

$$\frac{\text{Total Depreciation}}{\text{Sum of the years}} = \frac{\$98,150}{15} = \underline{\underline{\$6,543}} \text{ (Annual Weighted Depreciation)}$$

the University purchased an aircraft for its executive use, a full-time pilot would probably be hired. However, his full responsibility may not be to only pilot the aircraft but possibly also to direct an aviation department, teach in his related area, or to work in some administrative position. Therefore, rather than to attempt to estimate these possibilities, a $6 per-hour rate was applied for the pilot salary cost. This rate was used because in the Grand Forks area there are several professional pilots who would be available on a per-trip basis at this hourly rate. Table 7 then summarizes the operating costs per airplane and shows the average operating cost for each group and also the total cost (including depreciation of resale value) for each group, rounded to the nearest dollar. Quite frankly, no one except the airlines and military have had enough experience to determine precisely what the increase or decrease of operating costs will be when buying new equipment.[1] A sensible assumption is that the increase in maintenance costs of older aircraft is offset by the decrease in depreciation.

It should be noted that the cost per airplane hour does not provide a true indication of the real cost or values of the airplane because it does not take into full consideration the speed or the passenger carrying capability of the

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[1]Harley D. Kysor, An Operator Looks at Business Aircraft Operating Costs (Reprint from May 1965 Conference Proceedings of Society of Automative Engineers), p. 65.

TABLE 7

OPERATING COST ANALYSIS

	Hours Per Year		
	300	500	700
Operating Costs Per Hour: (1)			
GROUP I (200 MPH)			
Piper Aztec	$32.41	$30.48	$29.64
Beech Baron	33.70	31.59	30.68
Cessna 310	32.82	30.77	29.90
GROUP II (180 MPH)			
Piper Commanche	19.62	18.50	18.02
Beech Debonair	18.64	17.47	16.97
Cessna 210	21.25	20.10	19.60
GROUP III (160 MPH)			
Mooney M21	16.02	15.10	14.70
Cessna 182	18.01	17.02	16.60
Average Operating Cost:			
GROUP I	$32.98	$30.95	$30.07
GROUP II	19.84	18.69	18.20
GROUP III	17.01	16.06	15.65
Average Total Cost Per Hour: (2)			
GROUP I (215 MPH)	$54	$44	$39
GROUP II (182 MPH)	28	23	22
GROUP III (162 MPH)	24	20	20

(1) Appendix C.

(2) Includes depreciation of resale value from Depreciation Analysis on Page 29; total cost is rounded to nearest dollar. MPH is based on average cruise speed.

airplane. The cost per hour is only a step that must be taken to determine the cost per mile and the cost per passenger seat mile. The cost per mile is the first indication of the real value of the airplane as it indicates the cost to fly the airplane per mile; the cost per passenger seat mile indicates the cost to fly each passenger seat in the airplane one mile.[2] Table 8 indicates the average cost per airplane mile and the cost per passenger mile. These costs were determined by using the average total cost per hour and the average block speed. Block speed, which includes ground handling, taxiing, and maneuvering, was used in an attempt to give an accurate as possible picture of the true costs. Block speed for the purpose of this study is considered to be a realistic speed at 90% of average standard cruise speed. Although the average total cost per hour and the average cost per airplane mile vary considerably, it should be noted how close the average cost per passenger seat mile is in all three groups. This is an accurate cost which gives consideration to the cost per hour, speed, and number of passenger seats. Under all bases, the average cost per passenger seat mile in Group I is actually slightly less than the Group II or III aircraft. Therefore, in addition to increased safety, the twin-engine is actually more economical on the cost per passenger seat basis.

However, in terms of strictly dollars and cents,

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[2]Harley D. Kysor, An Operator Looks at Business Aircraft Operating Costs (Reprint from May 1965 Conference Proceedings of Society of Automative Engineers), p. 64.

TABLE 8

AVERAGE COST PER AIRPLANE AND SEAT MILE

	Hours Per Year 300	500	700
Average Cost Per Airplane Mile:[1]			
GROUP I (194 MPH)	$0.278	$0.226	$0.201
GROUP II (164 MPH)	0.17	0.14	0.134
GROUP III (146 MPH)	0.164	0.136	0.136

	300	500	700
Average Cost Per Passenger Seat Mile:[1]			
GROUP I (5 Pass. Seats)	.055	.045	.040
GROUP II (3 Pass. Seats)	.056	.046	.044
GROUP III (3 Pass. Seats)	.054	.045	.045

[1]Costs per mile are based on block time which is 90% of manufacturers specified cruise speed.

business aircraft are not economical 100 per cent of the time. It costs $.08 per passenger seat mile for first class passage on scheduled domestic airline flights with many of the smaller feeder lines slightly higher.[3] Needless to say, a person can fly from Grand Forks to New York more economically on airlines than by business aircraft because of the speed and the low cost per seat mile. However, there are additional costs in lost time incurred, such as waiting for the airline, baggage, tickets, checking baggage, and passenger congestion when loading. Take for example, a typical trip from Grand Forks to Minneapolis. The following parameters are established in making the time comparisons:[4]

1. Best airline schedule available from Grand Forks assuming, when applicable, a straight non-stop flight.

2. Unless indicated, the Group I, twin-engine aircraft, will be used with an average block speed of 194 MPH and a total average operating cost of $44 per hour. In all examples, the costs under the 500-hour per-year basis will be used as in the opinion of the author they most closely represent the actual costs to be incurred by the University.

3. Business aircraft and airliner will land at the same airport.

4. In some cases, the airport to meeting time is considered slightly greater because of walking

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[3]Air Transportation Association of America, Air Transportation Facts and Figures, 1966, An Official Publication of the Air Transport Association of America (Washington: Air Transportation Association, 1966), p. 35.

[4]Henry W. Ryan, Economics of Business Aircraft, presented at Business Aircraft Conference, Wichita, Kansas (March 30 - April 1, 1966), p. 3.

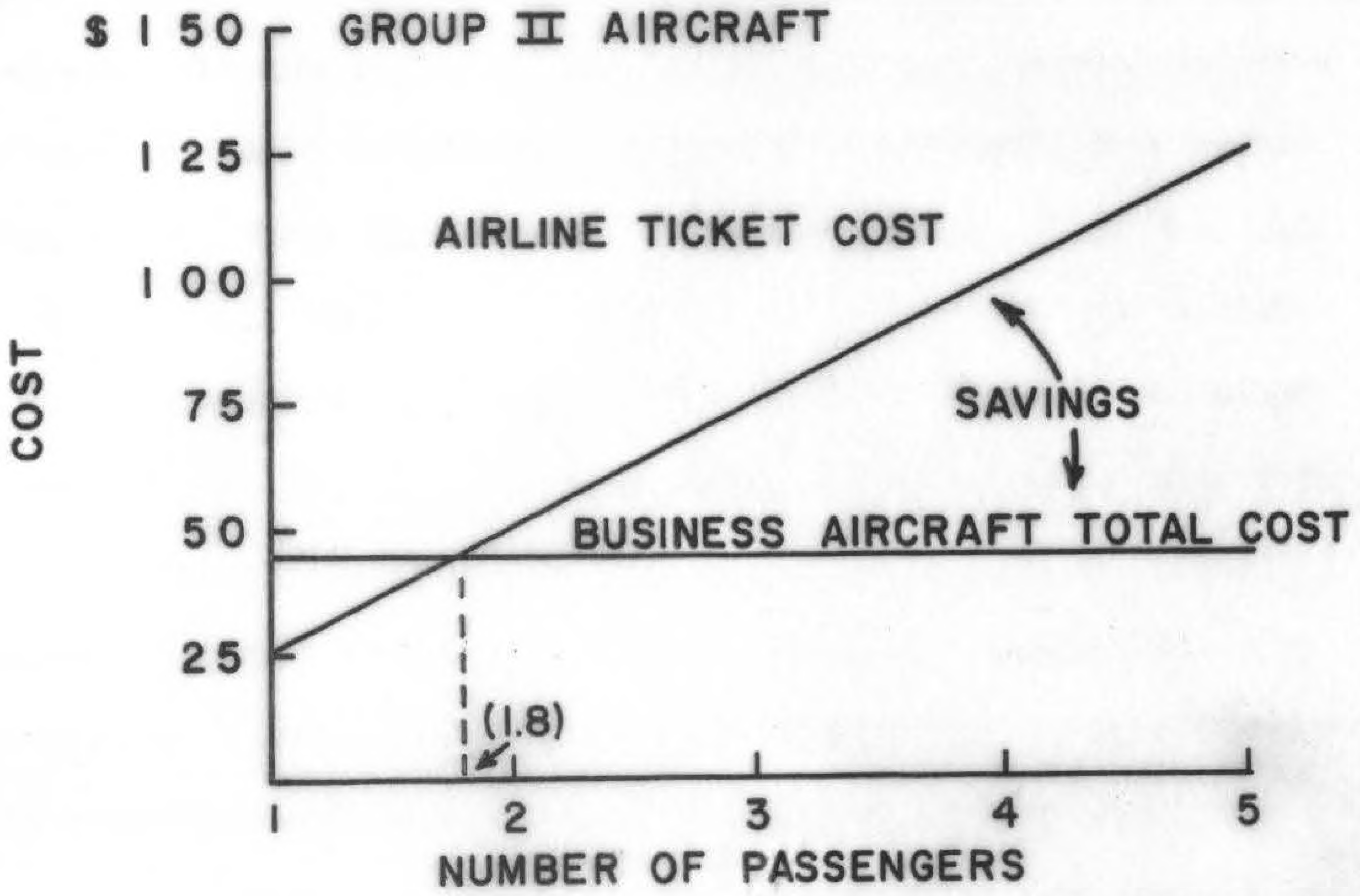
distance to cab stations and frequent congestion during flight times. Also, cab connections can actually be made via the business aircraft radio before landing which can result in no loss time.

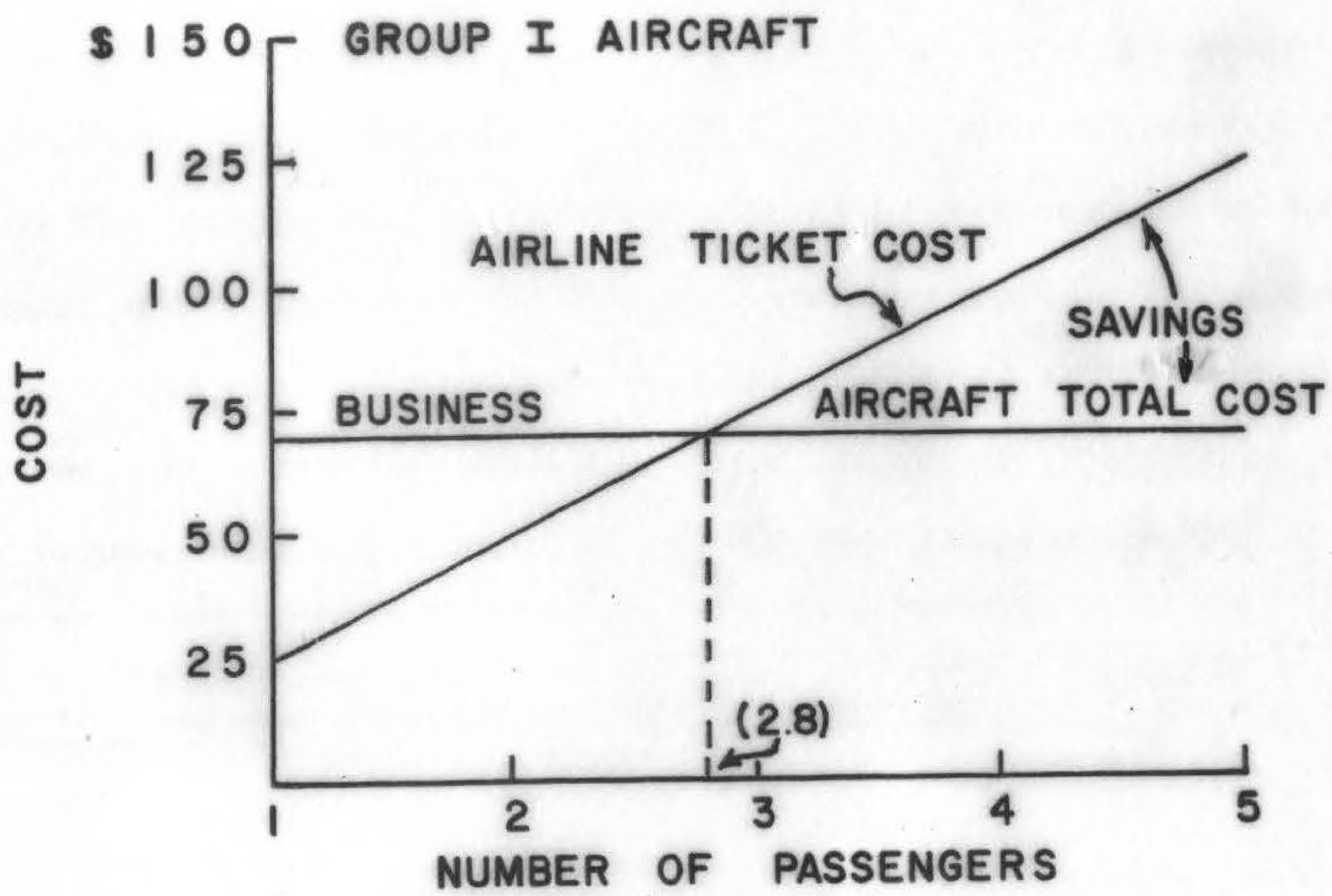
	AIRLINE	GROUP I (TWIN-ENGINE) BUSINESS AIRCRAFT
University campus to airport	:15	:15
Terminal Boarding	:30	:10
Enroute	1:15	1:55
Deplaning	:30	:10
Airport to meeting	:20	:15
	2:10	2:05

The five-minute time difference as indicated in this case probably would not justify the use of a business aircraft for one person. Examining the costs involved, it can be seen on the simple break-even charts (Figure 1) that it is more economical for one person to take an airliner than to travel via business aircraft. However, additional passengers can be carried on the business airplane at no added costs, while traveling by airliner will increase costs arithmetically with the load factor. Figure 1 illustrates the simple break-even points for both Group I twin-engine and Group II single-engine aircraft. This shows that any time the load factor is greater than 1.8 for Group II or 2.8 for Group I, it is more feasible to use the business aircraft. Assume this trip is taken with three passengers in the Group II plane and five passengers in the Group I airplane; on a one-way basis, approximately $31 would be saved in the Group II airplane and $56 by the Group I. On a round-trip basis, these figures would be doubled. This is one obvious illustration of the economics of business aircraft.

FIGURE I

COST COMPARISON, GRAND FORKS TO MINNEAPOLIS





But another significant factor must be introduced--the value of an administrator's or faculty member's time to his University. The value per man hour must be considered in whatever activity an employee is engaged; however, a common denominator is often difficult to determine. Many business organizations and consulting firms have studied this value per man hour (VMH) factor and have determined, for the business world, the VMH of an employee is 2.5 times the annual direct compensation divided by the number of working hours in a year.[5] It could be argued that this formula was determined for the profit-seeking business world and consequently includes a profit factor. This is true, but certainly the president or vice-president of any company is no more directly involved with their actual profit-seeking activities than the president or vice-president of the University and should not actually be considered "worth more" per hour. On the contrary, many people probably feel just the opposite. The pressures and problems with the expanding enrollment and complexities facing the modern day university administrator appear to be at least equal to those of the business world. In the author's opinion, the rate established for the business environment is also realistic for the academic environment of the University. This formula was applied, and the VMH was determined for

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[5]"Who Flies Business Aircraft and Why"? Management Guide to Business Aviation, 1967 Edition, p. 13.

University administrators, faculty, and employees in Table 9. These additional costs are then applied to the "out-of-pocket" transportation costs in determining the total cost for transportation. Take, for example, a trip by the President of the University to the Williston Branch, using the same parameters established for the Minneapolis trip comparison.

	AIRLINE	GROUP I (TWIN-ENGINE) BUSINESS AIRCRAFT
University campus to airport	:15	:15
Terminal Boarding	:30	:10
Enroute	10:00	1:30
Deplaning	:15	:10
Airport to Branch	:10	:10
	11:10	2:15

Figure 2 illustrates that considering the costs of the transportation alone, the trip is more feasible by the airline; however, considering the time involved, and therefore the VMH, the costs incurred in using the airline transportation are extremely excessive as noted in the second illustration in Figure 2. The extreme variance in this example is caused by an eight-hour layover in Minot which is necessary to make connections to get to Williston.

Another example, which is not quite as extreme, is the comparison of airline and business aircraft of a trip to Bismarck. For simplicity, the VMH used is $20 as it is a conservative average of all administrators, faculty, and employees of the University. The same parameters are true as established for the Minneapolis trip comparison.

TABLE 9

VALUE PER MAN HOUR (VMH)[a]

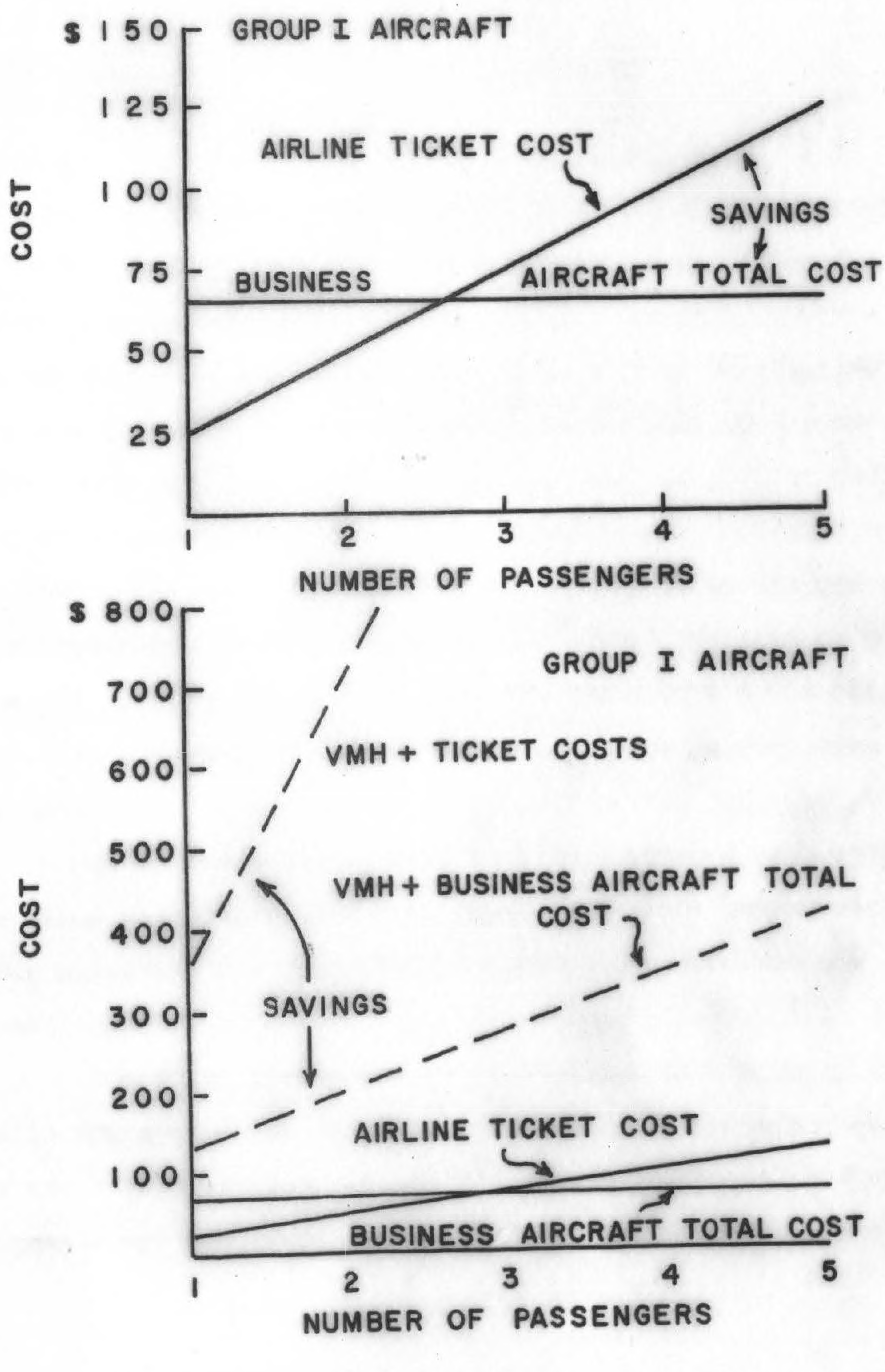
	Earnings Per Year	VMH
UNIVERSITY ADMINISTRATORS: (2,000 Hours Per Year)	$24,000	$30.00
2.5 x Yearly Earnings / 2,000 hours = VMH	22,000	27.50
	20,000	25.00
	18,000	22.50
UNIVERSITY FACULTY: (1,500 Hours Per Year)	$16,000	$26.67
	14,000	23.33
2.5 x Yearly Earnings / 1,500 hours = VMH	12,000	20.00
	10,000	16.67
	8,000	13.33
UNIVERSITY EMPLOYEES: (2,000 Hours Per Year)	$16,000	$20.00
	14,000	17.50
2.5 x Yearly Earnings / 2,000 hours = VMH	12,000	15.00
	10,000	12.50
	8,000	10.00
	6,000	7.50

[a]Economics of Business Aircraft by Henry A. Ryan, Presented, Business Aircraft Conference of Society of Automotive Engineers, Wichita, Kansas. April 1, 1966.

[a]Management Guide to Business Aviation, 1967 Edition, Editorial Director, Robert I. Stanfield, Ziff-Davis Publishing Company, New York.

FIGURE 2

COST COMPARISON, GRAND FORKS TO WILLISTON



	AIRLINE	GROUP I (TWIN-ENGINE) BUSINESS AIRCRAFT
University campus to airport	:15	:15
Terminal Boarding	:30	:10
Enroute	2:55	1:00
Deplaning	:15	:10
Airport to Meeting	:15	:10
	4:10	1:45

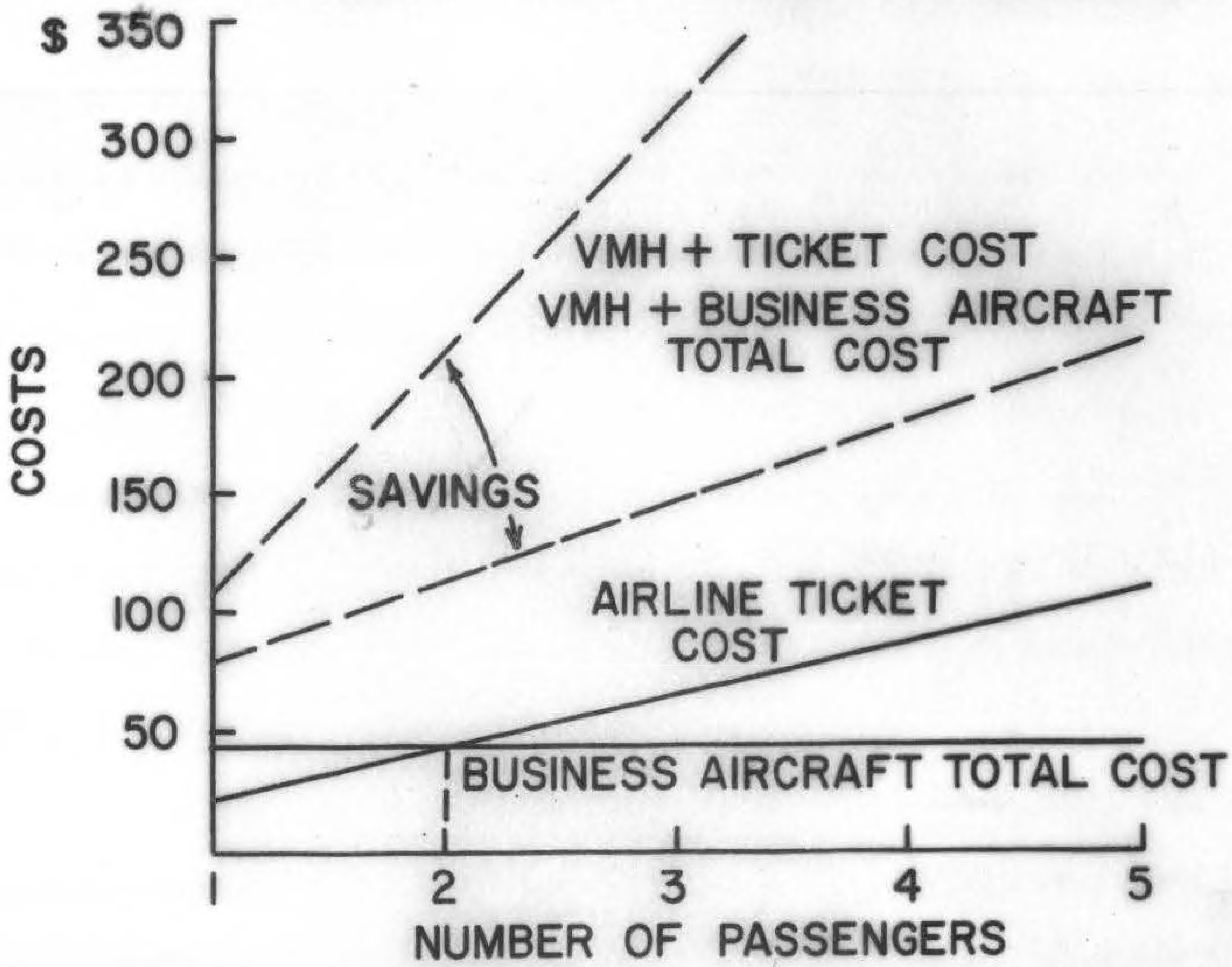
In Figure 3, the cost comparison of Grand Forks to Bismarck, it can be plainly seen that the break-even load factor for the transportation cost alone is two people. However, considering the VMH also, it is far more economical to fly the business airplane for only one person than it is to take the airliner, as the total cost for the one-way trip via the airline would be $105 compared to $79 by the business plane. Introducing the VMH to the previous illustration comparing travel costs to Minneapolis, it can be seen on the lower illustration of Figure 3 that the break-even point is lowered from 2.8 people to 2.3 people when the actual time difference is only five minutes.

It is therefore obvious that the business aircraft can allow considerable savings over the airline transportation media providing the load factor, connections, and VMH are considered.

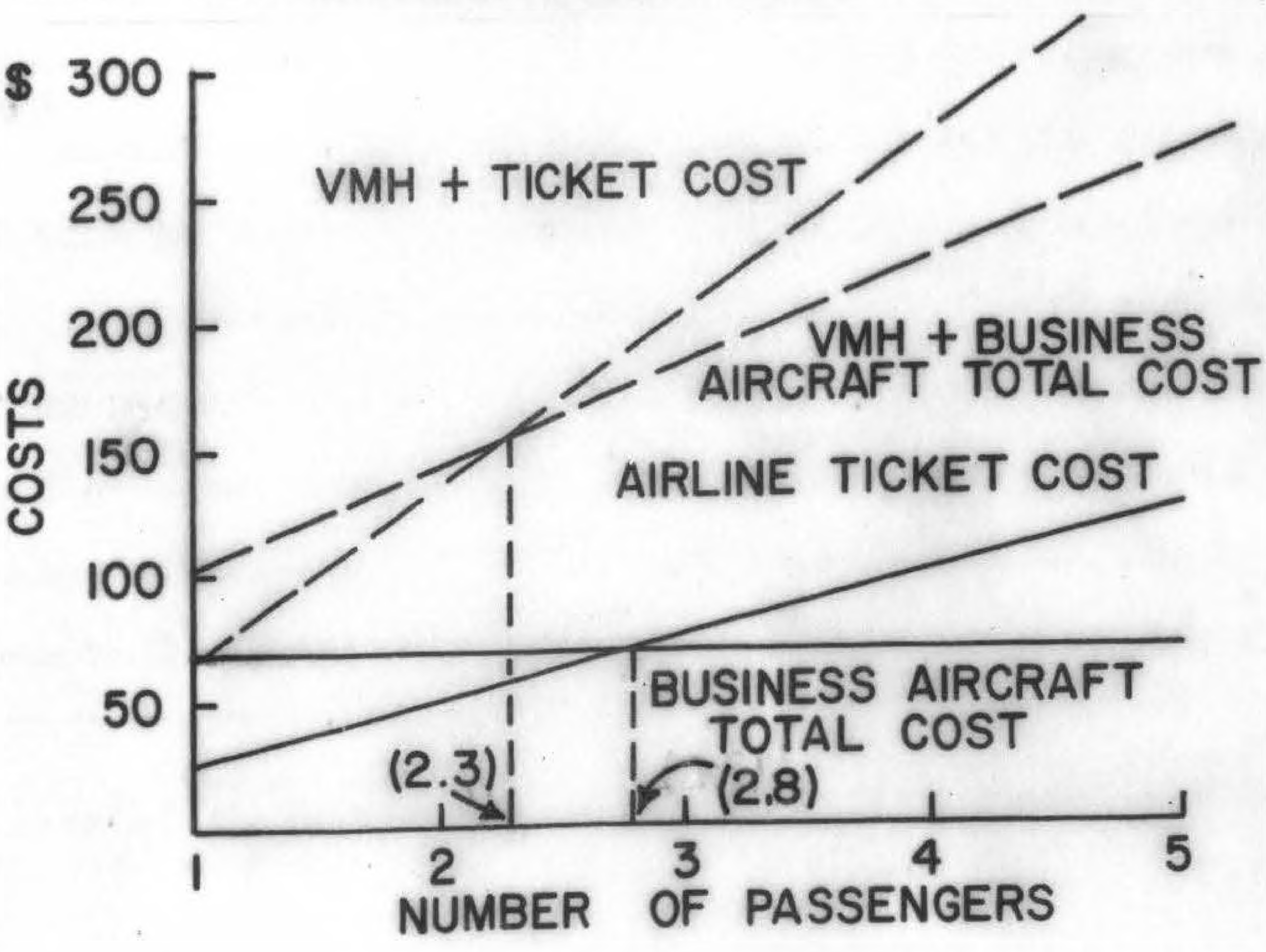
Comparing business aircraft transportation to automobile transportation is more difficult as comparable statistics are not available, and the two methods of transportation are so completely different; however, most businessmen "eventually

FIGURE 3

COST COMPARISON, GRAND FORKS TO BISMARCK



COST COMPARISON, GRAND FORKS TO MINNEAPOLIS



boil down all standards to the universal yardstick, the big dollar sign."[6] The common denominators are convenience and time-saving; and, therefore, the comparisons are made giving consideration to VMH and the estimated costs incurred. Also a detailed study was conducted analyzing all trips taken in University Motor Pool cars from September 1, 1965 to August 31, 1966, to determine the average number of people per trip, destinations of trips, and the average mileage incurred. Tables 10 and 11 are summaries of the study and will be used in determining comparisons between automobile and aircraft transportation.

It can be observed that Bismarck is by far the most popular destination but is also in a very inconvenient location from the University for travel purposes. Figure 4 is a comparison of automobile to aircraft transportation costs to Bismarck. Assuming a \$20 VMH, it costs \$254 for one person to travel round trip to Bismarck by automobile in comparison to \$158 by a Group I twin-engine airplane--a savings of \$96 to fly. Expanding this illustration, it would cost \$654 for three people to take the trip by car in comparison to \$298 to fly--a savings of <u>\$356</u> to fly. Referring to the Motor Pool Analysis Summary, Table 10, and assuming 60 of the 83 trips made to Bismarck were made by administrators or faculty in

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[6]Harley D. Kysor, <u>Business Aviation Department Analysis</u>, presented at International Automotive Engineering Congress, Detroit, Michigan (January 11-15, 1965), p. 3.

TABLE 10

UNIVERSITY OF NORTH DAKOTA
MOTOR POOL ANALYSIS
SUMMARY SHEET

ANNUAL AVERAGES 9/1/65 - 8/31/66

	Average Number of People Per Trip*	Total Number of Trips	Average Number of Miles Per Trip*
Fargo	2.5	80	173.7
Valley City	1.3	23	282.4
Bismarck	1.9	83	539.5
Dickinson	2.3	21	767.6
Minot	2.5	27	450.4
Devils Lake	1.9	11	212.1
Ellendale	1.8	14	506.2
Williston	2.6	8	745.6
Jamestown	3.0	21	344.1
Other (In-state)	2.1	131	296.9
Other (Out-of-state)	3.3	172	821.5
Average Number of People for All Trips in Motor Pool Vehicles	2.3 People		
Average Number of Miles for All Trips in Motor Pool Vehicles	433.3 Miles		

* Averages exclude any trips that had multiple stops.

TABLE 11

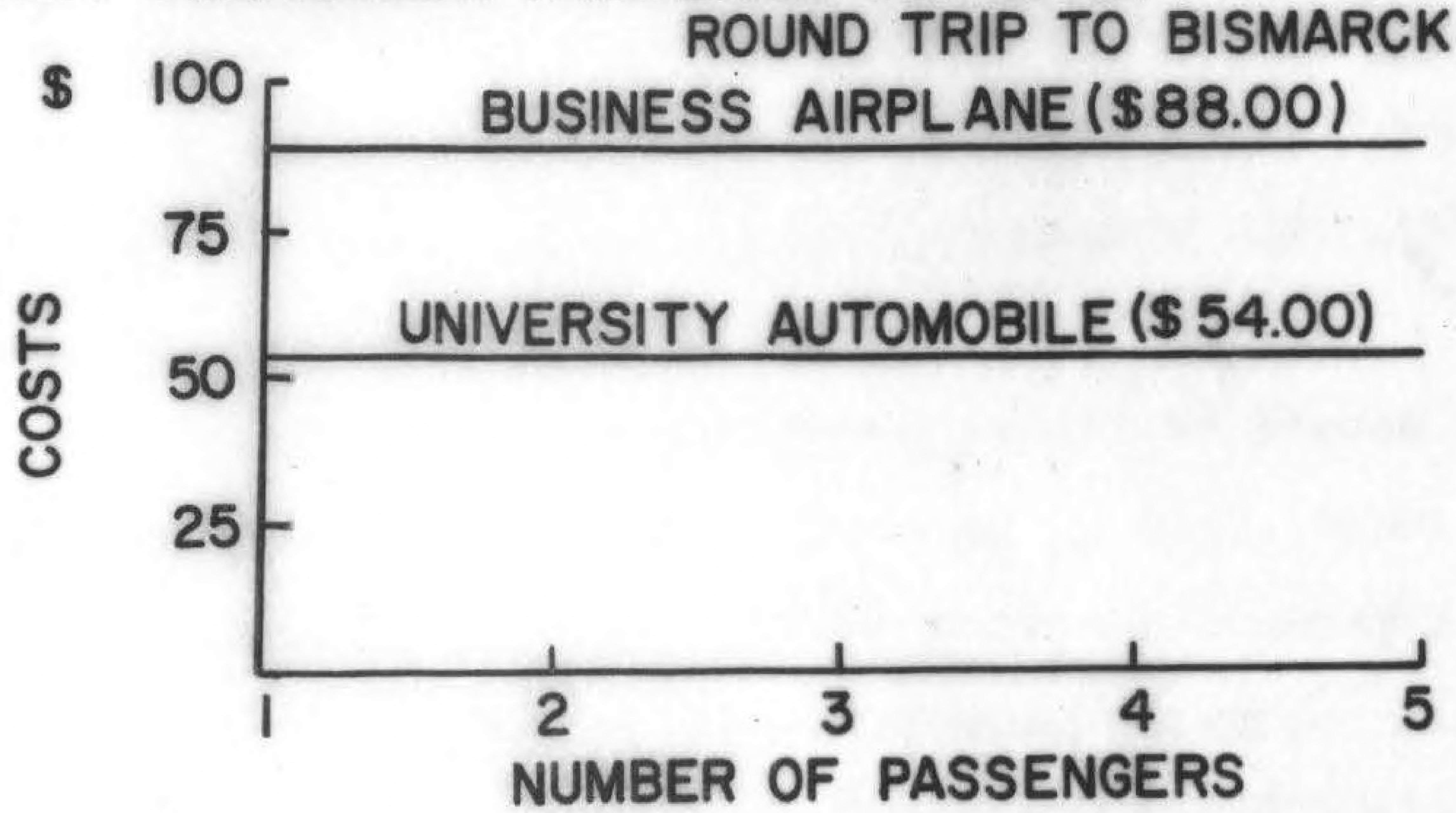
UNIVERSITY OF NORTH DAKOTA
MOTOR POOL ANALYSIS (SUMMARY SHEET)*

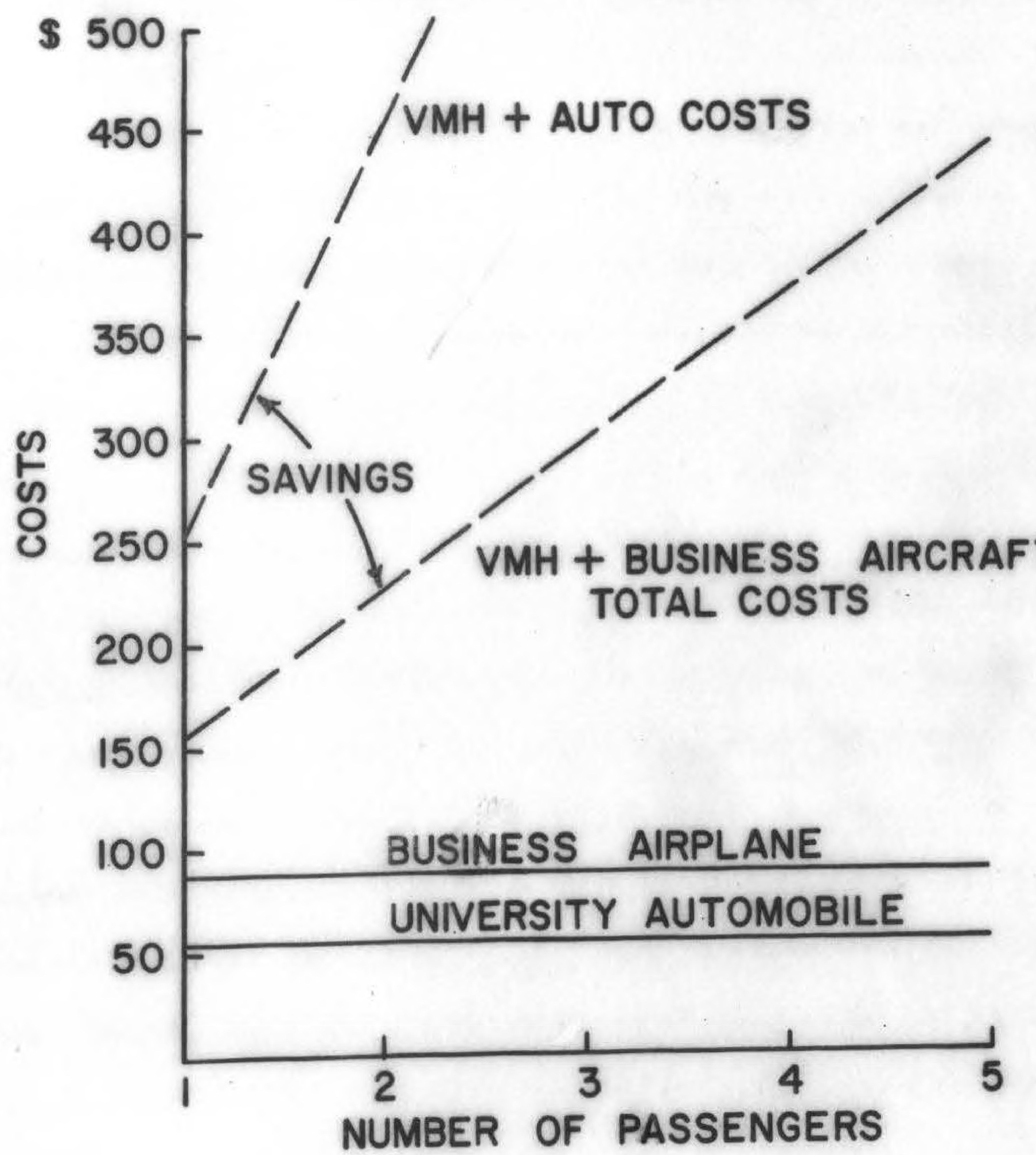
From 9/1/65 to 8/31/66	Number of Trips	Number of People	Total Mileage
Local (Includes GFK Air Force Base)	119	208	4,704
Bismarck	83	156	46,321
Fargo	80	198	14,538
Minot	27	64	14,086
Valley City	23	31	6,495
Jamestown	21	64	8,038
Dickinson	21	36	17,903
Ellendale	14	25	7,087
Devils Lake	11	21	2,333
Williston	8	21	5,965
Other (In-state)	131	272	38,893
Other (Out-of-state)	172	561	141,297
Total	710	1,657	307,660

*Information obtained from a detailed study by author of all University of North Dakota motor pool activities from 9/1/65 to 8/31/66.

FIGURE 4

COST COMPARISON (AIRPLANE VS. AUTO)





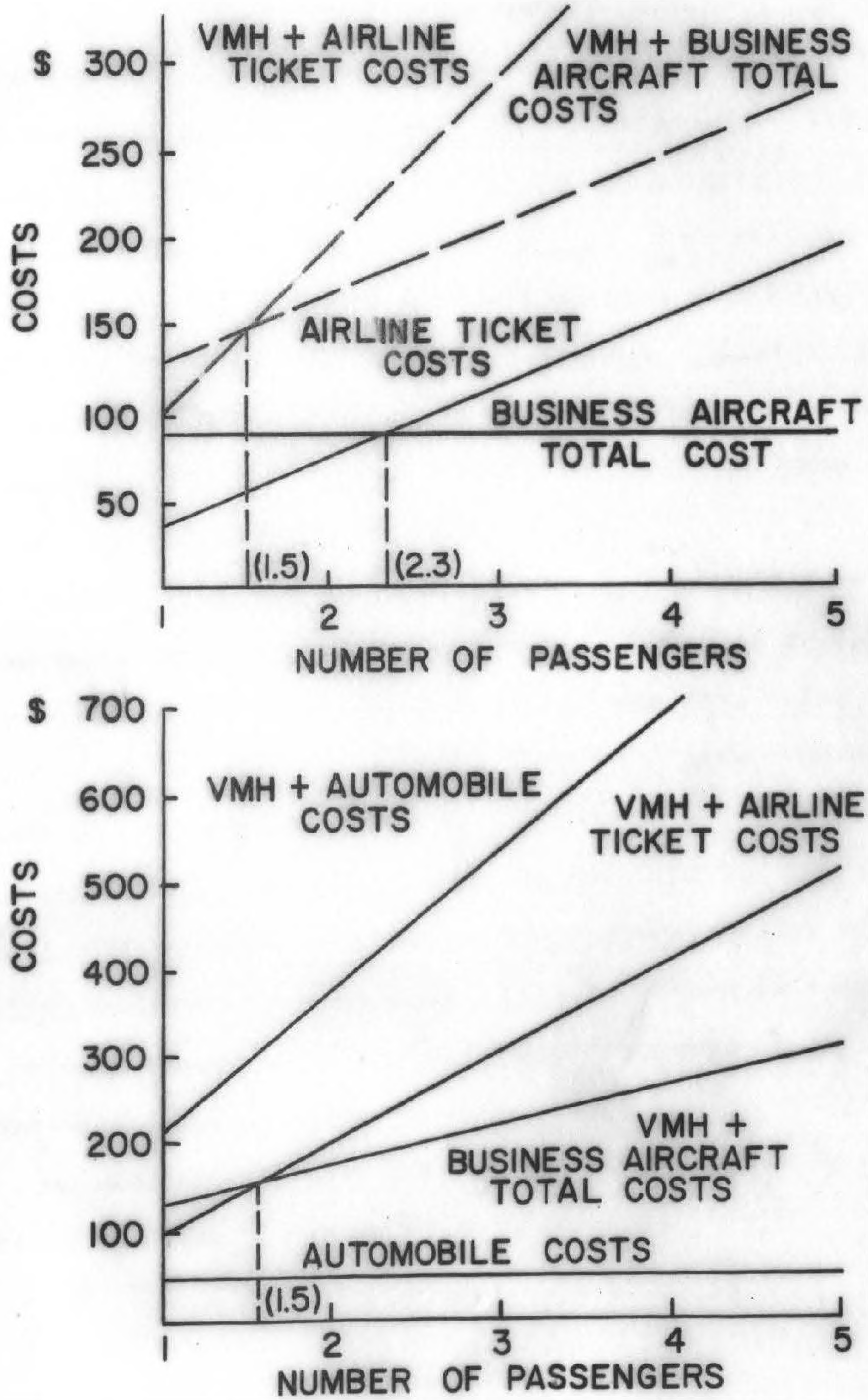
the $20 VMH area, and using the 1.9 average number of people per trip, the University could have had a savings of $12,780 just from these Bismarck transportation costs alone. Therefore, the savings that are possible by using business aircraft where applicable are definitely substantial.

The savings incurred in travel by air to places such as Dickinson are naturally quite obvious; however, Minot has good airline connections and a fairly straight highway from Grand Forks and therefore should be studied further. Figure 5 is a comparison between airline, automobile, and business aircraft transportation costs of a round trip to Minot. It indicates that, although airline ticket costs for two people are lower than the operating costs for the aircraft when consideration is given to the VMH, two people can travel via the business aircraft more economically than by the airline. One person may travel more economically by the airline; however, the costs incurred by automobile exceed both the airline and business aircraft transportation costs.

The results of the interaction of speed, VMH, and load factor have been illustrated with averages as exact models; and graphic guides are available only if a specific aircraft is chosen. For the purposes of this paper, averages were used; but they still positively indicate the economical advantages derived from the proper use of business aircraft. In addition,the less apparent considerations such as flexibility of scheduling, availability of many additional locations

FIGURE 5

COST COMPARISON, ROUND TRIP TO MINOT (AIRLINES, PRIVATE AIRCRAFT AND AUTO)



not served by airlines, and the convenience must be given weight in the evaluation.

Flexibility alone is an extremely important factor considering the scheduling problems faced in attempting to attend meetings and maintain some form of schedule. Take, for example, a trip to Bismarck. If you were to travel by the airlines, you must leave at 12:30 p.m. and would arrive in Bismarck at 3:20 p.m. To attend a morning meeting, it is necessary to fly down the previous afternoon. However, with a business aircraft available, it would be possible to fly to Bismarck at 8 a.m., attend a 9:30 a.m. meeting, have lunch, and return to the University before 2 p.m.

Many intangible factors should also be considered such as increased goodwill generated by attendance at important meetings which may otherwise be impossible. Also consider such factors as the efficiency of a person after he has made a four-and-one-half hour drive over icy roads or on a hot, humid day. Naturally, this is very tiring; and a person cannot possibly perform at his optimum ability after traveling under such conditions. It should then be concluded that private aircraft transportation for University administrators will increase their productivity and efficiency; it will also decrease "total" travel costs and allow more effective management and control in general.

CHAPTER IV

AIRCRAFT FINANCIAL ALTERNATIVES

The financial alternatives for business aircraft operation are normally classified and will be compared in three categories: charter, lease, and ownership. However, once again, the problem of having standardized and identical conditions presents itself; therefore, the author has made several assumptions and estimates, when necessary, to present as fairly and consistently as possible the comparisons between the various alternatives. For example, Grand Forks charter rates vary from $.18 to $.40 per mile depending on the type of aircraft flown; however, in the comparisons in Figures 6 and 8, the rate of $.35 per mile is used as this rate is available for a Group I twin-engine aircraft in the Grand Forks area. For the ownership costs, the Group I twin-engine and the Group II single-engine aircraft costs from Appendix C are separated into fixed and variable costs with an average variable rate per hour of $27 and $17 for the Group I and Group II, respectfully, as indicated in Appendix D. These hourly rates are then applied in Figures 6, 7, and 8 to compare and analyze the various alternatives. The total lease costs are determined from actual bids received from local fixed-base operators at Grand Forks International Airport and are shown in Appendix E.

Charter Alternative

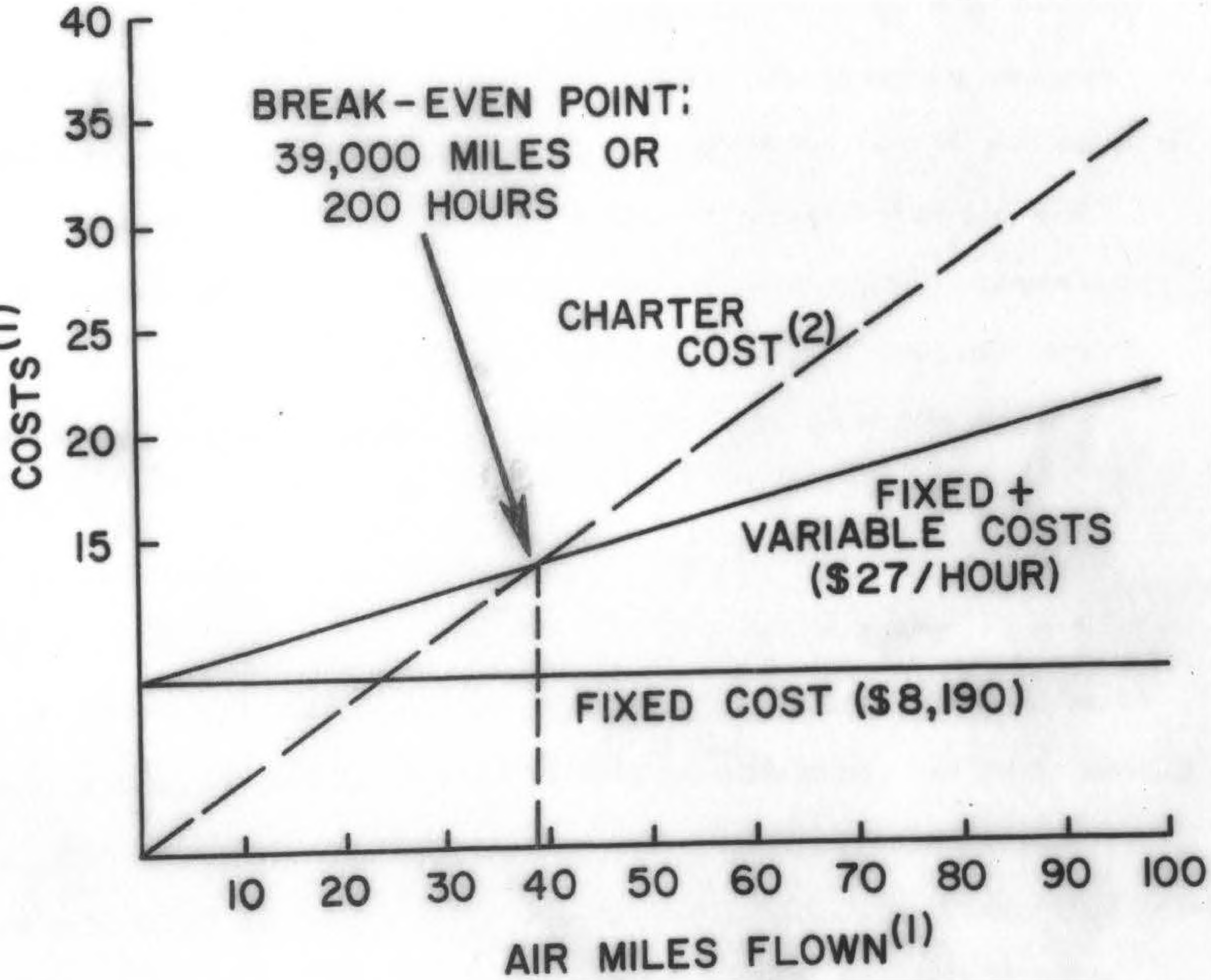
The charter method of air transportation is economical only if there is a minimum of air travel. One very definite advantage of this method is the lack of any ownership responsibility for the University. Any time a flight is desired, a call can be placed to a local charter operator, referred to as "fixed-base operator," and arrangements completed providing an airplane is available. However, the availability is often a problem as the airplane is not used exclusively for any one person or organization. Normally, the biggest disadvantage of the chartering method is the rate-per-mile cost which often proves to be the most expensive alternative assuming there is sufficient need to justify the purchase of an aircraft.

Figure 6, in comparing the ownership costs to charter costs of the twin-engine Group I aircraft, indicates the break-even point is reached at 39,000 miles or 200 hours of operation. Therefore, if less than 200 hours of flying is expected to occur during the year, it would be more economical to charter than to own a Group I aircraft. Another example is the following comparison of actual round-trip charter costs and the total costs from Grand Forks to various selected destinations that are often traveled by University personnel:

FIGURE 6

BREAK-EVEN ANALYSIS - COMPARING OWNERSHIP AND CHARTER COSTS

GROUP I BUSINESS AIRCRAFT



1) IN THOUSANDS
2) CHARTER RATE - $ .35/MILE

COMPARISON OF ROUND-TRIP COSTS
FROM GRAND FORKS TO SELECTED DESTINATIONS

Destination	Charter	Own
Bismarck	$138.60	$ 88.00
Fargo	56.00	27.00
Minot	140.00	90.00
Williston	206.00	132.00
Dickinson	202.00	130.00
Minneapolis	203.00	138.00

This example shows, on a per-trip basis, the savings of the business aircraft ownership over the charter method excluding any consideration of the break-even point of operation. The costs indicated under the "charter" column are actual rates as received from a local Grand Forks fixed-base operator. The costs indicated under the "own" column are based on a 500-hour level of operation for a University aircraft.

Estimating the total hours the University aircraft would fly per year is extremely difficult; however, the minimum of 200 hours required to break-even with a Group I twin-engine aircraft could, conservatively speaking, be very easily met. For example, assuming only one-third of the 317,660 miles traveled by University Motor Pool vehicles from September 1, 1965, to August 31, 1966, (Table 6, page 29) could have been more efficiently traveled via a University aircraft, the Group I aircraft would have logged over 500 hours. This is excluding any consideration to the travel that was made by personal cars and by airlines.

The break-even point can be somewhat lowered by comparing the ownership costs to the charter costs of the less expensive Group II single-engine aircraft. Figure 7 indicates this break-even point is reached at 28,000 miles or 180 hours. The charter rate used in this figure is $.22 per mile as several aircraft in the Grand Forks area with Group II characteristics are available at that rate.

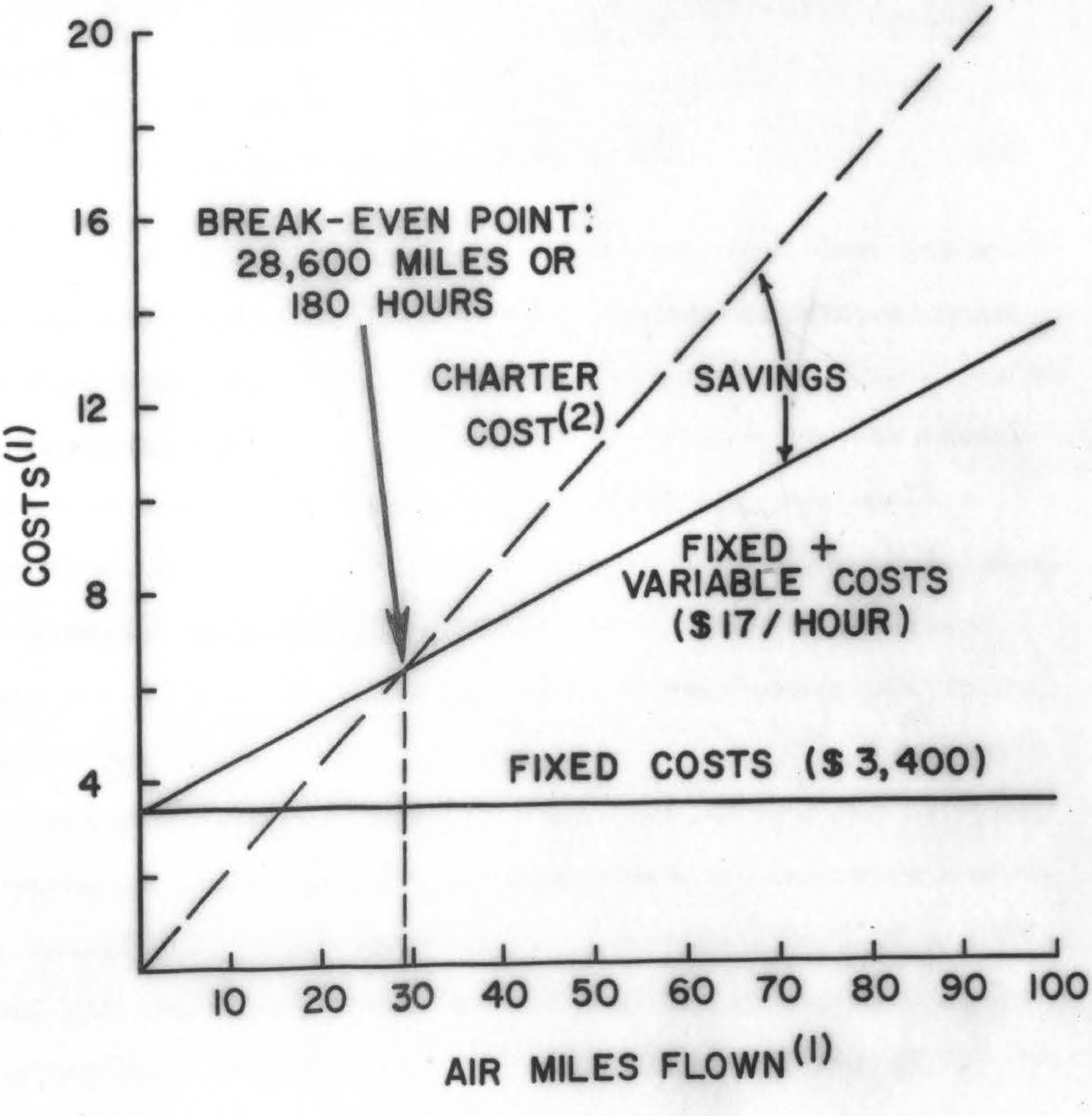
Lease Alternative

The leasing alternative can be more economical than the charter method but only if the minimum hour commitment of 300 hours of guaranteed annual operation is satisfied. The leasing method becomes less convenient as the University must make arrangements for a pilot, pay the gasoline and oil costs, and provide for advanced scheduling of the airplane to insure its availability. However, under the leasing method, as with the chartering plan, the profit factor must be considered. The lease alternative will cost more than actual aircraft ownership assuming, for the Group I aircraft, a minimum of 200 hours are flown annually.

Two lease agreements received from local Grand Forks fixed-base operators, both of which require a 300 hour minimum guarantee (Appendix E), are compared as follows:

FIGURE 7

BREAK-EVEN ANALYSIS - COMPARING OWNERSHIP AND CHARTER COSTS



1) IN THOUSANDS
2) CHARTER RATE - $.22 / MILE

	Cessna 310C	Piper Aztec
Lease Aircraft:		
Per hour lease cost	$35.00	$46.00
Gasoline	11.69	10.66
Oil	.98	.87
Pilot	6.00	6.00
Total Cost	$53.67	$63.53
Cost Per Mile (Block Speed)	.276	.327
Cost Per Passenger Seat Mile	.069	.065

Obviously, the total cost per hour and cost per mile for the four passenger Cessna 310C is more economical than the five passenger Piper Aztec; however, considering the cost per passenger seat mile, the Piper Aztec becomes the most economical as it has one more passenger seat available. Therefore, consideration must be given to the job to be done. For example, when comparing these two aircraft, the Piper Aztec would be more economical if five passengers are to be transported; but, with less than five passengers, the Cessna 310C would cost less. However, the ages of the two aircraft involved in these specific lease agreements, somewhat reduce the validity of the comparison as the Cessna 310C is a 1959 model and the Piper Aztec is a 1966 model. Consequently, some consideration should be given to the price and age of the aircraft.

The bid received for the Cessna 310C is not used in Figure 8, which compares the three alternatives, as the costs, because of its age, are not comparable to the Group I twin-engine costs which include depreciation on a new airplane.

Figure 8 shows the total cost for the 300-hour minimum is $19,200 and indicates that the leasing alternative is more economical than the charter method once the 300-hour minimum is satisfied. However, it also indicates that the ownership alternative would be the most economical.

Ownership Alternative

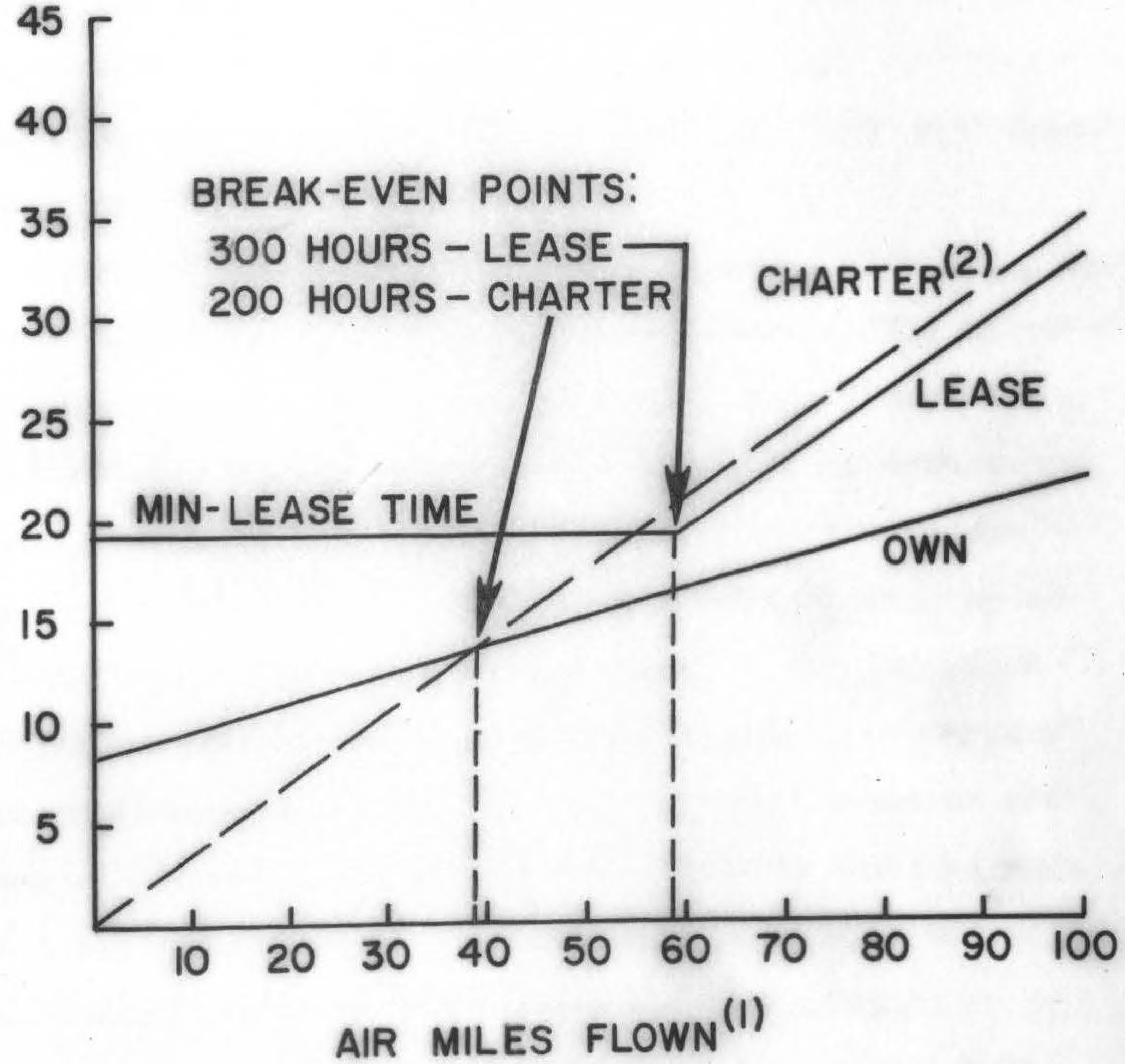
It is apparent that the ownership alternative will cost the least, compared to the three alternatives, providing the hourly usage will exceed the break-even point for that particular aircraft. Previous illustrations indicate it is more economical to own an aircraft once the hourly usage exceeds 200 hours for the Group I aircraft and 180 hours for the Group II aircraft. In addition to the increased economy, the "own" approach offers the advantage of total availability of the aircraft for University use. However, a few of the problems of management should be mentioned.

The University would need some type of management to control the usage and scheduling of the aircraft. More important, the University would be responsible for its operation and maintenance. A possible problem here is that more technical aviation knowledge may be required than is necessary for normal automobile motor pool operations. Also, procedures, priorities, and policies for travel arrangements via the University aircraft would have to be established.

One possible solution may be to have the UND Flying

FIGURE 8

BREAK-EVEN COST COMPARISON
(CHARTER-LEASE-OWN)



1) IN THOUSANDS
2) CHARTER RATE $.35 / MILE

Club, Inc., manage the maintenance and operational aspects of the aircraft. The Flying Club currently owns and operates four aircraft that are flown totally over 3,500 hours per year and is considering the purchase of a fifth aircraft. The Club is governed by a board of directors, all of whom are experienced pilots and several have flight instructor, multiengine, and instrument ratings. Three members of the Board of Directors are University faculty members. Needless to say, they would have all the technical and practical knowledge and experience necessary to manage the aircraft properly.

Another consideration could be to enter into an agreement with the Flying Club whereby they could rent the University aircraft for instructional purposes. The Flying Club has an excellent reputation for safe operating procedures and training practices, with the Club's main objective being training. The University aircraft would be used only by experienced, licensed pilots, accompanied by a FAA Certified Commercial Flight Instructor, for flight training necessary to receive advanced aviation ratings such as instrument and multiengine. Renting the aircraft to the Club would be with a restriction to the local area with any University travel requests having preferential treatment. "Restriction to the local area" means the aircraft would never be more than 10 minutes from Grand Forks Airport and would always be in radio contact. With this restriction, maximum utilization of the aircraft could be achieved without restricting the availability of the aircraft. For example, if an administrator had an important trip come up, the airplane could be contacted via the radio, landed, gased, preflighted, and prepared for departure. This could usually be accomplished before the passengers would arrive from the University. In addition, as explained in a previous chapter, the cost per hour to the University decreases as the total hourly use increases because the fixed costs are allocated over a greater number of hours. Consequently, renting the aircraft to the Flying Club would increase the total hourly use of the aircraft and thus reduce the total cost per hour to the University.

The conclusion that aircraft ownership by the University is the most economical approach to air transportation thus becomes obvious. Its feasibility can best be substantiated by the aircraft ownership of local area universities and colleges. The following information, verifying aircraft ownership, was received by telephone conversation on May 1, 1967, with either the person in charge of the aviation department or the school's business manager:

LOCAL SCHOOLS OWNING AIRCRAFT FOR TRANSPORTATION

	Number Engines	Number Seats
UNIVERSITY OF MINNESOTA:		
Aero Commander	(Twin-engine)	7
Douglas DC-3	"	28
Piper Cherokee	(Single-engine)	4
Beech Bonanza	"	5
SOUTH DAKOTA STATE UNIVERSITY:		
Piper Commanches (Two)	"	4
Cessna 170	"	4

UNIVERSITY OF SOUTH DAKOTA:	Number Engines	Number Seats
Piper Cherokee Six	(Single-engine)	6
Cessna 180	"	4
IOWA STATE UNIVERSITY:		
Twin Beechcraft C-45	(Twin-engine)	8
Aero Commander	"	7
Mooney M21	(Single-engine)	4

Several of the colleges contacted had just become involved in the aviation transportation area and were currently leasing aircraft:

LOCAL SCHOOLS LEASING AIRCRAFT FOR TRANSPORTATION

	Number Engines	Number Seats
MONTANA STATE UNIVERSITY:		
Douglas DC-3	(Twin-engine)	28

(Aircraft leased from Johnson Flying Service and used mainly for transporting the athletic teams and large groups of people.)

JAMESTOWN COLLEGE:		
Cessna Skymaster	(Twin-engine)	6
NORTH DAKOTA STATE UNIVERSITY:		
Beech Bonanza	(Single-engine)	6

(Aircraft leased from Flight Development, Inc., for specific trips.)

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

To keep pace with rapid expansion and to economize on the time required for its management, the University of North Dakota should operate aircraft for transportation purposes.

Flying is extremely safe! Nation-wide statistics in the text show private aircraft flown by professional pilots are slightly safer than flying in a commercial airliner. But more important, this type of flying is 685% safer than automobile transportation. In addition, North Dakota with its level terrain and few obstructions is, in effect, one big airfield. An FAA approved airport is always within 10 minutes flying time while enroute from Grand Forks to typical University in-state destinations.

Flying is dependable! A study of the flying weather in the State of North Dakota indicates, on an annual average, that the weather is suitable for flying 97% of the time. After a severe snowstorm, airports are normally cleared; and airplanes are actually flying before highway travel resumes. In addition, flying time, after consideration of the enroute weather, can be estimated to the minute. This, of course, helps to reduce "lost time."

Flying is practical! Based on a study of actual University of North Dakota travel statistics, the author believes 500 hours of flight time per year to be a conservative estimate if the University utilized private aircraft for transportation. Assuming one-third of the 307,660 miles traveled by motor pool vehicles had been flown instead, this alone would exceed 500 hours of flight time. With this volume of use, this study positively indicates that the University should <u>own</u> rather than lease or charter an aircraft. In fact, based on the data in the text, the University could justify the purchase of two aircraft--one Group I twin-engine and one Group II single-engine aircraft. The total time required to justify both airplanes is only 380 hours of operation per year; however, the primary need which must be considered first is a twin-engine aircraft.

The twin-engine aircraft offers greater speed, safety, and dependability. If the University operated a single-engine aircraft, it would probably be restricted to daytime operation only. The twin-engine aircraft becomes more dependable as it can safely be flown at night and in instrument weather. The plain psychological fact that people feel safer in a twin-engine aircraft would increase its use and the productivity of the people who may be somewhat hesitant to fly in single-engine aircraft.

Flying is convenient! The "time-savings" and convenience experienced by personnel traveling is extremely important. Very often, important meetings that should be attended are missed because of the inconvenience and time lost in traveling to another city. Human efficiency is also affected. For example, assume that an administrator has to make a presentation before the Board of Higher Education in Bismarck. Realistically, his mode of transportation is limited to driving or flying. Needless to say, the administrator could perform better after a relaxing one-hour flight reviewing his notes than after a five hour drive. Intangible factors such as these are impossible to quantitively analyze but should be considered.

"Time savings" achieves paramount importance when considering the value per man hour. When a quantitative amount is determined for University personnel while traveling, their dollar cost in lost time not only justifies but demands aircraft ownership and use.

This study clearly indicates that the safety, dependability, practicality, convenience, and cost savings highly justify the University of North Dakota to own and operate a twin-engine private aircraft for transportation purposes.

APPENDIX A

EXHIBIT 1

North Dakota

STATE BOARD OF HIGHER EDUCATION

State Capitol

Bismarck

Application for Travel Authorization to Points
Outside of the State of North Dakota

Department or Institution______________________________

Name and Title_______________________________________

Place and Date_______________________________________

Method of Travel: Train ( ) Bus ( ) State Car ( ) Personal Car ( )

Fund Charged____

Purpose of Meeting or Trip_______________________________

____

____

____

____

Estimated Cost of Trip $____________________

Approved by:

__________________________ Date________________________

____
Position

__________________________ Date________________________

____
Position

State Board of Higher Education

__________________________ Date________________________
Commissioner

__________________________ Date________________________
Governor of North Dakota

EXHIBIT 2

University of North Dakota

Report of Absence from Campus

Name:______________________________ Department:____________________

Dates of absence:____

Address during absence:____

Reason:____

____

Arrangements for substitute during absence:____________________________

____

Date:______________ Signed:___________________________________
Department Chairman

Date:______________ Signed:___________________________________
Dean

Date:_____________________

To:________________________

Your request to be absent from the campus on__________________________
(dates)

for the purpose of:____

______________________________ ________________approved.
(is-is not)

Signed:_______________________
Dean

EXHIBIT 3

UNIVERSITY OF NORTH DAKOTA
Grand Forks, N. Dak.

STATE TRAVEL REGULATIONS

The State Auditing Board is composed of the Governor, Secretary of State, State Treasurer, Auditor and State Examiner. These members examine and approve all travel vouchers and the Board is empowered to make such regulations as they deem necessary.

GENERAL PROVISIONS:

Since out-of-state travel requests must have the approval of the President, the Board of Higher Education and the Governor, the Board has ordered that such requests should be submitted at least one month in advance. Requests submitted after a trip has been made will not be allowed.

Do not enter expense of more than one person on a voucher. If a room is shared, be sure to explain on both vouchers, and supply a receipt for each. A photostated copy seems to be permissible. This applies also when two or more persons ride together in one car, and share the expense.

Mode of travel must agree with whatever has been approved by the Board, when application is made for out-of-state travel.

When travel has been authorized for only a limited amount, the actual cost of the trip should be itemized, and on the bottom of the voucher where the amount to be paid is normally inserted, use only the amount allowed for reimbursement, and label it "amount allowed".

Staff members are required to have prior approval of their respective deans before making the trip and all travel vouchers against appropriation accounts must be approved by the Dean before being turned in for payment. Be sure the voucher bears all the necessary signatures (on all copies) and that the purpose of travel is shown in the proper space. All travel expenses to be reimbursed from research grants or similar funds are subject to all state regulations that apply to appropriated funds.

IN-STATE TRAVEL:

1. Travel by personal car is at the rate of $8\frac{1}{2}$¢ per mile. Half-cents in calculating mileage should be dropped; for example: if the mileage is 105 miles, the amount to be claimed would be \$$8.92\frac{1}{2}$. This should be entered as \$8.92, not \$8.93. Mileage must conform with that shown on state maps, unless "vicinity" travel is indicated on voucher.

Plane travel inside the state will be paid only if certain unusual circumstances make air travel necessary and if reasons are fully explained and justified on the voucher.

2. Meals and lodging are to be allowed as shown on the back of the voucher, not to exceed \$12.00 per day. Receipts are not required for meals or for taxi fares (each trip) of less than \$5.00. Follow instructions on the back of the voucher as to the quarters covered (show these as 1,2,3, or 1,2, or 2,3,4,-or all.)

You may claim as your first quarter of coverage that quarter in which you had been away from Grand Forks for six or more hours. Example: If you left Grand Forks at 8:00 A.M., you could <u>not</u> charge for the first quarter even though you were gone for more than six hours. However, if you left at 6:00 A.M., you could charge for quarter #1 if you were out for the entire quarter or longer. This does not apply to the quarter of the day in which you return.

<u>Items for lodging must not be lumped</u> - enter each night's lodging against the date for which the room was reserved.

The numbers along the left side of the voucher are the days of the month. The trip made should be entered opposite the applicable date or dates - for instance, if the trip began on the 10th of the month, the first entry for the trip should be opposite the number 10 on the voucher.

3. Items for entertaining guests or other person's meals or lodging, etc., will not be allowed. This applies to both in-state and out-of-state travel.

4. There will be no reimbursement for tips.

5. Car storage, parking lot charges, and bridge tolls for personal cars will not be allowed, as these are considered to be included in the mileage allowance. Such charges are allowable for state car use only.

6. Taxi fares, telephone and telegram charges for business purposes will be paid if properly itemized by the day and explained. A receipt is required if such a charge is $5.00 (each) or more - so these should be itemized separately, rather than as a total per day.

7. Be sure to use tax exemption certificate (obtainable in the Comptroller's office, Room 202 Twamley) if travel is by common carrier.

8. Mileage claimed for use of personal car must be mileage shown on state road map rather than the mileage shown by the speedometer of the car.

OUT-OF-STATE TRAVEL:

1. Travel by personal car is not reimbursable unless permission through the President's Office is obtained in advance. Where two or more persons travel together in one car such approval can usually be obtained. It is possible, under certain circumstances, to get permission for travel by car for only one person. In such cases, the mileage rate is 6½¢ per mile for one person, 8½¢ per mile for several in a car. Plane travel (tourist if possible) will be allowed if application for out-of-state travel so states, and is approved. Be sure to obtain tax exemption certificate for all travel, by common carrier. Any tax paid by the individual for transportation cannot be reimbursed. Receipts should be obtained for all such transportation, except taxi fares of $5.00 or under.

2. Meals are allowed at actual cost up to a maximum of $8.00 per day. Lodging is allowed at actual cost, with receipt required. Taxes charged on hotel bills will be reimbursed.

3. Tips will not be allowed.

4. Registration fees for conventions will be reimbursed if supported by a receipt.

5. Telephone and telegraph charges for business purposes will be reimbursed if explained and itemized. Any charge of $5.00 or more must be supported by a receipt.

6. Car storage charges for personal cars will not be reimbursed, nor will toll charges or parking fees.

TIPS TO HELP IN PREPARING TRAVEL VOUCHERS:

Travel vouchers must be typed, making original and two carbon copies. See first paragraph above as to placing on voucher of the various day's charges.

Each day's meals should be shown, actual total amount, for out of state travel, even though the total might be more than the $8.00 allowed. See back of the voucher for showing these expenses for in-state travel. If the total paid for out-of-state travel is more than $8.00, carry forward to the total column only $8.00 of it, so the total for the day equals no more than $8.00 for meals, plus actual hotel cost.

Each day's lodging should be entered in the "lodging" column. This should be the actual cost including any tax charged.

Items such as phone calls, registration fees, car storage and toll charges for a state car, should be entered in "Miscellaneous Expense" column and total entered in space marked "Total Misc. Expense". Receipt required for such charges over $2.00 each.

No purchases of any kind of supplies made on a trip, and no personal charges such as valet or laundry, will be reimbursed. If any supplies are bought, for any purpose, these should be presented on a regular purchase voucher.

Be sure to show purpose of travel in box at bottom of voucher.

Be sure payee signs in proper place at bottom left of voucher. Where it reads: "I________, being first duly sworn ...." is not the place. The signature goes on the second line. The name should be typed in on the first line.

Be sure that any voucher chargeable to departmental travel is turned in to the Dean of the College for approval, before being sent to the Asst. Comptroller's Office.

In the case of travel to be charged to research grants, the administrator of the grant must approve the voucher. If the administrator is the one who made the trip, he should sign both places on the voucher.

Travel vouchers charged to appropriation accounts:

Each staff member submits only one voucher, showing all trips, in or out of the state, made during the month, that are to be charged to departmental travel budgets. The auditing board will pay once a month, all vouchers that have been received in Bismarck by the 5th of the month. This means that vouchers must be received in the assistant comptroller's office for processing by the end of the month, so that payment is not delayed unnecessarily.

October 5, 1965

EXHIBIT 4

[S]TATE OF NORTH DAKOTA, DR.

Claim No. ______

[T]o ______ Month of ______, 196__

[Ad]dress ______ Official Position ______

[De]pt. or Institution ______

DAILY EXPENSES FOR WHICH REIMBURSEMENT IS CLAIMED (See Instructions - Reverse Side)

POINTS COVERED BY TRAVEL (2)	Personal Vehicle Miles (3)	Miscellaneous Expense (4)	OUT-OF-STATE Meals (5)	OUT-OF-STATE Lodging (6)	IN STATE Qtrs. Day Claimed (7)	TOTAL MEA[LS] AND LODGI[NG] (8)

[Pur]pose Of Travel And [Ex]planation Of Expenses:

Total Miles →		
	Total Meals and Lodging →	
	Total Miscellaneous Expense →	
	Miles @ 8½c Per Mile	
	Miles @ 6½c Per Mile	
	Commercial Transportation Expense	
	Total	

CHARGE:

Appropriation

APPENDIX B

EXHIBIT 1-A

DEPRECIATION ANALYSIS OF RESALE VALUES[a]

Name and Type	Original Retail Price[1]	Average Resale Value[2]	Total Depreciation	Average Depreciation Per Year[3]
Twin-Engine (Over 200 MPH)				
Piper Aztec PA-23 (203 MPH)				
1965	$54,990	$42,700	$12,290	$12,290
1964	52,990	38,100	14,890	7,445
1963	52,990	34,700	18,290	6,097
1962	52,990	29,000	23,990	5,968
1961	52,990	24,300	28,690	5,738
Beech Baron B-55 (220 MPH)				
1965	59,950	46,800	13,150	13,150
1964	59,950	44,700	15,250	7,625
1963	58,950	39,700	19,250	6,417
1962	58,950	39,700	19,250	4,813
1961	58,250	33,000	25,250	5,050
Cessna 310 (221 MPH)				
1965	62,950	52,000	10,950	10,950
1964	62,950	46,000	16,950	8,475
1963	62,950	43,150	19,800	6,600
1962	59,950	37,600	22,350	5,588
1961	62,500	33,100	29,400	5,880

EXHIBIT 1-B

DEPRECIATION ANALYSIS OF RESALE VALUES[a]

Name and Type	Original Retail Price[1]	Average Resale Value[2]	Total Depreciation	Average Depreciation Per Year[3]
Single-Engine (180 MPH)				
Piper Commanche P-24 (176 MPH)				
1965	$22,600	$20,000	$ 2,600	$2,600
1964	21,990	18,000	3,990	1,995
1963	21,990	15,800	6,190	2,063
1962	12,990	14,000	7,990	1,998
1961	20,485	12,450	8,035	1,607
Beech Debonair B-33 (180 MPH)				
1965	23,500	19,000	4,500	4,500
1964	23,500	17,000	6,500	3,250
1963	23,500	15,880	7,620	2,540
1962	22,750	13,700	9,050	2,263
1961	21,550	12,200	9,350	1,870
Cessna 210 (190 MPH)				
1965	25,250	21,250	4,725	4,725
1964	25,000	18,500	6,500	3,250
1963	24,625	15,100	9,525	3,175
1962	23,450	13,200	10,250	2,563
1961	23,450	12,400	11,050	2,510

EXHIBIT 1-C

DEPRECIATION ANALYSIS OF RESALE VALUES[a]

Name and Type	Original Retail Price[1]	Average Resale Value[2]	Total Depreciation	Average Depreciation Per Year[3]
Single-Engine (160 MPH)				
Mooney M21 (168 MPH)				
1965	$16,450	$13,400	$3,050	$3,050
1964	16,450	11,600	4,850	2,425
1963	16,450	9,500	6,950	2,317
1962	16,450	9,500	6,950	1,738
1961	15,995	9,000	6,995	1,399
Cessna 182 Skylane (159 MPH)				
1965	17,995	13,700	4,295	4,295
1964	17,875	12,200	5,675	2,838
1963	18,990	11,400	7,590	2,530
1962	18,490	10,800	7,690	1,923
1961	17,950	9,600	8,350	1,670

[1] Prices are based on standard aircraft with standard equipment as advertised by the manufacturer.

[2] Resale values are developed from dealers' and distributors' monthly sales reports for standard aircraft and equipment as of December, 1966.

[3] Straight-line depreciation based on resale value.

[a] <u>Blue Book of Aviation</u>, Price Guide for December 1966, published by Inter-State Aircraft Corporation, Columbus, Ohio.

APPENDIX C

EXHIBIT 1

COSTS USED IN DETERMINING ESTIMATES

(1) GASOLINE:

	80 Octane	100 Octane
Price	$.37	$.40
State Tax	.06	.06
Less: Tax Refund	.05	.05
Net Cost per gallon	$.38	$.41

Current prices at Grand Forks International Airport.

(2) OIL:
Based on $.60 per quart price and assuming an oil change every 25 hours. Actual consumptions are based on manufacturers' specifications and actual national statistics.

(3) INSPECTIONS, MAINTENANCE, AND PROPELLER OVERHAUL:
Costs are based on national averages and manufacturers' recommendations of all inspections and miscellaneous repairs including parts and labor.

(4) ENGINE EXCHANGE ALLOWANCE:
Costs are based on 1,000 hours replacement using T. W. Smith Aircraft rebuilt engines. Prices include installation, all accessories, 100 hour guarantee, and a prorated use warranty.

(5) HANGAR RENT:
Current hangar rental rates at Grand Forks International Airport:

Cessna 310, Beech Baron, and Piper Aztec . $37.50/month
Piper Commanche, Beech Debonair, Cessna 210, and Cessna 182 . . . . $27.50/month
Mooney M21 . . . . $25.00/month

EXHIBIT 1- (Continued)

COSTS USED IN DETERMINING ESTIMATES

(6) INSURANCE:

Quoted from Dick Kuklock, Minneapolis Area Agent for National Aviation Underwriters. Liability is maximum of $1,000,000 covering any bodily injury or property damage, excluding the pilot. Liability rate excluding passengers is $123 per year. Passengers can be covered for an additional $124 (4 place) or $167 (6 place) per year. Hull coverage is:

GROUP I (over 200 MPH)	2% per year
GROUP II (180 MPH)	2.5% per year
GROUP III (160 MPH)	3% per year

80% of original retail value would represent an average insurable value and is used in determining the applicable costs based on 1966 prices.

Aircraft	Original Price	Insurable Value	Hull Insurance Cost/Year
GROUP I (Over 200 MPH)			
Piper Aztec	$54,990	$43,992	$1,002.84
Beech Baron	62,950	50,360	1,130.20
Cessna 310	59,950	47,960	1,082.20
GROUP II (180 MPH)			
Piper Commanche	23,990	19,192	506.84
Beech Debonair	26,425	21,140	545.80
Cessna 210	25,975	20,780	538.60
GROUP III (160 MPH)			
Mooney M21	16,950	13,560	394.20
Cessna 182 Skylane	17,995	14,396	410.92

EXHIBIT 2-A

ESTIMATED OPERATING COSTS ANALYSIS

GROUP I TWIN-ENGINE (Over 200 MPH)	Number of Hours Per Year		
Piper Aztec PA-23 (203 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (26 gal./hr.)	$10.66	$10.66	$10.66
(2) Oil (1 pt./hr.)	.87	.87	.87
(3) Inspection, Maintenance, and Propeller Overhaul	5.25	5.25	5.25
(4) Engine Exchange Allowance	4.79	4.79	4.79
Total Direct Operating Costs	21.57	21.57	21.57
Indirect Operating Costs Per Hour:			
(5) Hangar Rent ($450/yr.)	1.50	.90	.64
(6) Insurance ($1,002.84/yr.)	3.34	2.01	1.43
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	10.84	8.91	8.07
Total Operating Cost Per Hour	$32.41	$30.48	$29.64

Beech Baron B55 (220 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline ($26\frac{1}{2}$ gal./hr.)	$10.87	$10.87	$10.87
(2) Oil (1 pt./hr.)	.87	.87	.87
(3) Inspection, Maintenance, and Propeller Overhaul	5.90	5.90	5.90
(4) Engine Exchange Allowance	4.79	4.79	4.79
Total Direct Operating Costs	22.43	22.43	22.43
Indirect Operating Costs Per Hour:			
(5) Hangar ($450/yr.)	1.50	.90	.64
(6) Insurance ($1,130.20/yr.)	3.77	2.26	1.61
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	11.27	9.16	8.25
Total Operating Cost Per Hour	$33.70	$31.59	$30.68

EXHIBIT 2-A- (Continued)

ESTIMATED OPERATING COSTS ANALYSIS

	Number of Hours Per Year		
Cessna 310 (221 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (28.5 gal./hr.)	$11.69	$11.69	$11.69
(2) Oil (2 pt./hr.)	.98	.98	.98
(3) Inspection, Maintenance, and Propeller Overhaul	4.25	4.25	4.25
(4) Engine Exchange Allowance	4.79	4.79	4.79
Total Direct Operating Costs	21.71	21.71	21.71
Indirect Operating Costs Per Hour:			
(5) Hangar ($450/yr.)	1.50	.90	.64
(6) Insurance ($1,082.20/yr.)	3.61	2.16	1.55
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	11.11	9.06	8.19
Total Operating Costs Per Hour	$32.82	$30.77	$29.90

EXHIBIT 2-B

ESTIMATED OPERATING COSTS ANALYSIS

GROUP II SINGLE-ENGINE (180 MPH)	Number of Hours Per Year		
Piper Commanche P-24 (176 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (13.5 gal./hr.)	$ 5.54	$ 5.54	$ 5.54
(2) Oil (1 qt./4 hr.)	.39	.39	.39
(3) Inspection, Maintenance, and Propeller Overhaul	2.50	2.50	2.50
(4) Engine Exchange Allowance	2.40	2.40	2.40
Total Direct Operating Costs	10.83	10.83	10.83
Indirect Operating Costs Per Hour:			
(5) Hangar ($330/yr.)	1.10	.66	.47
(6) Insurance ($506.84/yr.)	1.69	1.01	.72
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	8.79	7.67	7.19
Total Operating Costs Per Hour	$19.62	$18.50	$18.02

Beech Debonair C-33 (180 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (11.5 gal./hr.)	$ 4.37	$ 4.37	$ 4.37
(2) Oil (1 qt./f hr.)	.39	.39	.39
(3) Inspection, Maintenance, and Propeller Overhaul	2.56	2.56	2.56
(4) Engine Exchange Allowance	2.40	2.40	2.40
Total Direct Operating Cost	9.72	9.72	9.72
Indirect Operating Costs Per Hour:			
(5) Hangar Rent ($330/yr.)	1.10	.66	.47
(6) Insurance ($545.80/yr.)	1.82	1.09	.78
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	8.92	7.75	7.25
Total Operating Cost Per Hour	$18.64	$17.47	$16.97

EXHIBIT 2-B- (Continued)

ESTIMATED OPERATING COSTS ANALYSIS

	Number of Hours Per Year		
Cessna 210 (190 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (16.5 gal./hr.)	$ 6.77	$ 6.77	$ 6.77
(2) Oil (1 pt./hr.)	.59	.59	.59
(3) Inspection, Maintenance, and Propeller Overhaul	2.50	2.50	2.50
(4) Engine Exchange Allowance	2.50	2.50	2.50
Total Direct Operating Cost	12.36	12.36	12.36
Indirect Operating Costs Per Hour:			
(5) Hangar Rent ($330/yr.)	1.10	.66	.47
(6) Insurance ($538.60/yr.)	1.79	1.08	.77
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Cost	8.89	7.74	7.24
Total Operating Cost Per Hour	$21.25	$20.10	$19.60

EXHIBIT 2-C

ESTIMATED OPERATING COSTS ANALYSIS

GROUP III SINGLE-ENGINE (160 MPH)	Number of Hours Per Year		
Mooney M21 (168 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (9 gal./hr.)	$ 3.69	$ 3.69	$ 3.69
(2) Oil (1 qt./4 hr.)	.32	.32	.32
(3) Inspection, Maintenance, and Propeller Overhaul	2.00	2.00	2.00
(4) Engine Exchange Allowance	1.70	1.70	1.70
Total Direct Operating Costs	7.71	7.71	7.71
Indirect Operating Costs Per Hour:			
(5) Hangar Rent ($300/yr.)	1.00	.60	.43
(6) Insurance ($394.20/yr.)	1.31	.79	.56
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	8.31	7.39	6.99
Total Operating Cost Per Hour	$16.02	$15.10	$14.70

Cessna 182 (159 MPH)	300	500	700
Direct Operating Costs Per Hour:			
(1) Gasoline (13 gal./hr.)	$ 5.33	$ 5.33	$ 5.33
(2) Oil (1 qt./4 hr.)	.37	.37	.37
(3) Inspection, Maintenance, and Propeller Overhaul	1.84	1.84	1.84
(4) Engine Exchange Allowance	2.00	2.00	2.00
Total Direct Operating Costs	9.54	9.54	9.54
Indirect Operating Costs Per Hour:			
(5) Hangar Rent ($330/yr.)	1.10	.66	.47
(6) Insurance ($410.92/yr.)	1.37	.82	.59
(7) Pilot Salary	6.00	6.00	6.00
Total Indirect Operating Costs	8.47	7.48	7.06
Total Operating Cost Per Hour	$18.01	$17.02	$16.60

APPENDIX D

EXHIBIT 1

FIXED AND VARIABLE COST ANALYSIS

AVERAGE FIXED COSTS PER YEAR:

GROUP I (200 MPH Twin-Engine)	
Hangar Rent	$ 450
Depreciation	6,440
Insurance	1,050
Annual Maintenance	250
Total Average Fixed Cost	$8,190
GROUP II (180 MPH Single-Engine)	
Hangar Rent	$ 330
Depreciation	2,400
Insurance	520
Annual Maintenance	150
Total Average Fixed Cost	$3,400

	Hours of Operation		
AVERAGE VARIABLE COSTS:	300	500	700
GROUP I			
Average Operating Cost	$32.98	$30.95	$30.07
Average Depreciation	21.46	12.87	9.20
Total	54.44	43.82	39.27
Fixed Cost	27.30	16.38	11.70
Variable Cost per Hour	$27.14	$27.44	$27.57
GROUP II			
Average Operating Cost	$19.84	$18.69	$18.20
Average Depreciation	7.99	4.79	3.42
Total	27.83	23.48	21.62
Fixed Cost	11.33	6.80	4.87
Variable Cost per Hour	$16.50	$16.68	$16.75

EXHIBIT 2

BREAK-EVEN ANALYSIS
(Computations for Figures 6, 7, & 8.)

	Hours of Operation			
	100	300	500	600
GROUP I				
Variable Cost[1]	$ 27	$ 27	$ 27	$ 27
Hours Flown	100	300	500	600
	2,700	8,100	13,500	16,200
Fixed Cost	8,190	8,190	8,190	8,190
Total Cost	$10,890	$16,290	$21,690	$24,390
Block Speed (MPH)	194	194	194	194
Hours Flown	100	300	500	600
Total Miles Flown	19,400	58,200	97,000	116,400
GROUP II				
Variable Cost[1]	$ 17	$ 17	$ 17	$ 17
Hours Flown	100	300	500	600
	1,700	5,100	8,500	10,200
Fixed Cost	3,400	3,400	3,400	3,400
Total Cost	$ 5,100	$ 8,500	$11,900	$13,600
Block Speed (MPH)	164	164	164	164
Hours Flown	100	300	500	600
Total Miles Flown	16,400	49,200	82,000	98,400

[1]Variable Costs are rounded to nearest full dollar for simplicity.

APPENDIX E

EXHIBIT 1

MONTGOMERY AIRSPRAY, Inc.

April 27, 1967

Mr. John Odegard
University of North Dakota
College of Business Administration
Grand Forks, North Dakota 58201

Dear Sir:

Montgomery Airspray, Incorporated, offers for lease the following aircraft:

PIPER AZTEC

300 hours	@ $48.00	=	$14,400
500 hours	@ $46.00	=	$23,000
700 hours	@ $44.00	=	$30,800

PIPER APACHE

300 hours	@ $26.00	=	$ 7,800
500 hours	@ $25.00	=	$12,500
700 hours	@ $24.00	=	$16,800

We will have available one stand-by pilot at all times.

Yours truly,

MONTGOMERY AIRSPRAY, INC.

*Original Signed By:
James T. Montgomery, President

JTM:jrm

EXHIBIT 2

GRAND FORKS AIRMOTIVE INC.

April 4, 1967

Mr. John Odegard
University of North Dakota
College of Business Administration
Grand Forks, North Dakota 58201

Dear Sir:

Grand Forks Airmotive offers for lease the following aircraft:

CESSNA 310C

300 Hours @ $36.00	$10,800.00
500 Hours @ $35.00	$17,500.00
700 Hours @ $34.00	$23,800.00

CESSNA 206

300 Hours @ $18.00	$ 5,400.00
500 Hours @ $17.00	$ 8,500.00
700 Hours @ $16.00	$11,200.00

(The above prices include maintenance, storage, and insurance.)

The purchase prices are as follows:

Cessna 310C	$26,000.00
Cessna 206	$18,000.00

We will have available on either lease or purchase agreement two stand-by pilots.

Sincerely yours,

GRAND FORKS AIRMOTIVE INC.

*Original Signed By:
Doyle Kargel, President

DK:rd

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