General Aviation Aircraft Utilization in the Construction Industry

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A major report submitted in partial
fulfillment of the requirements
for the degree of

Master of Science in Engineering

University of Washington

1987

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Abstract

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This research concerns the uses for general aviation type aircraft within the area of heavy construction and building construction. General aviation aircraft are fixed-wing airplanes, helicopters and lighter-than-air craft. The investigation deals primarily with use of aircraft over which the construction company has direct control as opposed to commercial airline and air freight use. The direct control may be through ownership, lease or rental (including charter). Uses identified consisted of heavy lifts, job site investigation, photo/observation platform, parts & equipment expediting, personnel transport and executive mobility.

A mail survey of construction companies from throughout the continental United States was conducted to gather data on use of general aviation aircraft in company operations. Data collected included company characteristics, whether or not aircraft were used, type(s) of aircraft used, applications made of aircraft, trends in

usage, and cost data. Companies not using aircraft were polled concerning reasons for non-use and attitude concerning possible future use.

DIALOG Information Services was utilized to search the compendex co-operative engineering information data base and the aero-space abstracts data base to identify literature pertinent to this subject.

The discussion includes aspects of uses for general aviation aircraft in the construction industry, analysis of survey results, and conclusions concerning utilization of general aviation by construction companies.

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Chapter One-- Introduction

The construction industry employs many types of tools and equipment to effectively and economically build infrastructures in the United States. Studies have been conducted on many of the various aspects of the industry and on the equipment it employs. This research studies the use of general aviation type aircraft by construction firms in pursuit of their business.

For the purpose of this research, a general aviation aircraft is defined as an airplane, helicopter, or lighter-than-air craft; the term "aircraft" is used to denote all three of these in the remainder of this report unless a specific type is noted. The primary focus of this study is aircraft over which the construction firms have direct control. As in the case of other types of equipment, this control may be by outright ownership, leases, or rentals. Chartered aircraft are included as these arrangements include the aircraft and operating crew but are under the control of the company for the purpose chartered and thus would fall into the rental category. Use of commercial air carrier airlines (scheduled and commuter) are excluded from consideration as are air freight uses.

The types of firms included in this research were not limited to any one specific size or work category but consist of primarily building construction, heavy earth-work, utilities, mechanical, heavy structural steel,

and industrial. No attempt was made to focus on any specific size in terms of employees or gross revenues. An attempt was made to obtain data from firms throughout the continental United States only; Alaska and Hawaii were deemed to have peculiarities which would be better addressed by separate investigation and are not included in this research.

Uses of aircraft in the construction industry may be divided into two primary types-- direct construction operations and indirect construction support. Except for some unique and specialized uses, the predominant direct construction use is heavy lift capability typically employing helicopters or lighter-than-air craft. The area of indirect construction support finds a much wider range of uses for aircraft. The major applications are listed as follows:

--Job-site investigation

--Photo & observation platform

--Parts & equipment expediting

--Personnel transport

--Executive mobility

To be of benefit to a company, any tool or equipment must either accomplish a unique task or enable accomplishment of a task in a more economical manner than other available tools or equipment. This is true whether the task is a direct construction item or an indirect support task. The economics to be considered in the

employment of any tool or equipment include not only the direct costs of obtaining the item which is usually through either purchase, lease or rent, but also the operating costs such as insurance, fuel, maintenance, repairs, and operator wage costs. An item commonly overlooked in assessing the economic viability of a tool or piece of equipment is cost avoidance-- what costs will not be incurred or will be avoided by the employment of the specific equipment. In a "hard" economic analysis where specific contender/defender comparisons are conducted, these costs would be appropriately applied to the method in which they would be required for the accomplishment of the task as opposed to being taken as a "credit" for the benefit of the task being considered. However, it is often the case that less than precise economic analysis is performed to assess the virtue of a tool or equipment. In discussing only the one item, it is appropriate to take into consideration the benefits of cost avoidance at least in a qualitative sense.

Heavy lift use is often the proverbial "sky-hook" which certain tasks require. Heavy lift consists of attaching an item or assembly to a sling point attached to the aircraft, lifting the item, transporting it horizontally, and lowering it into final position. The helicopter is the predominant craft used for this purpose but the lighter-than-air craft also has definite application in this regard. The fixed wing airplane has little practical use for this purpose and the term "heavy lift" has

come to be used exclusively for sling load operations using helicopter and lighter-than-air craft. For some tasks there is simply no other available method to accomplish the task due to physical constraints. Often it is economics which leads to the choice of using a heavy lift. The benefits of this method are basically speed of transport, flexibility and range, avoidance of costly mobilization and demobilization of conventional equipment, and avoidance of costs of site access roads. Deterrents associated with heavy lift operations are limits on maximum weight thus perhaps necessitating piece-by-piece transport, high hourly cost of equipment, requirement for careful planning of operation to ensure efficiency and safety, and limitations on flight path dictated by the Federal Aeronautics Administration (FAA). This method is discussed further in Section 2.2.1.

Parts and equipment expediting is a support function which consists of using airplanes and helicopters to transport urgently needed items to company project sites. There is some possible application for lighter-than-air crafts for transporting very heavy parts or equipment but this would be unique and would be essentially as described under heavy lift operations above. The benefit of using company-controlled aircraft for this purpose is the speed and flexibility of delivery. Having this capability can significantly reduce the impact of unanticipated equipment breakdowns or delays in transport by other means. This is

not a contractor operated freight system as the cost of delivery will exceed commercial freight or air freight costs. Distance to be transported, availability of other means of commercial transport, timeliness of commercial transport, urgency of the required part or equipment, and weight are considerations in this application. Refer to Section 2.2.2 for further discussion.

Job-site investigation is a support operation defined as transport of company estimating and management personnel to a project site for any purpose either prior to beginning or during actual construction. Helicopters and airplanes are the primary types of aircraft employed for this purpose with no application envisioned for lighter-than-air craft. In a very few situations, a helicopter may be the only reasonable means of access to a remote site but usually this is not the case. The basic benefit of this use is speed and avoidance of costs in terms of labor time in travel. Use of aircraft should increase productivity of company personnel by enabling them to visit more sites in less time thereby providing additional time for personnel to be productively employed on other company matters of concern. Travel distance and availability of commercial modes of travel are essential factors in this use. Sites reasonably close to the home office are usually best visited by auto; sites a great distance away are usually best visited by using commercial airlines if available. There is a range of distances between these

extremes where it is cost effective to fly company controlled aircraft. Aspects which should be considered are availability of commercial airline services, time lost in waiting for commercially-scheduled flights and expectation of delays, availability of airfields near the site suitable for the company operated aircraft, and availability of ground transportation between the airfield and the site. The helicopter is usually superior to the fixed wing airplane in the efficiency of travel consideration due to its ability to land usually at or very near the site thus avoiding the problem of ground transportation from the airfield to the site. However the cost of operating a helicopter is significantly higher than that for an airplane and the number of passengers able to be carried is often less. Use of helicopters and airplanes for job-site investigation is discussed further in Section 2.2.3.

Use of aircraft as a photo and observation platform consists of taking pictures or making personal observations from the air using primarily helicopters or airplanes. Little use of lighter-than-air craft is seen for this purpose. Photogrammetry and remote sensing is a highly specialized application of aircraft and for the purposes of this report is not considered as an application normally used by construction companies. The term aerial photography is a more appropriate description of the application as it applies to usual construction company operations. There are several purposes for making aerial observations or

photographs of projects-- collecting information to be used in project estimating and investigation, recording existing conditions for historical purposes at various stages of construction, and monitoring project progress especially when a series of pictures is taken at weekly or monthly intervals. Observation of a project from an aerial vantage point can reveal aspects of the project or the surrounding area which may impact the project and which are not obvious from the ground. This can be especially beneficial in the investigation of a project to be bid. Use of helicopters and airplanes for aerial photography and observation is discussed further in Section 2.2.4.

Personnel transport is the movement of project personnel between company projects and the home office. In usual practice it is a support function but may in rare instances be a direct movement of personnel on a daily or weekly basis to a remote site. This is distinct from the job-site investigation use described above and the executive mobility use described below. Helicopters and airplanes are both used for this purpose while lighter-than-air craft has no usual application in this area. People are one of the resources which a company has at its disposal and efficient employment of this resource is prudent. While this use is stated to be different from job-site investigation described above, the characteristics and considerations stated there apply equally here. This use however deals primarily with transporting personnel during the construction phase and may

consist of movement of important technicians, trade specialists, and urgently needed labor forces. Medical evacuation of injured personnel would also be contained within this area of use and may be vitally important for some project locations.

Executive mobility is the use most commonly envisioned when considering company-operated aircraft. Key company personnel are often vital to the operation of a company and maximizing their productivity is important. Use of a company controlled airplane or helicopter can provide management personnel with mobility to attend important project meetings, visit job-sites on a routine basis, make aerial tours of projects, show prospective clients past projects, etc. The most sophisticated method is the company-owned jet, complete with a flight crew. However there is an application for the smaller company where the owned or rented airplane is operated directly by the company management personnel. While often criticized as a questionable perquisite by casual observers and closely scrutinized by the Internal Revenue Service, provision and use of aircraft as a tool of mobility for company personnel should be considered as would any other company vehicle but with its own unique set of criteria. The remarks dealing with criteria made in discussing job-site investigation apply equally to executive mobility. Use of company-operated aircraft for personnel and executive transport is discussed further in Section 2.2.5.

A literature search was conducted in association with this research. The results of this search and a discussion of the articles discovered are included in chapter 2. The search revealed that little information has been published specifically addressing the use of general aviation aircraft by construction companies. This information could be quite valuable to those companies contemplating such use. It is in this regard that this research is being performed. It is believed that many companies in the small to medium size range could benefit from use of aircraft. Because of a lack of information, these companies are perhaps unaware or uninformed as to the aspects and benefits of aircraft use. It is hoped that this research may create renewed enthusiasm in consideration of use of this tool in the construction industry and indirectly result in development of new uses.

A survey was conducted of construction firms from throughout the continental United States to collect data on the types and sizes of firms that are using aircraft in their operations, what applications they are making of aircraft and how the usage of aircraft had changed with time. A description of the survey methodology is included in chapter 3 and Appendix D. Discussions of the survey analysis and its results are provided in Chapters 4 and 5.

Chapter Two-- Background Information

2.1-- Literature Review

One of the goals of this research was to compile a comprehensive listing of available literature dealing with the use of general aviation aircraft in the construction industry. The primary means of identifying the available literature was by way of a computerized literature search augmented by preliminary and follow-up manual searches. The results of the literature searches indicate that little published information exists at this time. The details of how the computerized search was performed and discussion of the search strategy is included as Appendix E. Discussion of the pertinent literature is included in the portions of Section 2.2 relating to respective aircraft uses.

The abstracts resulting from the literature search were reviewed and it was revealed that, as suspected, they were not all applicable to the research topic. Of the 134 abstracts reviewed, thirteen were found to be relevant and available. Ten items identified were associated with heavy lift including some design and feasibility considerations of lighter-than-air and examples of helicopters on construction sites. Three items identified dealt with use of helicopters and airplanes as photo and observation platforms. These are discussed in the second section of this chapter dealing with their respective subjects. Eight additional items were

identified but could not be located. Review of the abstract of these articles indicated that they had only marginal bearing on the subject under investigation and their omission was not deemed significant.

It is noted that two items identified by the search appear to be applicable to this study but were unavailable for review. They are journal articles written in German and published in the journal "Technisch-oekonomische Informationen der zivilen Luftfahrt". The title and references are as follow:

"The employment of helicopters in construction engineering and assembly operations in the German Democratic Republic" by Schulz, B.; Vol.13, no. 4, 1977, pg 194-198.

"Helicopter as flying cranes" by Kroenert, G.; Vol.8; no. 7; 1972, pg 299-308.

2.2-- Discussion of Aircraft Uses in Construction

2.2.1-- Heavy Lift Operations

Heavy lift operations appear to be the primary single area in the direct construction role where general aviation aircraft have application. Heavy lift operation is the lifting, transport, and placement of items. These can include construction materials, equipment, prefabricated assemblies or component parts. At the current time, as revealed from the review of the literature, this application is almost exclusively performed by helicopters. As described later in this section, there is interest and developmental work in the area of lighter-than-air for this purpose. Heavy-lift operations are primarily a specialty task with the majority of the work being contracted to heavy-lift helicopter companies.

The utility of the helicopter in performing heavy lift operations makes it indispensable in those instances where no other means exists for movement and placement of items. However this is seldom the case and more usually the situation is that employment of a helicopter is but one choice available for consideration. In the former instance there is no alternative-- the choice is simply to use a helicopter or not do the task. The considerations and choices which are entailed in the second situation are much more involved. Gary R. Broad and William

H. Treharne (Broad and Treharne, 1975) describe various aspects to be considered in selecting a crane or helicopter for a roof-top construction lift. This article is suggested reading for anyone contemplating heavy lift operations. The more significant considerations identified in Broad and Treharne's article are discussed in the following paragraphs.

Equipment Rental-- When considering only the hourly costs, the helicopter is significantly more expensive than a conventional crane. However, there are other factors which must be taken into consideration, namely the items which constitute the total cost. These include the costs of setting up and dismantling of the boom on the crane and the mobilization time for the crane from the rental yard to the job-site especially if this is any significant distance. Any charges for specialty equipment such as an extra long boom or a jib boom must be considered also.

Load Capacity-- The largest helicopter currently available to be purchased in the United States commercial market is the Sikorsky S-70C with a maximum lifting capacity 10,092 pounds (Lawrence, 1984). This figure must be reduced to reflect pilot weight, any on-board equipment, sling/ rigging weight and fuel for the flight time. Truck mounted cranes are commonly available up to 155 tons lifting capacity but at extended reaches, this value will be significantly reduced. The lifting capacity of helicopters is fairly uniform over all conditions.

Productivity-- The agility and speed of transport and setting operations are greater with the helicopter which should significantly reduce the job time and manpower requirements. An example of the viability and effectiveness of helicopter-assisted construction is the placement of the eighteen roof support cables for the air-supported fabric roof on the Pontiac Metropolitan Stadium. The original time estimate of placing the cables using crane and winch was three weeks. By using a single helicopter, all eighteen cables were places in a single sixteen hour period (Geiger, 1975).

Timing-- To maximize the use of the equipment, a carefully planned and orchestrated operation is suggested when using a crane and is essential when using a helicopter. With an effective schedule, a helicopter can set as many pieces in three hours as a long-boom crane can set in eight hours (Broad and Treharne, 1975).

Ground Access-- Helicopters have access to almost all sites while large cranes require an access road to the job-site and if none exists, one would have to be built. The only limitation with helicopters would be overhead obstructions which would also be a consideration with cranes.

Availability-- For equipment to be useful, it must be available. Helicopters are able to be relocated from job to job rather quickly and the firms dealing in helicopter rentals operate pretty much on a nation-wide basis.

Literature indicates that the usual scheduling lead time is several weeks (Broad and Treharne, 1975). An interesting article with international comparison was identified in the literature search. An author from the USSR (Chernitskiy, 1984) was extolling the virtues of helicopters in construction work but noted that due to the requirement for many months of lead time in scheduling the availability of the helicopters in that country, its use as a construction tool was severely limited.

Lift Path-- The FAA requirements dictate that no personnel not associated with the operation be under the flight path while carrying a sling load. This requires careful selection of route from staging area to job-sites. In the event flight over city streets is necessary, assistance from local police will be required to block off traffic under the flight path.

A second article which deals with the unique benefits of employing a helicopter on a tightly constrained project is described by Charles R. Schrader (Schrader, 1975). The literature revealed several additional articles where helicopters were employed in association with a construction project (Electrical Construction and Maintenance, 1971; Martin, 1984), the most notable being construction of the 700-meter tall CN Tower in Toronto, Ontario (World Construction, 1977).

An additional aspect of heavy lift operations was discovered in the literature search-- propelled lighter-than-air craft. These are seen to be the modern reincarnation of the dirigibles of early 1900's. The principal is to combine the buoyant lift of a balloon with the powered lift of the helicopter and gain the advantages of both. Helicopters are limited in that they are very expensive in terms of initial capital expense, hourly operating costs, and maintenance costs. One of the reasons for this is the fact that to be effective, the helicopter must be light because every extra pound of weight in the craft itself means one less pound of load it can carry. To be light means that the parts are highly stressed and made of light-weight alloys. This, coupled with the cyclical loads inherent with helicopter flight, leads to fatigue of parts and thus to periodic mandatory replacement of critical parts. An additional limitation of helicopters is the limited weight they can carry. The largest commonly available commercial helicopter, the Sikorski S-70C, has a maximum load lift capacity of 10,096 pounds and the largest non-commercial helicopter in the world, the Russian Mi-26, has a load lift capacity of 22 tons. To achieve this useful load, the power-plants must be exceptionally large and correspondingly require a larger air-frame. The S-70C has an empty weight of 10,158 pounds, slightly more than its lift capacity while the Mi-26 has an empty weight of 40 tons, slightly less than <u>twice</u> its lift capacity (Lawrence,

1984). The propelled lighter-than-air craft would have a distinct advantage over the helicopter in both of these areas, empty weight and lift capacity. The basic air-frame would not be nearly as weight-conscious and thus the extreme concern to limit air-frame weight would be reduced. Also the loads imposed in flight would be less cyclical and thus less prone to fatigue. Finally the air-frame weight would support itself and thus nearly all of the installed power would be available to lift the sling load.

The literature revealed some interesting information on lighter-than-air craft. The first concerned testimony before the Senate Committee on Commerce, Science, and Transportation (Senate, 1979). Testimony before the committee was made by numerous parties including representatives from Williams Crane & Rigging and Piasecki Aircraft Corporation. In essence the testimony states that there is a need for heavy lift capability beyond the current capabilities of current helicopters in support of the construction industry and industrial plant development. An interesting aspect of this need is the fact that it is often not only weight which limits components but also the physical size. It is stated that in the area of weights up to ten tons and widths less than 12 feet, conventional ground transport systems appear to be entirely adequate. For weights in excess of 10 and up to 100 tons that are less than 12 feet wide, there are no extreme difficulties provided they can be set by crane. It is the transporting

and positioning of components from 100 tons up to 500 tons and/or over 16 feet in width for which is a need. The width limitation is dictated by access-width along roads, rail lines, and available waterways. The representatives of Piasecki Aircraft Corporation provided testimony concerning the development of a propelled lighter-than-air craft and its costs. The testimony records contain lengthy reports by both parties that testified on the subject. Although it is interesting, it contains little further information pertinent to this research subject.

Several additional items associated with the area of propelled lighter-than-air craft for heavy lifts were identified in the literature. Cyclo-Crane[1], one of the companies responding to the original request for information, currently has a flying prototype capable of two-ton useful lift. Crimmins article (Crimmins, 1985) provides an interesting investigation into this craft. The Erickson Group is a commercial operator of four Skycrane helicopters having a lift capacity of ten tons each. It is noted that earlier reference in Lawrence's article to a maximum lift capacity of five tons is for helicopters

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[1] Refer to ends of respective chapters for chapter footnotes; typical for remainder of report.

available for commercial purchase; Erickson Group's Skycrane helicopters are converted ex-military helicopters and are not available for commercial purchase. In Whittenbury's analysis (Whittenbury, 1986), the "hybrid airship" (propelled lighter-than-air) is expected to cost $1050 per hour compared with $3200 per hour for the Skycrane helicopters. In a study conducted under NASA contract by Mettam, Hansen and Ardema (Mettam, Hansen and Ardema, 1981) the authors discuss heavy lift airships and conclude the most probable applications include:

-- High rise building construction

-- Power plant construction

-- Pipeline construction

-- Transmission tower erection

-- Heavy & outsized cargo transportation

The concept of propelled lighter-than-air craft is currently being developed for the logging industry but as seen from the above literature, it has definite applications in the construction field as well. Until these have been developed, the primary vehicle for heavy-lift operations will continue to be the helicopter.

2.2.2-- Parts and Equipment Expediting

Parts and equipment expediting is a support function which consists of using airplanes and helicopters to transport urgently needed items to company project sites. It can play a major role in the smooth operation of any construction project. Ideally it would never be necessary to scramble to quickly obtain an item of equipment or a part because of good planning. However this never seems to be the situation and the ability to quickly deliver items is an essential aspect of a successful construction operation. The literature search did not identify any published information on this topic.

There are several aspects of this purpose which bear discussion. All construction companies will do some expediting. The real question is not whether this function is an important part of a construction company's operation management but how it is to be accomplished. There are be two basic methods of expediting items, in-house or contracted. The contracted method may be by commercial carrier, air freight, parcel delivery such as UPS or Emery, or parcel post. In-house expediting is usually a company owned and operated vehicle. The deciding factor on which method to use is threefold: availability, timeliness, and cost.

If the commercial or contracted carrier does not operate from the point of origin and/or does not deliver to the destination desired, an alternative solution must be found. The company could do its own delivery or try to arrange a series of transport modes to get from origin to destination. The latter can be time-consuming, both in terms of finding suitable arrangements and in terms of speedy delivery. Each time there is a change of transportation mode, time is lost while waiting for connections and the added handling increases the chance of loss or damage to the shipped item. Thus in-house delivery will often be preferred over a contracted service if direct delivery is not available. This is especially true for construction projects in remote locations. However, if the contracted delivery services do provide service from origin to destination, this method is invariably more cost effective than in-house delivery.

The decision to make deliveries by using in-house means is often subconsciously made on the basis of distance and is consciously dependent on the second factor of timeliness. Disregarding time constraints, practically anything can be sent to any location. In construction operations, time is essential and an idle piece of machinery can be very expensive both in terms of the lack of its use and the adverse impact on the performance of related work. Timeliness of contracted delivery is discussed in the above paragraph dealing with availability. When done by in-house

means, time and distance are often considered to be the same. If only one method of travel is being considered, this is true. However if alternative means of transport are considered, such as aircraft, distance and time are only roughly equated. Three ranges of distances influence how items will be expedited. For distances within one-hour driving time, a company truck will usually be optimum while for distances beyond four-hour driving time, other means are invariably more cost effective. If company aircraft are used, deliveries beyond a half-hour flight time but less than four-hours flight are suitable. This would typically result in a mileage radius of from one-hundred to five-hundred miles for the smaller single-engine aircraft and ranging up to a thousand miles for the larger twins.

While not dealing with construction expediting specifically, the article by David S. Lawrence (Lawrence, 1984) of Sikorsky Aircraft points out a very real consideration in the area of expediting. This concerns traffic delays in the larger metropolitan areas. If a part must be expedited through a major traffic congestion-prone area, it is possible that a company-operated aircraft and especially a helicopter will provide more timely delivery, even within the usual fifty mile radius typically reserved for land transport. For timeliness in the area of transport whether for the delivery of parts, equipment, materials or people, the helicopter has a unique advantage over the airplane in the short haul. This advantage stems primarily

from the ability of helicopters to land close to the delivery point and thus eliminate the need for land transportation from the destination airport to the job-site.

The final consideration in the choice of the method of delivery is cost. As stated above, if a contract carrier is available and if it can meet the timeliness criteria, there is little doubt that this will be the most cost effective alternative. Cost considerations must include driver wages for travel in both directions, vehicle ownership costs and operation costs. If no contract carrier is available or if deliveries cannot be made in a timely manner, the alternatives fall to land transport or aircraft. Again, for short distances and lacking extenuating circumstances such as major traffic delays or physical obstacles (impassible roads or no roads) a company-owned truck is generally the most cost effective. When the choice is for the use of aircraft, the decision to utilize a helicopter or airplane depends on several factors. Cost of this equipment is a primary concern. The hourly cost of a helicopter, in terms of capitol investment and operating costs, is significantly higher than that of a similarly-sized airplane. Cost of transport time is another consideration. This includes the cost of the operator and also the cost of the delays being incurred by lack of the item to be delivered. Again for the intermediate range and especially where there is a large distance from the

destination airport to the job-site, the helicopter is preferred. For longer distances and where a destination is in close proximity to the airport, an airplane will usually yield lower overall costs.

Bulk and weight of the delivered item is another aspect of the expediting of parts and equipment by means of aircraft that should be mentioned. To be applicable to delivery by aircraft, the item must not be excessively bulky or awkward to the point of denying loading on-board the aircraft. A usual size limitation would be no larger than two-feet by two-feet by four-feet. For some aircraft this may be too large to allow loading. For the smaller helicopters, a two-foot by two-foot cube is a practical maximum size. Weight limitation on delivery items depends on the size of the aircraft. For the smaller helicopters and airplanes, 250 pounds would be a reasonable maximum while the larger craft could accommodate weights of 500 pounds or more. However the weight limit is best achieved through several smaller packages to facilitate loading.

2.2.3-- Job-Site Investigation

Job-site investigation is the application of transporting personnel from the home office to a job-site. This may be done to conduct initial investigations for bidding purposes and to make visits during the course of construction. Regular job visits by management personnel occur to either keep abreast of the job progress or to investigate some anomaly or problem on the job. In some respects the latter-type visits are closely associated with the category of executive mobility. The different purposes for visiting job-sites will be discussed in greater detail.

A pre-bid site visit on any large construction project is essential. This is especially true for projects that are large in expanse such as large earth moving projects or developments. Use of company-operated aircraft can have several benefits. Pre-bid site visits are best made by those company personnel who are estimating and/or supervising the estimating of the project. The talents of these people are valuable to the company and their time is obviously important and expensive. This expense is often falsely measured in terms of their hourly wage equivalence but to be realistic, the cost is often higher than what the employee is paid in wages. The company is employing these persons for their talents including their abilities to estimate accurately and correctly. They are also expected to be creative and imaginative in bidding projects in order

to identify potential alternative methods and foreseeing potential difficulties which must be factored into the bid. Considering these purposes, the value of such an employee to the company is difficult to measure. This value indirectly reflected in the value of the bids that are successful, the profits made by the company, the money-saving innovations incorporated in the construction bid or process, and the bids astutely prepared. The use of aircraft in pre-bid site visits can enhance the value of the personnel. In a productive sense, the time of estimating and management personnel is best spent in the office working up the estimate or on the site gathering information and not in transit between office and job-site. The time spent by the estimator or superintendent sitting in a vehicle driving to a site is less than optimally utilized. Some will argue that this time allows "thinking time", away from interferences. In reality, the productive thinking that does occur could be better obtained in a quiet setting at the office with limited outside distractions. There is another cost associated with travel time that can have a negative impact on the employee's ability to function efficiently. Employees are best utilized when they are alert and innovative. A three-hour drive to a job-site in heavy traffic, followed by a three-hour drive back to the home office cannot help but degrade the energies and enthusiasm of an employee. To best benefit the company, travel time for estimating and management employees must be

made as short and as enjoyable as possible.

Travel time and its adverse impact can be best minimized through use of company-operated aircraft. For project sites within a one-hour drive, site visits by company personnel are best made by conventional ground transportation methods. For distances in excess of 400 miles, commercial air transport usually the best mode of transporting the estimating and management personnel provided that commercial air-lines offer timely service to the destination with reasonable connections. Time spent sitting in an airport waiting for flight connections (whether scheduled or unscheduled flight delays) is generally non-productive and is often taxing on employees energies. In the intermediate range, and even in some of the longer distances where commercial air transport is not available or not timely, the company-operated aircraft can offer significant benefits. As with parts expediting described earlier, there are trade-offs to be considered between employing helicopters or airplanes for transport. A helicopter is better suited to shorter hauls and in instances where there is no convenient airport located close to the destination. However, the helicopter is more expensive than the airplane. The use of company-owned aircraft for transporting personnel is distinct from parts expediting. As viewed by the Federal Aviation Administration (FAA) and the Federal Aviation Regulations (FAR's) there is a distinction between carrying parts and

equipment and carrying passengers-for-hire. The usual company-operated aircraft will not be carrying passengers-for-hire and is, therefore, not be subject to FAR Part 135-- Air Taxi Operations. Usually the company will rent, lease or own an aircraft and it will be treated as would a company car. One or several of the company personnel might be certified pilots and would operate the aircraft. This is distinctly different from what is known as "corporate aviation" in which the company maintains a full-time flight department complete with full time pilots. In the usual sense of construction company operated aircraft, it is only the extremely large companies which are able to afford a corporate flight department. However, this does not negate the potential benefits of aircraft to the smaller companies, just as corporate limousines do not make the company car less beneficial.

An additional benefit associated with use of company-operated aircraft in the area of job-site investigation is that of perspective. Situations and job-sites have a different perspective when viewed from the air. Terrain features which are less than obvious from the ground are often starkly evident from the air. Items of interest include neighboring properties, distances to roads, locations of developed borrow areas and quarries, general topography which may influence run-off, geological formations, and other factors which may impact or could be employed for the benefit of the operation. A brief aerial

tour of the prospective job-site, perhaps combined with aerial photographs, is an excellent method of collecting data and should allow more productive ground investigation of site which should follow. The next section deals specifically with use of aircraft as a photo and observation platform.

The use of company aircraft for job-site investigations/ visits during the course of construction is similar to personnel transport and executive mobility. This is the transport of management personnel between the home office and the project site. The above arguments related to effective and productive use of the company estimators applies equally to management during the construction process. Time is valuable and time spent behind the wheel of a car, waiting for a connecting (or delayed) flight in an airport terminal, or in any other mode of transportation is less than optimally utilized and should be minimized. While the literature search failed to identify any information regarding this use of aircraft in construction, there is an aspect of interest concerning another study. Hinze and Pannullo (Hinze and Pannullo, 1978), in a study entitled "Safety: Function of Job Control", point out that there is a definite correlation between top management visits to company projects and injury frequency. The companies that had more frequent job visits by the company president (or owner) had better safety performances on their jobs.

> It is understandable that top management is more aware of the various projects and their needs when more frequent job visits of this nature are made. Top management is thereby placed in a better position to foresee future problems that the job supervisors may fail to recognize. Through this assistance in predicting future problems, preventive action can be taken to minimize or even eliminate the anticipated work interruptions. Logically, such jobs will run smoother than those where the problems are not foreseen. This smoothness of operation is beneficial to productivity and also to safety.

The added flexibility afforded by company-operated aircraft would definitely the range of projects available to routine visits by top management and as such if employed should significantly improve project productivity and safety. The research refers specifically to top management and owners. For the small to medium sized construction companies, these are the individuals who would be operating the company airplane. In the larger firms and some of the upper-end medium sized companies the aircraft are expected to be probably operated by a company pilot or the employee himself depending on size of aircraft and capabilities of the manager. The final section of this chapter deals further with the matter of corporate aircraft.

2.2.4-- Photography and Observation Platform

Use of company-operated aircraft as a photo and observation platform allows a unique benefit for the company. As noted in the introduction, this function is not to be confused with aerial photogrammetry. In the latter, very precise control is exercised and expensive photogrammetric camera equipment is required. The final product is a photo-map of the area with a known horizontal scale and perhaps a topographic map depicting vertical terrain features. Photogrammetry has a definite function in the construction field but not usually during construction. Aerial photography is the use of a hand-held camera (typically 35-mm) for taking pictures from the air. An interesting article on this subject was located in the literature search. J. Quick (Quick, 1977) relates that aerial photography dates back to 1906 when an aerial photograph was taken of San Francisco after the earthquake. This picture was taken from a camera attached to a kite. The first aerial picture taken from an airplane was in 1910 of Wright's hangar. The benefit relative to perspective is discussed in the section on job-site investigation. This benefit extends beyond the pre-bid analysis however and is of definite benefit in the active construction process. It is important to properly monitor and record job progress. To accomplish this, adequate and meaningful photographs should be taken supported by written progress documentation.

Pictures provide decisive evidence in cases of dispute and along this vein an aerial photograph or series of photographs may prove invaluable in a claim situation. On large projects the available ground vantage points are often much less than ideal for purposes of properly recording on film the overall or large scale progress. An aerial platform allows much greater flexibility in this regard. Aerial photographs for record purposes are only one use of the platform. Shafer and Degler (Shafer and Degler, 1986) list the following specific applications they have made of aerial photography in Alaska:

* Monitoring for historical purposes
* Predictive monitoring
* Monitoring to correct design problems
* Monitoring construction projects and other activities
* Monitoring and documentation of processes

Their article contains detailed suggestions on procedures and equipment along with benefits of this application and is suggested reading for any company interested in this application. Another means of using the aircraft as an aerial platform was discovered in the literature. Long, Taylor and McCarthy (Long, Taylor and McCarthy, 1986) discuss aspects of using aerial video and still-camera equipment including details of a door-mounted camera box for use on smaller Cessna aircraft.

While the use as a platform to take photos or videos is a useful purpose of aircraft, the application as an observation platform should not be discounted. Often an aerial tour of a project will convey a sense of progress or reveal an impending problem that might be missed from ground observations. A weekly aerial tour of a large project by the superintendent and management personnel could be a good way to "step back" and assess the over-all job in a manner that is rarely available otherwise. Additionally there is the opportunity to utilize the aircraft as a sales tool to prospective clients by providing them with an aerial view of current and recently completed projects.

2.2.5-- Personnel Transport and Executive Mobility

The use of general aviation aircraft to transport personnel and for executive mobility is the final category which was identified during this research. As briefly discussed in the introduction, the transport of personnel generally consists of the movement of company technicians and management personnel to and between job-sites. The executive mobility function is transport upper management personnel to jobs, meetings, bid openings, negotiations, and similar purposes as required in the business routine. While in theory there is a subtle distinction between personnel transport and executive mobility uses, in reality, and especially for smaller and medium sized companies, there is little difference between the two functions. For this reason and since considerations applying to one generally applies equally to the other, the two functions are treated here in the same section.

The literature search failed to identify any specific information regarding personnel transport in the construction industry. The failure to locate such references may have been due to the selection of search parameters that were used rather than to lack of available information. However, several excellent sources of information on this use were revealed in the course of this research. As can be expected, the use of aircraft in construction for personnel and executive transportation is a

subset of a wider range of use in the business arena. There are many large companies outside the area of construction which own and operate corporate aircraft. In the area of personnel and executive transportation, the use by construction companies is essentially the same as in other businesses with a few added dimensions. As discussed in earlier sections on job-site investigation, expediting, and aerial observation, the value of company-owned aircraft is realized in the speed and flexibility it allows. Thus, the productive use of the talent embodied in the company personnel and management is enhanced. Still, there is a seemingly common misconception that the company aircraft is a frill or a luxury which does not earn a return in proportion to its cost or is simply a "perk" for the executive. Randal Smith touched on this in his article (Smith, 1986):

> Company planes can be a target for cost-cutting, or a lightning rod for criticism for shareholders who see them as a costly perk for high-living executives. And yet 328 of the 500 largest industrial corporations own their own planes. And one aircraft industry study says companies that do have greater return on equity.
>
> Aircraft industry representatives say companies need planes so executives can travel to plants that have been located in remote parts of the country ..... Shareholders, one says, may fail to visualize "the chairman of the board sitting down in Atlanta for three hours [after] he missed .....[a] flight."
>
> Earlier this month, the trade magazine Business and Commercial Aviation published a supplement, "Management Mobility," that profiled top executives who use company planes. They included Hershey Foods chairman Richard Zimmerman, Coleman chairman Sheldon Coleman and American Express chairman James Robinson.

"It's not always easy to get the top executives together for a few hours at the office," Mr. Coleman says. "But when we are together in the airplane there are no distractions. We have the time and, believe me, the juices flow. We have some of our most productive meetings in those airplanes."

In a business sense, the use of aircraft has a definite function. While the above article speaks primarily to the larger companies, there is application in even the smaller construction companies. The common misconception is that the aircraft must be a large turbo-prop or jet to be useful to a company and that the aircraft really does not fill a need but is only a luxury for top management. This is incorrect; as described in the above sections, there are identifiable benefits to be obtained from company-operated aircraft. Unfortunately it is extremely difficult to quantify these benefits. The benefits exist and are of real value but are largely intangible. Thus, in the highly competitive arena of construction contracting, often the highly evident costs of owning or renting and of operating an aircraft over-ride the less evident, but equally important costs of lost time, lost projects, lost productivity, increased injuries and lost job control. It takes imagination and understanding to be successful in the long term and utilization of aircraft in a company's operation is only a portion of that philosophy.

For the company interested in utilizing aircraft in business, reference is made to several publications by the National Business Aircraft Association (NBAA)[2]. This organization has available several publications dealing with business use of aircraft. While dealing generally in the larger aircraft, useful information on all sizes of aircraft is presented. These publications are primarily concerned with the personnel and executive mobility uses and generally do not address the other aspects discussed in this research. The following publication available from NBAA deals extensively with the business use of aircraft:

> "A Study of Business Aviation in 1985"-- Study aimed at describing the condition, scope and activity of the business aviation community in the United States in the year 1985. Particular emphasis placed on depicting quantitatively and qualitatively measures related to the organization and management of business aviation activity. Business aviation is the largest activity grouping within the general aviation category. By definition, general aviation includes all elements of aviation in the United States other than air carrier, commercial, and military flying.

The publication described above provided the following list of benefits attributed to use of business aircraft.

*Provided rapid response capability to unexpected events
*Improved access to remote locations not served by commercial airliners
*Increased access to geographically dispersed plants and offices
*Provided a vehicle for courier services
*Enhanced the public image of the corporation and provided free publicity

*Saved executive time by reducing travel time and delays
*Increased flexibility and reliability of scheduling
*Improved executive security
*Provided greater comfort and privacy
*Helped attract and retain executives
*Improved productivity during travel time
*Acknowledged importance of executive time

A second publication which is of general interest is also made available by the NBAA and is entitled "Business Aviation: America's Economic Catalyst". This is a slide presentation intended "to successfully communicate the value of business aviation to a lay audience." Additionally the NBAA publishes periodic reports and bulletins associated with business aircraft use. These publications contain a wealth of information pertinent to business use of aircraft and are highly recommended as is membership in the National Business Aircraft Association.

An additional informative publication is available from Piper/ Lear Siegler Company[3] entitled "Plane Sense." As described in the publications forward:

> PLANE SENSE is a primer on using airplanes in business. It contains information that will be of value to executives searching for an alternative to the modes of transportation currently used by their companies. Facts, figures, comparisons and case histories are compiled in such a manner that the reader can gain a broad picture of what corporate aviation is and how a number of individuals and companies have included airplanes in the mix of business tools that have made their enterprises successful. It's a book about airplanes. It's also a book about people.

Unique people. People who routinely fly in conducting business ....

While the above discussion may seem to address primarily the executive, the application also includes transportation of other company personnel. The company aircraft, whether it is a helicopter, single engine airplane, or multi-engine airplane, can be a valuable tool for a company if warranted by the situation and if the company is aware of the capabilities and benefits available. The discussion in this chapter has provided descriptive information and references to assist the reader in making educated and informed decisions in this regard.

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[1]Aero Lift, Inc.; 4105 Blimp Boulevard; Tillamook, Or 97141

[2]National Business Aircraft Association, Inc.; 1200 Eighteenth Street N.W.; Washington DC 20036

[3]Piper Aircraft Corporation; 2926 Piper Drive; Vero Beach, Fl 32960

Chapter Three-- Research Methodology

Research on the use of aircraft in the construction industry was conducted for the following purposes:

1. To identify literature available dealing with General Aviation usages in the construction industry.
2. To conduct a survey on the utilization of aircraft by construction firms throughout the continental United States; to summarize the results as to what size and type firms are using what type and size of aircraft and for what typical purposes; to establish any trends in usage; to determine typical costs; and to determine whether aircraft are generally owned, leased or rented.
3. To identify and discuss key applications of general aviation within the construction industry.

The vehicle for gathering data was primarily by method of a brief mail survey sent to construction firms throughout the continental United States. Because of the unique geographic aspects encountered in the states of Hawaii and Alaska, it was determined to exclude these states from this research. An extensive search of the literature was conducted prior to conducting the survey. The results of the literature search and its methodology are described in chapter 2 and Appendix E respectively.

It was felt that aircraft manufacturers would perhaps be able to provide pertinent literature concerning the use of their aircraft in the construction field. Accordingly, a listing was made of all major airplane, helicopter and lighter-than-air manufacturers by reference to Jane's All the World's Aircraft 1986-87[1]. On 1 February 1987 letters were sent to these manufacturers requesting information on their products use in the construction industry. A copy of this request is attached as Appendix A. Of the nine that replied, most of them indicated that they had no literature dealing with the use of their products in construction. Seven of the nine did however provide some information which was reviewed and found to be somewhat informative concerning this research topic.

Another possible source of information was pursued in the form of associations which dealt in some way with construction or aircraft. A listing of such associations was made using the Encyclopedia of Associations[2]. Appendix B contains a listing of the associations as well as the aircraft manufacturers which were addressed in this and the above discussed request. On 5 February 1987 letters were sent requesting the assistance of these associations. A copy of this letter is attached as Appendix C. Letters were sent to eighteen associations and eight replies were received, but only two of the replies contained some information that was of use in this research.

Success for conducting the research study survey depended heavily on the compilation of a nationwide list of construction firms which used aircraft in connection with their operations. This proved to be a major difficulty as no readily available source for such a listing was able to be located. Appendix D contains a detailed description of the process followed in attempting to obtain such a list. Eventually, through the assistance of the Associated General Contractors (AGC) Chapters in the various States, a listing of 302 companies was able to be developed.

During the time that the listing of construction company names and addresses was being developed, a parallel activity was being conducted. This consisted of the development of the survey form. An initial survey questionnaire was developed, reviewed, and a pilot survey was conducted for the purpose of identifying any problems with the forms. These survey forms were essentially the same as those sent out in the nation-wide survey. The results of this pilot survey were incorporated with the final survey results for analysis. This pilot survey consisted of questionnaires being sent to the forty-four members of the National Constructors Association[3]. These were mailed on 26 March 1987 with return requested no later than 20 April 1987. Ten replies were received. The replies were reviewed for the purpose of identifying any misunderstandings or errors in the forms and on 23 April three of the respondents were called and questioned

concerning the ease and understandability of the survey forms. This resulted in several minor changes to the survey form. A copy of the final survey questionnaire is attached as Appendix G.

The final survey forms were sent out in three separate mailings: ninety-three were sent April 24, thirty were sent May 1, and the remaining 187 were sent May 5. All of the final survey requests had a requested return date of 15 May 1987. This was deemed acceptable in light of the time constraints to compile the final results and also in light of the fact that the responses to the pilot survey had all been returned within a ten day period after mailing. This proved to be adequate as the return of survey forms was essentially complete on 18 May. Of the 302 survey forms mailed, 124 were returned for a return rate of forty-one percent.

The final survey raw data was compiled by use of a data base on a micro computer. Discussion of this analysis is included in Chapters 4 and 5. Printout of the raw survey data is included as Appendix H.

An aspect of the survey form is collection of the information concerning the geographic location of the respondents. None of the survey questions asked for this information directly. However this information was desired for analysis purposes since it was hypothesized that this may have some bearing on whether aircraft were used. To gather this information and to track which companies had

replied, an inconspicuous coding system was employed wherein the survey forms contained blackened letters in strategic paragraphs which corresponded to the company's code number. By comparison with the state of the mailing address, it was thus a simple matter to identify by state where the response had originated. This state code is shown next to the respondent's code number in the tables of Appendix H.

The final mailings of the survey form contained a request for the respondents to provide names of additional construction companies they were aware of which operated aircraft. This was done in an effort to expand the number of companies identified as possibly using aircraft and thus allow follow-on surveys in this area to have a broader base. A printout of the companies addressed in this survey is attached as Appendix I; those companies which were identified but not send surveys as part of this research are noted as being "NEW".

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[1]Jane's All the World's Aircraft 1986-87; Jane's Publishing Inc; 4th Floor; 115 5th Ave; New York, NY. 10003

[2]Encyclopedia of Associations 21st Ed. Gale Research Co.; Book Tower; Detroit, Mi. 48226

[3]National Constructors Association; 1101 15th Street N.W.; Suite 1000; Washington, DC 20005

Chapter Four-- Survey Data Analysis Discussion

The survey conducted in association with this research consisted of a questionnaire containing fifteen questions. These questions were grouped into the following areas:

Questions 1- 4: Information concerning the company including size, geographic area covered, types of projects constructed, and whether aircraft were used.

Questions 5-11: Information from those companies using aircraft concerning:

a. The purposes for which the aircraft were used, the types of aircraft being used, and whether the aircraft are owned, rented or leased.
b. Whether usage had increased, decreased or remained unchanged in the last five years and for what reasons.
c. Whether the usage was anticipated to increase, not change or decrease in the next three years and for what reasons.
d. Hourly costs associated with operation of aircraft segregated by aircraft type and whether owned, rented or leased.
e. Identification of uses of aircraft not addressed in the previous questions.

Questions 12-14: Information from those companies not using aircraft concerning:

a. The reason(s) for not utilizing aircraft.
b. The type of use the company would make of aircraft if they were to use them in the future.
c. Whether the company planned to consider the use of aircraft in their future operations.

Question 15: Thanked the respondents for their time and efforts and requested a name and address if they desired to receive a summary of the survey results.

The survey was conducted in two steps-- a pilot mailing to forty-three addressees and a series of three main mailings to a total of 302 addressees. The pilot mailing was conducted for the purpose of identifying any difficulties in the survey questionnaire. This resulted in only minor changes to the survey form and there is essentially no difference in the questionnaires used in the pilot and main surveys. A copy of the pilot survey form is attached as Appendix F and a copy of the final survey questionnaire is attached as Appendix G. Ten replies were received from the pilot mailing and 124 were received from the main mailings for a total of 134. The replies were consolidated into one set for analysis purposes. Appendix H contains the coded replies for the survey. In this table, the code numbers preceded by a "P" are from the pilot mailing; code numbers with no preceding letters are from the main mailings.

As described in Appendix D, the method of obtaining the roster of companies for this survey depended heavily on input from chapters of the Associated General Contractors. The survey portion of this research was possible only through the personal assistance of members of the AGC chapters. This method of collecting the data sources did however result in the surveyed group not being an indication of how widespread the use of aircraft is throughout the construction industry. To accomplish this goal, it would have required a survey which randomly

selected companies from throughout the United States as opposed to selectively identifying companies believed to use aircraft. The selective identification method was employed in this survey as the goal was to quantify the use of aircraft on the basis of company type, size, location, and to identify typical uses. Due to the imposition of financial constraints, the survey that was conducted was deemed to be the most appropriate to collect the desired data.

The response rate for this survey of thirty-nine percent (134 of 345) was significantly better than anticipated. It is unsure precisely why this resulted. Perhaps it was due in part to the propensity of companies using aircraft, which as expected did constitute a large percentage of the surveyed group, to reply. Another factor may have been that conscious steps were taken to make the survey questionnaire short, understandable, and easy to complete . Also the letter accompanying each survey specifically expressed to the addressee that this was not a large mailing and that their response was therefore important.

Finally, there had been some concern as to whether the method of addressing and stamping the letters containing the questionnaires would have some influence on the response rate. It was reasoned that a hand written address and a personally applied stamp (as opposed to mailing labels and postal-metered stamping) would convey to the addressee a

sense of personal importance and would result in an increased return rate. This survey used mailing labels on both the pilot and main mailings; individual stamps were used on the pilot mailing and postal metering was used on the main mailings. The response rate for the pilot survey mailing was twenty-three percent (ten of forty-three) and for the main mailing was forty-one percent (124 of 302). In this regard it appears that mailing label addressing and postal metering did not adversely impact the response rate.

For analysis purposes, the responses were divided into two groups-- those indicating use of aircraft and those indicating non-use. Of the 134 responses, ninety-four indicated use of aircraft and forty indicated non-use. This translates to seventy percent and thirty percent respectively. However, it should not be inferred from this that seventy percent of the construction industry in general use aircraft.

Results of the analysis of the data resulting from this survey is described in Chapter 5.

Chapter Five-- Results of Survey Data Analysis

5.1-- General Discussion

Data was collected concerning the characteristics of the companies for the purpose of determining if use of aircraft could be associated with these characteristics. Tables 5-1A and 5-1B show the compiled data by characteristic with companies separated into the categories of those using aircraft, those not using aircraft and all firms combined. Table 5-1A is the summary of the raw data with no revisions. As can be seen, on the basis of number of field employees, number of active projects, and gross revenue, there is apparently little difference between those companies using and those not using aircraft . Some apparent distinction is observed on the basis of the number of home office employees; those companies using aircraft reported a significantly higher average number for home office employees. However it was suspected that these statistics were being influenced by the presence of a small number of replies which reported values significantly beyond the normal range of responses. This was suspected based upon the large standard deviations being observed. Further analysis was performed wherein for each group and characteristic, an assessment was made to determine whether some elements were present which were significantly outside

	(Number)	Maximum	Minimum	Average	StDev
Number of Field Employees:					
Using A/C	(89)	10,000	0	549	1445.8
Not Using	(40)	10,000	6	652	1709.6
Combined	(129)	10,000	0	581	1526.4
Number of Home Office Employees:					
Using A/C	(89)	5,000	1	115	543.7
Not Using	(39)	700	2	79	148.2
Combined	(128)	5,000	1	104	460.1
Number of Active Projects:					
Using A/C	(88)	200	1	22	36.0
Not Using	(39)	200	2	21	39.4
Combined	(127)	200	1	22	36.9
Gross Revenue Last Year (in Million-Dollars)					
Using A/C	(78)	2,000.0	0.2	112.9	298.1
Not Using	(33)	900.0	0.5	102.7	223.7
Combined	(111)	2,000.0	0.2	109.9	277.1

TABLE 5-1A: COMPANY CHARACTERISTICS (ORIGINAL)

	(Number)	Maximum	Minimum	Average	StDev
Number of Field Employees:					
Using A/C	(84)	3,000	0	301	460.0
Not Using	(38)	2,500	6	318	549.0
Combined	(124)	3,000	0	306	486.8
Number of Home Office Employees:					
Using A/C	(85)	475	1	46	80.9
Not Using	(37)	250	2	49	63.2
Combined	(124)	475	1	47	75.8
Number of Active Projects:					
Using A/C	(86)	200	1	22	36.3
Not Using	(37)	75	2	13	13.6
Combined	(127)	200	1	22	36.9
Gross Revenue Last Year (in Million-Dollars)					
Using A/C	(76)	850.0	0.2	73.7	162.6
Not Using	(29)	114.5	0.5	27.2	31.9
Combined	(108)	850.0	0.2	74.9	165.5

TABLE 5-1B: COMPANY CHARACTERISTICS (REVISED)

the usual range. In those instances where such elements were observed, they were considered to be non-typical and were removed. In the usual instance, no more than two non-typical elements were removed. The results of this revised analysis is shown in Table 5-1B. From this Table it is apparent that based on the average of number field employees and number of home office employees, there is little difference between those companies using and those not using aircraft. On the basis of average number of active projects and gross revenues, a distinct trend is observed. Companies using aircraft have more active projects and have higher gross revenues than those companies not using aircraft.

It was suspected that use of aircraft would be related to geographic diversity of projects. One of the survey questions requested information on this in the form of typical percent of projects within 100 miles, from 100 to 400 miles, and beyond 400 miles from the home office. Table 5-2 is a summary of the responses separated into geographic ranges and by companies using aircraft, not using aircraft and combined. As observed, companies not using aircraft reported a larger proportion of projects within 100 miles of the home office than did those companies using aircraft. For the intermediate range from 100 to 400 miles, companies using aircraft reported a higher percentage of projects than those not using aircraft. And for distances beyond 400 miles, there was essentially no

difference noted between those using and those not using aircraft. Additionally it is observed that for those companies using aircraft, nearly two-thirds of the projects, on the average, are within 100 miles; for those companies using aircraft, over three-quarters of the projects, on the average, are within 400 miles. On the basis of geographic distribution of projects, there is a distinct trend observed that those companies using aircraft have more projects between 100 and 400 miles. The results for those distances beyond 400 miles is perhaps due to the use of commercial airlines and air-freight for support of these projects. This finding supports the observations made in the discussions of Chapter 2.

	(Number)	Maximum	Minimum	Average	StDev
Projects within 100 Miles (%)					
Using A/C	(91)	100	0	47	32.9
Not Using	(40)	100	0	64	38.3
Combined	(131)	100	0	52	35.4
Projects 100 to 400 Miles (%)					
Using A/C	(91)	100	0	37	28.1
Not Using	(40)	100	0	18	27.6
Combined	(131)	100	0	31	29.1
Projects beyond 400 Miles (%)					
Using A/C	(91)	100	0	17	25.1
Not Using	(40)	99	0	18	32.4
Combined	(131)	100	0	17	27.4

Table 5-2: Project Geographic Diversity

Characteristics concerning the type of work performed by the companies were collected through survey question number three. It was suspected that aircraft usage by the construction companies for business

would be related to type of work. Table 5-3 contains a summary of the results of the responses to this question. Higher aircraft use is noted for firms performing highway construction and dam & heavy earthwork projects. Conversely, lower aircraft use is reported by companies performing multi-story building projects and power plant construction. For the other types of projects, there appears to be little significant difference between those using and those not using aircraft. This result is possibly due to highway and heavy earthwork projects tending to be fairly widely distributed thus being more suitable to requiring use of aircraft for construction support. Multi-story buildings and power plants are often either located in one locality or separated by such distances that commercial transportation is more advantageous. Additionally, highway and heavy earthwork projects would be expected to be more remotely located than building or power plant projects and thus less accessible by commercial forms of transport.

	A/C Users	Non-Users	Combined
Highway Construction	52(26%)	10(14%)	62(22%)
Multi-Story Buildings	22(11%)	16(22%)	38(14%)
Dam & Heavy Earthwork	25(12%)	6(8%)	31(11%)
Bridge & Other Steel	27(13%)	8(11%)	35(13%)
Utilities (Water,Sewer)	29(14%)	8(11%)	37(14%)
Power Plants	12(6%)	8(11%)	20(7%)
Other Types	*35(18%)	**18(23%)	53(19%)
	100%	100%	100%

*-- Industrial/Commercial- 16
Marine Construction--- 3
no significant others

**-- Industrial/Commercial-- 7
Petro-chemical--------- 2
Marine Construction---- 2
no significant others

Note: Numbers shown are the number of times respective category indicated in responses. Some respondents indicated performing multiple types of construction thus numbers indicated may exceed number of respondents.

Table 5-3: Types of Construction Performed

5.2-- Analysis of Responses Indicating Use of Aircraft

One of the primary purposes of the survey was to gather information concerning the purposes to which aircraft were being placed within the construction industry. Question number five related to the purposes for which companies were using aircraft and whether those aircraft were owned, rented or leased. The results of this portion of the survey are shown in Tables 5-4A and 5-4B. As shown in Table 5-4A, a nearly even distribution of responses resulted between the three uses of site investigation, personnel transport and executive mobility. A review of the raw data (Appendix H) reveals that there are very few companies using aircraft for only one purpose. Many companies that indicated using aircraft for personnel transport also indicated uses for executive mobility and/or site investigation. That is not to imply that all companies used aircraft for all three purposes for there were many which did report two of these uses but not all three. These three uses collectively accounted for nearly three-fourths of the total number. Of the remainder, parts and equipment expediting was the most often reported use followed by use as a photography and observation platform and, finally, heavy lift operations. It had been suspected that some other uses might be made of aircraft which had not been included in the list of uses. To encourage respondents to provide information on such uses, an "Other" response

category was included. When this response was indicated, the respondents were asked to specify what that use was. There were three responses indicating other uses; attend machinery auction, bidding, and taking bids to openings. These are essentially forms of executive mobility and no other significant uses of aircraft were discovered by the survey.

	Number of Indications
Heavy Lift Operation	14(4%)
Job-site Investigation	78(24%)
Photo & Observation	27(8%)
Parts & Equip Expediting	49(15%)
Personnel Transportation	74(23%)
Executive Mobility	83(25%)
Other Uses	3(1%)
	100%

Note: Numbers shown are the number of times respective category indicated in responses. Some respondents indicated multiple types of use thus numbers indicated may exceed number of respondents.

Table 5-4A: Summary of Type of Uses being made of Aircraft

Concerning what types of aircraft were used for what purposes, examination of Table 5-4B reveals that for the three most reported uses, the predominant type reported was the multi-engine airplane with the single engine airplane constituting slightly more than half as many reports; the use of a helicopter for these purposes was

	Owned	Rented	Leased	Total
Heavy Lift Operation				
Single Engine Airplane	0	1	0	1
Multi Engine Airplane	3	0	0	3
Helicopter	0	7	3	10
total----------	3(21%)	8(58%)	3(21%)	14(100%)
Job-site Investigation				
Single Engine Airplane	20	5	5	30
Multi Engine Airplane	34	1	1	36
Helicopter	9	1	2	12
total----------	63(81%)	7(9%)	8(10%)	78(100%)
Photo & Observation				
Single Engine Airplane	5	3	2	10
Multi Engine Airplane	5	1	0	6
Helicopter	7	3	1	11
total----------	17(63%)	7(26%)	3(11%)	27(100%)
Parts & Equip Expediting				
Single Engine Airplane	13	3	2	18
Multi Engine Airplane	23	1	2	26
Helicopter	5	0	0	5
total----------	41(84%)	4(8%)	4(8%)	49(100%)
Personnel Transportation				
Single Engine Airplane	16	2	2	20
Multi Engine Airplane	41	1	2	44
Helicopter	7	2	1	10
total----------	64(86%)	5(7%)	5(7%)	74(100%)
Executive Mobility				
Single Engine Airplane	20	5	3	28
Multi Engine Airplane	42	3	0	45
Helicopter	8	1	1	10
total----------	70(84%)	9(11%)	4(5%)	83(100%)
Other Uses				
Single Engine Airplane	0	1	1	2
Multi Engine Airplane	1	0	0	1
Helicopter	0	0	0	0
total----------	1	1	1	3

Table 5-4B: Type of Use by Aircraft Type and Acquisition Method

reported approximately half as many times as was the single engine airplane. A similar ratio was reported for the use "parts and equipment expediting". The remaining support

function, photography and observation platform, revealed a different distribution with equal representation by single engine airplanes and helicopters while use of multi-engine airplanes for this purpose was reported approximately half as often. In the area of direct construction support heavy lifts, helicopters dominated but interestingly there were some reported uses of airplanes. There was no reported use of lighter-than-air craft by any of the respondents but this was not entirely unexpected. The potential future use of lighter-than-air craft in the construction industry is discussed in Chapter 2.

Concerning the method of control exercised over the aircraft, for construction support uses, the survey results indicate outright ownership as the predominant arrangement with rental being reported only slightly more often than leasing. Helicopters dominated for heavy lift use, with rental being the most reported arrangement. Outright ownership and lease were reported with approximately equal frequency. This latter observation is suspected to be due to companies not maintaining heavy lift capability in-house and commonly renting or contracting with a company specializing in this operation when needed. For all other uses, ownership is observed to predominate for helicopters as well as for airplanes.

The trend in use of aircraft was addressed first by requesting information on how company use of aircraft had changed in the past five years. As shown in Table 5-5,

there was a fairly uniform distribution with no observable consensus. Somewhat less than half of the companies reported no change in use and there were nearly equal numbers of indications of increase and decrease in use. The predominant reason reported for the increase was changes in job geographic diversity followed by changes in company size/number of jobs. The two most reported reasons for decreases in use were economic conditions and changes in job geographic diversity. The other significant reason indicated for decreases in use was changes in company size/number of jobs. Two responses indicated that the decrease in use of aircraft had been due to changes in airline service which is interpreted to mean that airline service to their area improved. There were no responses indicating that a reduction in airline service had played a part in increased use of aircraft. Perhaps this is in part due to this not having been asked as a specific question. It is also noted that there were no indications that changes in use, whether increases or decreases, were due to tax revisions.

The second part of the trend in usage was measured by asking those companies now using aircraft to indicate their anticipated change in usage for the next three years and reasons for anticipated increases or decreases. The summary of the responses to this question is shown in Table 5-6. An optimistic forecast was observed. Over half of the respondents anticipated no change in usage and over

a third of the respondents indicated anticipated increases; very few respondents indicated foreseeing a decrease.

	Increase	Unchanged	Decrease
Number Indicating----------	26(28%)	37(40%)	30(32%)

Reasons Indicated for Change	Increase	Decrease
Economic Conditions------	2(5%)	15(36%)
Tax Revisions----------	0	0
Company Size/No. of Jobs-	13(34%)	7(17%)
Type of Jobs----------	4(11%)	2(5%)
Job Geographic Diversity-	19(50%)	13(32%)
Other Reasons*----------	0	4(10%)
	100%	100%

*-- Airline Service--- 2
Sold Helicopters-- 2

Table 5-5: Trend in Usage in Past 5 Years and Reasons for Increase or Decrease

Primary reasons cited for increases were changes in company size/number of jobs and change in job geographic diversity. A small number of responses anticipating increased usage would be due to changing economic conditions. Economic conditions was also cited as the primary reason for decreased aircraft usage but the number of these respondents is deemed to be too small to be significant. No reasons for anticipated changes other than those specifically stated in the survey question were observed in the responses.

	Increase	No Change	Decrease
Number Indicating---------- --	34(37%)	53(57%)	6(6%)

Reasons Indicated for Change	Increase	Decrease
Economic Conditions------	9(18%)	3(34%)
Tax Revisions----------	0	0
Company Size/No. of Jobs-	20(40%)	1(11%)
Type of Jobs----------	4(8%)	1(11%)
Job Geographic Diversity-	16(32%)	2(22%)
Other Reasons*----------	1(2%)	2(22%)
	100%	100%

*-- no significant reasons

Table 5-6: Anticipated Trend in Usage in Next 3 Years and Reasons for Increase or Decrease

Information was requested concerning the hourly costs of operating aircraft. Of the ninety-four responses received from companies indicating use of aircraft, sixty-two provided data on costs to operate at least one type of aircraft. The compiled results of this information is shown in Table 5-7. Several of the cost values reported were observed to be significantly higher than the majority of the other respondents' values. These were deemed to be unique responses and were removed from the set used to compute the values shown as noted in the table. This indicates that while the values shown are representative of typical costs to operate aircraft of respective types, costs significantly in excess of those stated can be expected for specific aircraft having unique qualities or characteristics.

	(Number)	Maximum	Minimum	Average	StDev
Airplane, Single Engine					
Owned	(17)	$150	$25	$78	37.5
Rented	(8)	$150	$45	$87	35.5
Leased	(4)	$110	$75	$91	16.2
Airplane, Multi-Engine					
Owned	(38*)	$550	$100	$266	110.0
Rented	(3**)	$300	$200	$248	50.2
Leased	(1)	$450	$450	$450	---
Helicopter					
Owned	(5)	$500	$ 95	$289	179.5
Rented	(2*)	$280	$200	$240	56.6
Leased	(1)	$400	$400	$400	---

*-- three responses of over $1000.00 not included (41 total)
**- one response of $1000.00 not included (4 total)
*-- one response of $950.00 not included (3 total)

Note: for those responses not included, unable to determine from the survey replies the specific reasons for higher costs.

Table 5-7: Hourly Costs of Aircraft*
(less operator)

As noted earlier, the predominant number of responses within each type of aircraft were those indicating ownership followed by rental and lease. Because of the corresponding size of the response group in the owned category, the hourly cost values resulting for owned aircraft are considered to be more reliable than those for the other categories. The respondents were requested to report only costs of owning and operating the aircraft excluding the cost of the pilot. This is considered appropriate since it is suspected that in the majority of instances the aircraft will be operated by an employee of the company who is not employed solely to fly the aircraft.

In instances where a full time pilot is employed, it is a relatively simple matter to factor in the pilots salary to obtain a revised hourly cost. Within the single-engine aircraft type, an average ownership cost was seventy-eight dollars per hour with this figure being fairly representative as indicated by a standard deviation of 37.5. It is interesting to note the tendency for average costs of rented and leased aircraft to become higher than the owned costs. This would be expected since equipment is generally more economic to own outright.

In the multi-engine aircraft type the average cost for rented aircraft is slightly lower than for owned aircraft. Additionally, the distribution of owned values is significantly wider than for rented. It is noted that the sample size for the rented category is very small and the resulting values are thus to be considered suspect in terms of reliability. In the leased category for multi-engine airplanes, there was only one response but it does fall within the upper range of costs reported for owned airplanes.

Cost values for helicopter use are observed to be very similar to those reported for multi-engine airplanes. With the small number of responses, no clear conclusions can be drawn.

It was suspected that usage of aircraft would be somewhat dependent on geographic location of company operations. For example, companies operating in states with wide distances between cities, such as in the north and south central regions and the pacific coast areas, were expected to report higher usage of aircraft. Conversely, those areas with higher population densities such as the New England and the east coast areas were expected to report lower aircraft usage. In an attempt to verify this, the data was analyzed with respect to the states from which the respondents reported. Table 5-8 shows the number of responses tallied by state and geographic region. The percentages shown represent the relative numbers for respondents in each region. States omitted from the summary indicate that no responses were received from companies in those states.

The results shown in Table 5-8 indicate that the North Central area has significantly more reported usage of aircraft, that New England has little reported usage, and that the remaining regions have approximately equal use relative to the other regions. Concluding that these results are a true representation of the distribution of usage on a nation-wide basis is tenuous. This is primarily because the method of obtaining the survey addressees resulted in non-uniform representation from all areas. Survey addressees from all states were desired and were

		Using	Not Using	Total
Pacific North-West				
WA		7	7	14
ID		1	0	1
MT		1	0	1
OR		0	1	1
WY		0	2	2
	TOTAL	9(9%)	10(25%)	19(14%)
Pacific South-West				
CA		3	2	5
NV		3	5	8
UT		2	0	2
CO		3	1	4
NM		2	0	2
	TOTAL	13(14%)	8(20%)	21(16%)
North Central				
ND		3	0	3
SD		3	0	3
MN		4	1	5
NE		5	0	5
IA		1	1	2
KA		9	3	12
WI		1	1	2
	TOTAL	26(28%)	6(15%)	32(24%)
South Central				
OK		2	0	2
TX		7	1	8
AR		1	2	3
LA		2	0	2
MS		1	1	2
	TOTAL	13(14%)	4(10%)	17(13%)
North East				
MI		1	1	2
IL		1	0	1
IN		3	0	3
OH		3	0	3
PA		0	1	1
NY		5	1	6
WV		1	0	1
KY		2	1	3
	TOTAL	16(17%)	4(10%)	20(15%)
S. East/Gulf				
AL		3	0	3
TN		7	1	8
NC		0	1	1
SC		1	0	1
GA		2	1	3
FL		1	2	3
	TOTAL	14(15%)	5(12%)	19(14%)
New England				
ME		3	0	3
MA		0	2	2
CT		0	1	1
	TOTAL	3(3%)	3(8%)	6(4%)
		100%	100%	100%

Table 5-8: Response Distribution By State

actually obtained from most states. In one instance, New Hampshire, the written and telephone request to the AGC Chapter requesting names of companies in that state was flatly denied and consequently representation in this survey from that area is lacking. In other states, numerous addressees were obtained. This may have been due to the use of aircraft being generally common and thus that addressees were plentiful. It is also possible that the AGC chapter official who was queried was more aware of companies using aircraft than were the officials from other areas that were contacted. In some instances the officials at state AGC Chapters were noted to be new to the assignment and somewhat at a loss to identify member companies using aircraft in their operations. None of the AGC chapters maintain a listing of members which utilize aircraft. From the results it is clear that some use of aircraft is made by construction companies from all regions and from most states. Though not able to be determined explicitly from the survey results, the subjective conclusion reached by the author through conversations with the AGC chapter officials is that indeed the use of aircraft by construction companies is greater for those regions where distances between projects and/or cities is greater and commercial airline service is sparser such as the Central regions, and the Pacific Coast area. This is a qualitative conclusion based on remarks made during conversations with AGC officials from

these areas. Officials representing contractors in some areas had difficulty identifying any companies using aircraft.

One final question posed to those companies operating aircraft concerned identification of uses they had made of general aviation aircraft which was not reflected specifically in the survey questions or aspects of aircraft use in construction which they felt were important. Of the eleven responses providing information to this question, five indicated times savings in travel as important and three indicated use of aircraft for advertisement, public relations or sales.

5.3-- Analysis of Responses Indicating Non-Use of Aircraft

Companies indicating they did not use aircraft were queried as to why they did not choose to use aircraft. This was asked in an attempt to determine if there was some single significant reason for non-use. The responses received are summarized in Table 5-9. It is noted that many of the respondents indicated more than one reason for not using aircraft. Unfortunately, few of the respondents indicated which was the primary reason for not using aircraft. Based on the number of responses for each category, it appears that the predominant reason was that using aircraft was not considered cost effective. The next

	Number Indicated
Had not considered using aircraft	3
Do not see aircraft as cost effective	26
Concerned about liability w/ aircraft	5
Concerned about safety of aircraft	3
No heavy lift operations	16
No remote sites where A/C are needed	17
Other reason	3

Table 5-9: Reasons Cited For Not Using Aircraft

most often-cited reasons are lack of heavy lift operations and not having remote sites where aircraft were needed. Interestingly, few companies cited concern about liability and safety as reasons for not using aircraft and a few

indicated they had not considered using aircraft. No significant "other" reasons were reported in the survey responses.

An additional request was made of those companies who did not use aircraft. They were asked to identify the uses for which they would envision using aircraft. Of the forty companies not using aircraft in their operations, thirty responded to this question. The responses received are summarized in Table 5-10. The most-reported use was stated to be personnel transportation followed closely by executive mobility and job-site investigations. It is interesting to note that these three uses were also the most often reported by those companies using aircraft. Several companies indicated potential uses as parts & equipment expediting and heavy lift operations.

To measure the attitude of those companies not using aircraft, a question was asked as to whether they intended to consider the use of aircraft in the future. Thirty-seven of the forty respondents completed this question. Interestingly, only five indicated "yes" while thirty-two indicated that they were not planning to consider the use of aircraft in their future operations. This result seems to indicate a closed attitude toward the use of aircraft as a useful item of equipment for a construction company. This is contrary to the apparent experience of

	Number Indicated
Heavy Lift Operations	4
Job-site Investigations	6
Photo & Observation	0
Parts & Equip Expediting	2
Personnel Transportation	9
Executive Mobility Tool	6
Other Uses	3*

*-- Air surveys-1
Remote sites-1
Special setting where A/C would be cost effective-1

Table 5-10: Type Of Use For Which Aircraft Would Be Considered

those companies using aircraft. Perhaps this is more of an indication of why those companies are not using aircraft, i.e., they may simply not be interested in using aircraft regardless of the utility or benefits.

Another measure of interest in the use of aircraft was obtained through the final question of the survey. Those companies interested in receiving a summary of this research were asked to indicate this by providing a name and address. A total of seventy-six respondents indicated interest in receiving a summary. Fifty-eight users of aircraft and eighteen non-users indicated a desire to receive a summary; this represents sixty-two percent of the user respondents and forty-five percent of the non-users. This may indicate more of an interest in future use of aircraft on the part of those not now using aircraft than was indicated by the immediately preceding question.

Chapter Six-- Summary and Conclusion

6.1-- Summary of Research Findings

The review of literature and results of the survey associated with this research lead to several conclusions related to general aviation aircraft utilization in the construction industry.

There is little literature dealing specifically with the use of aircraft in the construction industry. The predominant uses described in the literature were determined to be heavy lift operations and photo and observation uses with only a few articles related to each. The aircraft manufacturers appear to be doing very little in the way of marketing their products for use in the construction industry. No association or organization was able to be identified which maintained records or data associated with the extent of use of aircraft by construction companies or information on names of companies using aircraft in their businesses.

This research has revealed that general aviation aircraft are a useful tool in the construction industry. Many construction companies throughout the nation are employing aircraft in the performance of their daily operations and business. The following uses in order of frequency of reported use were revealed:

*Executive Mobility
*Site Investigation
*Personnel Transport
*Parts & Equipment Expediting
*Photo & Observation Platform
*Heavy Lift Operations

Of these, the first five fall generally in the construction support function while the last is the only direct construction operational use identified for aircraft. This is not to imply that heavy lift use is less important than the other uses, but only that of the amount of use is less. Where it is applicable, heavy lift operations is uniquely beneficial to the construction project. The majority of the responses indicated using aircraft for more than one purpose.

The type of projects for which aircraft are most often reported being used includes highway, dam and heavy earthwork projects. Correspondingly, companies which typically undertake multi-story building and power plant projects tend to report not using aircraft in their operations. Companies performing utility construction and bridge or heavy steel construction were determined to be fairly evenly divided on use and non-use of aircraft.

Of the different types of aircraft, the predominant type being used was the multi-engine airplane followed in frequency by the single-engine airplane and then followed by the helicopter. No use of lighter-than-air craft was observed in the survey results, however, the

development of this capability within the logging industry was identified in the literature review. Propelled lighter-than-air craft for heavy lift operations may prove to be applicable to the construction industry in the future.

The reported operating costs of aircraft, excluding pilot costs, varied somewhat for each type of aircraft but general cost ranges were identified. Multi-engines aircraft owned by the company could be expected to cost in the area of $156 to $376 per hour; single-engine aircraft from $41 to $115 per hour; and helicopters from $110 to $468 per hour. These ranges include sixty-eight percent of the total range of responses observed and are expected to encompass the most usual range of prices to be expected. There are expected to be instances where costs may be either above or below these ranges due to unique situations or abnormally expensive aircraft.

Companies using aircraft appeared to prefer outright ownership. This is followed in reported frequency by rental. Very few companies reported leasing aircraft. In the area of heavy lift use, rental dominated. This is perhaps due to tendencies for firms to contract (a form of rental in this instance) for heavy lift operations.

The use of aircraft in the past five years was observed to be fairly constant with the majority of companies indicating no change and an even distribution of the remaining responses being between increased and

decreased usage. The primary reasons cited for increased usage was change in geographic diversity and company size/number of jobs. The reasons given for decreased usage were changes in geographic diversity and economic conditions. There was little indication that tax revisions played a significant part in the past changes.

The anticipated use of aircraft over the next three years was generally optimistic with very few companies forecasting a decrease in use. The reasons most often cited for the increases was change in geographic diversity and company size/ number of jobs.

Aircraft use by construction companies was reported from all areas of the nation. There was no conclusive indication of use distribution by state due primarily to lack of representation from some states and an uneven distribution of survey addressees on a national basis. A tentative conclusion based on the data and conversations with AGC Chapter officials from throughout the nation is that indeed the use of aircraft is higher in those areas where distances between population centers is greater and commercial airline service is perhaps less. Regions with the highest apparent use of aircraft include the Pacific Coast and Great Plains areas.

Most companies not using aircraft rationalized non-use because aircraft use was not considered to be cost effective. This is somewhat rebutted by the number of companies successfully using aircraft in their operations.

A more meaningful, though less often cited, reason for non-use was lack of heavy lift requirements and not having remote sites where aircraft were needed. Little concern was expressed regarding the safety or liability issues involved with using company-operated aircraft. Companies not using aircraft in their current operations do not appear to even consider the use of aircraft in future operations.

A summary of the results of this research was provided to those respondents indicating an interest in receiving one. A copy of the letter and the summary is attached as Appendix J.

6.2-- Conclusion

This research has identified uses of aircraft in the construction industry, examined what type and size of companies are using aircraft, identified the purposes for which aircraft are used, and determined approximate hourly costs of using aircraft. It has also examined the past trends in aircraft usage and anticipated future trends. It has examined what type and size of companies are not using aircraft and the reasons for not using aircraft. This research has resulted in the collection of a data base of names of companies using aircraft which would be of significant benefit to future research in this area.

There is a need for additional follow-on research in the area of aircraft use in the construction industry. This research would build on the data obtained herein and would investigate the following aspects:

* Distribution of aircraft usage by construction companies on a state and regional basis.

* Proportion of Construction Industry utilizing aircraft in their operations.

* More detailed information on costs of aircraft usage by aircraft type including differences in costs between regions.

* More complete information on distribution of aircraft usage by type of work performed and effect of geographic diversity of projects on aircraft use.

* Investigation into benefits perceived by companies of aircraft usage within categories of use such as personnel transport, site investigation, expediting, etc.

* Collection of information concerning aspects of aircraft use for various types of usage as experienced by construction companies using aircraft.

The general aviation aircraft is a potentially useful tool for the construction company. It has been shown by this research to be much more than the commonly-perceived perquisite for the company executive. Construction companies are urged to view the use of aircraft with an open mind and to consider its use as a tool to expand their market area, to increase the productivity of their personnel, and to better support company operations. Business aviation is more than the corporate jet-- it is or can be an extension of the company car or pickup for the visionary and aggressive construction company. It is hoped that the information presented in this research paper will provide valuable information to those companies interested in the use of general aviation aircraft and that future interest in this area will result in discovery of new and improved utility for the advancement of the industry.

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Appendix A

Letter to Aircraft Manufacturers

1 February 1987

<Co. Name>
<Mail Address>
<City>, <State> <ZIP>

Dear Sirs,

This letter is to request your assistance in the form of providing information which will be beneficial to general aviation and to your company. I am a civil engineering graduate student at the University of Washington pursuing a masters degree in construction engineering and management. My masters research topic is "General Aviation's Utilization in Construction and Construction Management". Two types of information are requested which will assist in this research.

Literature on specific uses and benefits of using your aircraft in the area of construction operations and construction management is requested. Uses are seen to include both direct construction operations (heavy lift, project surveillance, aerial surveying, parts and personnel transport, etc.) and indirect operations/ construction management (site/project investigation, management personnel and executive transport, aerial photography, etc.). These are not inclusive lists and your assistance in identifying as many uses as possible will be appreciated. Information on the economics of using aircraft and of owning/ leasing/ renting is requested as this aspect will be addressed in the research.

A major aspect of the research will be collection of data from construction contractors and management firms in the area of general aviation usage. A mail survey will be used to sample firms on a nationwide basis and your company is expected to be able to assist in this effort in the following means. Your marketing department is expected to have collected a data file of companies who own or have expressed interest in your aircraft and also data on the company's type. A listing of construction firms and construction management/ engineering firms from this data base for the purpose of mailing the survey form is requested. Such data could be beneficial to your company in your marketing strategies and your assistance is truly necessary for a successful survey.

Finally I again thank you for your time and efforts in providing this information. Any additional data or information which may be helpful in my research, would be appreciated also. Receipt of this information no later than 2 March 87 is requested. If you have questions concerning this request, I may be reached at 206-337-4738.

Sincerely yours,

Gary W. Femling
12010 Nels Peters Rd
Everett, Wa 98204

Appendix B

Aircraft Manufacturer & Construction Association Addresses

Co. Name	Mail Address			
Aerolift Inc (Cyclo-crane)	4105 Blimp Blvd	Tillamook	Oregon	97141
Beech Aircraft Corp	P.O. BOX 85	Wichita	Kansas	67201
Bell Helicopter Textron Inc	P. O. Box 482	Fort Worth	Texas	76101
Bellanca Inc.	P. O. Box 964	Alexandria	Minnesota	56308
California Helicopter Parts Inc (Sikorski)	P. O. Box 815	Sun Valley	California	91352
Cessna Aircraft Company		Wichita	Kansas	67201
Champion Aircraft Company Inc.	P.O. Drawer K	Tomball	Texas	77375
Engstrom Helicopter Corp	P. O. Box 277	Menominee	Michigan	49858
Fairchild Aircraft Corp	P. O. Box 32486	San Antonio	Texas	78284
Gates Learjet Corp	P. O. Box 11186	Tucson	Arizona	85734
Gulfstream Aerospace Corp	P. O. Box 2206	Savannah	Georgia	31402
Helio Aircraft Ltd	P. O. Box 604	Pittsburg	Kansas	66762
Hiller Helicopters	W. F. Fairchild Airport	Port Angeles	Washington	98362
ILC Dover	P.O. Box 266	Frederica	Delaware	19946
Lake Amphibian Inc	Laconia Airport	Laconia	New Hampshire	03246
Maule Air Inc	Spence Air Base	Moultrie	Georgia	31768
McDonald Douglas Helicopter Co.	Centinela & Teale St.	Culver City	California	90230
Mitsubishi Aircraft International Inc	5400 LBJ Freeway, Suite 1500	Dallas	Texas	75240
Mooney Aircraft Corp	P. O. Box 72	Kerrville	Texas	78028
Piasecki Aircraft Corp	Elmwood Ave E. of Cancon Hook Rd	Philadelphia	Pennsylvania	19079
Piper Aircraft Corp	P. O. Box 1328	Vero Beach	Florida	32960
Robinson Helicopter Co. Inc	24747 Crenshaw Blvd	Torrance	California	90505
Saberliner Corp	6161 Aviation Dr	St. Louis	Missouri	63134
Sikorski Aircraft	North Main Street	Stratford	Connecticut	06601
Aircraft Owners & Pilots Association	421 Aviation Way	Frederick	Maryland	21701
American Society for Engineering Managemen	301 Harris Hall	Rolla	Missouri	65401
American Society of Civil Engineers	345 E. 47th Street	New York	New York	10017
Aviation Manufacturer's Association	1400 K st. N.W. Suite 801	Washington	D. C.	20005
Construction Management Assn of America	1025 Thomas Jefferson St. N.W.	Washington	D.C.	20007
International Society of Flying Engineers	c/o George Doane	Huntsville	Alabama	35802
National Business Aircraft Association	1200 18th St. N.W. 2nd Floor	Washington	D. C.	20036
National Society of Professional Engineers	1420 King Street	Alexandria	Virginia	22314
American Subcontractors Assn	1004 Duke Street	Alexandria	Virginia	22314
Associated General Contractors of America	1957 E Street N.W.	Washington	D.C.	20006
Associated Specialty Contractors	7315 Wisconsin Ave	Bethesda	Maryland	20814
Construction Industry Manufacturers Assn	Marine Plaza, Suite 1700	Milwaukee	Wisconsin	53202
Independent Electrical Contractors	1101 Connecticut Ave N.W.	Washington	D.C.	20036
Mechanical Contractors Assn of America	5410 Grosvenor Lane	Bethesda	Maryland	20814
National Association of Demolition Contrac	4415 W. Harrison St.	Hillside	Illinois	60162
National Contractors Association	1101 15th St N.W., Suite 1000	Washington	D.C.	20005
National Electrical Contractors Assn	7315 Wisconsin Ave.	Bethesda	Maryland	20814
National Utility Contractors Assn	1235 Jefferson Davis Highway	Arlington	Virginia	22202

Appendix C

Letter to Associations

February 5, 1987

<Co. Name>
<Mail Address>
<City>, <State> <ZIP>

Dear Sirs;

This letter is to request your assistance in providing information which may be beneficial to members of your association. I am a civil engineering graduate student at the University of Washington pursuing a masters degree in construction engineering and management. My masters research topic is "General Aviation's Utilization in Construction and Construction Management". Uses of interest include both direct construction operations (heavy lift, project surveillance, aerial surveying, parts and personnel transport, etc.) and indirect operations and construction management (site/project investigation, transport of executive and management personnel, aerial photography, job site safety visits, etc.).

A major aspect of my research will be collection of data from construction contractors and management firms in the area of general aviation usage. A mail survey will be used to sample firms on a nationwide basis and your association is expected to be able to assist in this effort in the following means. It is anticipated that your association may maintain a data file of member companies who own or utilize aircraft. A listing of construction and/or engineering firms from this data base is requested for the purpose of mailing the survey form. Such data is truly necessary for a successful survey and it is anticipated that the research results will reveal usages and trends in general aviation usage which will be beneficial to your members.

Any additional data or information your association may have related to the use of general aviation in the construction industry or in construction management would be appreciated also. Receipt of this information no later than 5 March 87 is requested. If you have questions concerning this request, I may be reached at 206-337-4738. Finally I again thank you for your time and efforts in providing this information.

Sincerely yours,

Gary W. Femling
12010 Nels Peters Rd
Everett, Wa 98208

Appendix D

Research Methodology

Research Methodology

Success for conducting the research study survey depended heavily on the compilation of a nationwide list of construction firms which used aircraft in connection with their operations. This proved to be a major difficulty as no readily available source for such a listing was able to be located. Initially it was believed that the major aircraft manufacturers would be able to assist in this effort. The hope was that their marketing departments would have compiled a data base of companies which had purchased or at least expressed an interest in their aircraft and that the manufacturers would be willing to provide this listing of companies.

Accordingly, a listing was made of all major airplane, helicopter and lighter-than-air manufacturers by reference to Jane's All the World's Aircraft 1986-87[1]. On 1 February 1987 letters were sent to these manufacturers requesting a listing of construction companies that had expressed an interest in their product. The response was less than anticipated. Letters were sent to twenty-four manufacturers, replies were received from nine, and one letter was returned due to the manufacturer having gone out of business. However none of the companies were able to provide listings of construction companies. Several

manufacturers indicated that they may have such data but that they considered it confidential and would not provide it even for research purposes.

While the primary hope had been that the aircraft manufacturers could provide a listing of construction firms, an alternate source of information was being pursued in the event that the primary source failed. After the letters were sent to the manufacturers, a list was compiled of associations which dealt in some way with construction or aircraft. This was accomplished by use of the Encyclopedia of Associations[2]. It was hoped that they could provide some information which was applicable to this research and perhaps provide a listing of companies owning or operating aircraft. On 5 February 1987 letters were sent requesting the assistance of these associations. Again the response was less than anticipated. Letters were sent to eighteen associations and eight replies were received, but only two of the replies contained some information that was of use in this research. None of the responding associations were able to assist in compiling a listing of construction contractors.

It became apparent that no progress was being made in obtaining a listing of contractors from manufacturers or from associations. One of the manufacturers which responded had suggested that a company named "MYRAID"[3] be contacted. This firm develops the data files on aircraft ownership for the Federal Aviation Administration (FAA) on a

monthly basis. It was hoped that somehow this company would be able to sort the data on aircraft registered and provide a listing of construction contractors. On 22 February 1987 a letter was sent to MYRAID requesting their assistance in compiling a listing of contractors who owned aircraft. A copy of this letter is attached at the end of this Appendix. In reply they sent a description of the data bases they provided and a listing of prices for their services. Unfortunately, a detailed investigation into the data bases revealed that there was no reasonable means of identifying aircraft which were owned by construction companies. Even if this had been possible, development of the survey list on such a basis would have totally omitted those companies which rent aircraft. This limitation would have been a serious shortcoming in this study.

At this point a reassessment of the situation and review of the options was conducted. A possible source of a listing of contractors was discovered. This information was sought through the Associated General Contractors (AGC)[4]. The AGC had provided a listing of its chapters throughout the United States and their mailing addresses. By use of this listing, a roster consisting of at least one chapter from each state was prepared. On 10 April 1987, letters were sent to these chapters explaining the purpose of the research and requesting their assistance in the form of identifying five companies from their chapter which they thought used aircraft. A copy of this letter is also

attached at the end of this Appendix. Of the eighty-five letters sent out to AGC Chapters, twenty-seven responses were received which resulted in the identification of ninety-three companies that presumably used aircraft in their operations. To increase the listing of construction companies, telephone contacts were made directly with each of the AGC chapters which had not responded. These chapters were called on May 1 and May 4, 1987 and the effort resulted in an additional 209 company names for a total of 302. These 302 combined with the 44 pilot survey addressees comprise the entire survey group.

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[1]Jane's All the World's Aircraft 1986-87; Jane's Publishing Inc; 4th Floor; 115 5th Ave; New York, NY. 10003

[2]Encyclopedia of Associations 21st Ed. Gale Research Co.; Book Tower; Detroit, Mi. 48226

[3]Myraid Systems, Inc; 3750 N. I-44; Oklahoma City, Ok. 73112

[4]Associated General Contractors of America; 1957 "E" Street N.W.; Washington, D.C. 20006

February 22, 1987

Myraid
7720 N. Robinson
Oklahoma City, Oklahoma 73116

Dear Sirs;

This letter is to request your assistance in providing information which is necessary for a research project which I am conducting. I am a civil engineering graduate student at the University of Washington pursuing a masters degree in construction engineering and management. My masters research topic is "General Aviation's Utilization in Construction and Construction Management". A major aspect of my research will be a mail survey to sample construction and construction management firms on a nationwide basis for the purpose of determining what type firms are using general aviation aircraft for what purposes and to what extent.

I understand that your company develops the Aircraft Registration Tape for the F.A.A. on a monthly basis. I would truly appreciate information concerning how to obtain a recent copy (or preferably a sorted copy) of such a listing for my use in compiling the above mailing list. Such data is truly necessary for a successful survey and it is anticipated that the research results will reveal usages and trends which will be beneficial to general aviation in general.

Receipt of this information no later than 15 March 87 is requested. If you have questions concerning this request, I may be reached at 206-337-4738. Finally I again thank you for your time and efforts in providing this information.

Sincerely yours,

Gary W. Femling
12010 Nels Peters Rd
Everett, Wa 98208

April 10, 1987

Dear Sir;

I am a civil engineering graduate student at the University of Washington pursuing a masters degree in construction engineering and management. A major portion of my masters research is a survey entitled "Utilization of Aircraft in Construction". I need the assistance of your association to enable this survey to be possible!

I need to identify construction companies from throughout the country who are possibly using general aviation aircraft in their operations now or who have used them in the past. This is only concerned with uses of non-commercial aircraft-- aircraft over which construction companies have direct control as opposed to commercial airlines or air freight companies. These companies will be sent a brief survey form intended to collect information on what uses are being made of aircraft and how widespread is this usage. Your association is the only one being approached in your state so to be represented in the survey, it is important that you reply to this request.

My request to you is quite simple. Please provide in the space below the names and addresses of 5 construction companies which you <u>think</u> may use aircraft in their operations or may have used them in the past. Note that you do not have to be certain and I do not expect you to spend a great deal of effort finding only companies which you are certain are using aircraft. If you know of more than 5, please feel free to include those names and addresses on the back of this page.

A prepaid reply envelope is provided for returning the completed form. I would appreciate your response by <u>24 April 87</u>.

Appendix E

Literature Review Search Strategy

Literature Review Search Strategy

Initially a manual search was conducted of the International Aerospace Abstracts (IAA), the Engineering Index Abstracts, and of the Science and Technology Aerospace Review (STAR). The function of this search was primarily to develop a sound foundation of key words or categories on which to base the follow-on computerized search. It became readily apparent that no single search parameters appeared adequate. None of the indexes had single categories which collected literature associated with the subject matter desired. The Engineering Index lacked any definitive categorization relative to aircraft. The STAR contained one category which appeared hopeful-- construction industry-- but this proved to be not only construction of facilities but also, and predominantly, aircraft construction. However this review did identify several articles which were related to the subject and also enabled development of the terms used for the computerized search.

The approach finally chosen for the computerized search was to describe the subject by means of basically two groups of identifying words. The computer then would search the articles in its data base and select those articles which contained one of the terms listed in each group. The first group of key words was a listing of aircraft types and consisted of the following:

Group A:	aircraft	balloon
	helicopter	rotor craft
	airplane	lighter-than-air
	airship	jet

The second group of key words was a listing of functions or purposes within the area of interest and consisted of the following:

Group B:	construction management
	construction industry
	building construction
	building contractor
	construction contractor

In addition to these two groups, one of the computerized data bases that was to be searched-- Compendex-- had broad groupings of subject categories and the following were selected for use in that portion. The numbers in parenthesis are the Compendex number for that subject catagory.

Group C:	bridges & tunnels (401)
	buildings & towers (402)
	construction equipment & methods (405)

It was suspected that the selection of articles based solely on use of the above groups of terms would include a large number of articles dealing with construction of airport facilities. The following set of terms was developed for the purpose of rejecting those articles.

Group D: airport
hangar
runway

The literature search vehicle utilized was DIALOG Information Services[1] accessed through the University of Washington Engineering Library. The following data bases within DIALOG were searched; the numbers after the title indicate the years of coverage and the DIALOG number of the data base.

Aerospace Data Base, 1962-present, (#108)

Compendex, 1970-present, (#8)

Ei Engineering Meetings, 1979-present, (#165)

The Aerospace Data Base covers all the aerospace publications, Compendex includes the engineering publications, and Ei Engineering Meetings includes the engineering conferences and meetings which have been separated from Compendex since 1979.

An initial literature search was conducted on 9 March 1987 using the scheme of linking each of the terms within a group by an "OR" association and then linking the groups to

each other by an "AND" association. The search identified all articles in each data base that contained at least one of the terms in Group A and at least one of the terms in Group B. In this initial search, the terms associated with airport facilities (Group D) were not included as it was not obvious at that time that this distinction would be necessary. Results of the initial literature was surprising in terms of the number of citations identified-- over 560 articles. It was readily apparent that either there was a wealth of articles on the subject or that there was a flaw in the search strategy. Abstracts of the first one hundred citations were requested and reviewed. The identification of articles relevant to this research topic was disappointing. Of the one hundred citations, only a few appeared pertinent-- and several of these were in German. However, analysis of the results did reveal the flaw in the search strategy which was corrected as follows. Firstly, the term "jet" had been included in the aircraft group and this had introduced numerous citations totally unrelated to the desired subject-- jetties, jetting of piles, water jet cleaning, etc. It was determined that deletion of the word "jet" was the best means of eliminating these articles. This was not anticipated to significantly alter the results as all jet-aircraft are either airplanes or helicopters. Thus, any relevant citations would still be identified. Secondly, the lack of a group of terms to exclude airport facilities appeared to result in a large number of citations

dealing with construction of airports, hangars and runways. This led to the development of the exclusion group shown above. Finally, the summary of the initial search listed the number of articles selected for each word in the group. The words "airplane" and "balloon" had introduced huge numbers of citations-- far in excess of what was reasonable. It was hypothesized that perhaps these terms were simply too general. Balloon describes such subjects as balloon framing, balloon roof structures, balloon pipe closures, etc. as well as lighter-than-air balloons. Aircraft as a general term includes airplanes, helicopters, ultralight, experimental, lighter-than-air, gliders, etc. It was decided that these words would be retained but would be treated as a subset of the general group and that the search sets would be identified such that if it became obvious that these terms were incorporating extraneous citations, they could be omitted.

On 7 April 1987 a final literature search was conducted employing the above listed groups modified as described. Table E-1 is the "prints summary" of the final literature search from the Compendex data base. This is included for the purpose of revealing the details of the search strategy and the number of items identified by each word and word group. In the final search, it was determined that there was no requirement to exclude the facilities group (Group D) but that it was best to exclude the words "aircraft" and "balloon". As shown in Table 2-1, this resulted in fifteen

items (identified as set 25 in the Table) and sixty-six items (set 31) from the Compendex data base. There were two sets for this data base only due to the third group of broad subject categories (Group C) described above being applicable only to this data base. Additionally the Aerospace Data Base resulted in identification of nineteen items and the Ei Engineering Meetings data base yielded thirty-four items. In total, 134 citations were identified by this search strategy. The abstracts of these were printed for review.

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[1] DIALOG Information Services, Inc; 3460 Hillview Avenue; Palo Alto, Ca. 94304

PRINTS SUMMARY User:001286 , File 8
TITLE:DIALOG (VERSION 2)

File(s) searched:

File 8:COMPENDEX - 70-87/MAR COPR. ENGINEERING INFO INC.
1987)

Sets selected:

Set	Items	Description
1	23168	AIRCRAFT
2	702	BALLOON
3	2791	HELICOPTER?
4	2	ROTOR()CRAFT
5	1538	AIRPLANE?
6	29	LIGHTER(1W)AIR
7	94	AIRSHIP?
8	172	CONSTRUCTION()MANAGEMENT
9	1960	CONSTRUCTION()INDUSTRY
10	302	BUILDING()CONSTRUCTION
11	7	BUILDING()CONTRACTOR
12	12	CONSTRUCTION()CONTRACTOR
13	2228	AIRPORT?
14	72	HANGAR?
15	845	RUNWAY?
16	6174	CC=401 (BRIDGES & TUNNELS)
17	20488	CC=402 (BUILDINGS & TOWERS)
18	27026	CC=405 (CONSTRUCTION EQUIPMENT & METHODS)
19	23832	10R2
20	4374	3-7/OR
21	25983	19OR20
22	2280	8-12/OR
23	2495	13-15/OR
24	48581	16-18/OR
25	15	21AND22
26	11	25NOT23
27	7	20AND22
28	6	27NOT23
29	451	21AND24
30	390	29NOT23
31	66	20AND24
32	57	31NOT23
33	12	21AND16
34	10	33NOT23
35	3	20AND16
36	3	35NOT23

Prints requested ('*' indicates user print cancellation) :

Date	Time	Description
07apr	12:55EST	P084: PR 25/5/1-15
07apr	12:55EST	P085: PR 31/5/1-66

Total items to be printed: 81

005521

Table E-1: Compendex Prints Summary

Appendix F

Pilot survey Letter and Questionnaire

March 26, 1987

Dear Sir;

Enclosed you will find a survey form. I am a civil engineering graduate student at the University of Washington pursuing a masters degree in construction engineering and management. The survey is being conducted in association with my research topic entitled "Utilization of Aircraft in Construction".

This research study is focused on the construction industry use of non-commercial aircraft-- aircraft over which construction companies have direct control as opposed to commercial airlines or air freight companies. Within this category are aircraft which are rented or leased as well as those which the company owns. Some typical uses may include direct construction operations such as heavy lifts, project surveillance, aerial surveying, parts and personnel transport, etc. Some indirect operations may include site/project investigations, management personnel and executive transport, aerial photography, etc. These are not inclusive lists and your assistance in identifying as many uses as possible will be appreciated.

Please note that my research is also very interested in the responses of those companies which are not using aircraft in their operations. If your company does not now use aircraft, I would still appreciate a response from you.

The enclosed form is brief and requires no extensive data collection on your part. A prepaid reply envelope is provided for returning the completed form. I would appreciate your response by 20 April 87. If unable to respond by this date, a late reply is better than nothing and is requested.

Your survey responses will be held in strict confidence.

- - - - S U R V E Y O N U S E O F A I R C R A F T - - - -

Please answer the following questions:

1. Descriptive information about the Company:
   a. Approximate number of field employees? _____
   b. Approximate number of home office employees? _____
   c. Typical number of active projects at any one time? _____
   d. Approximate company gross revenue for last tax year? _____

2. The portion of company projects located within the following distance of the home office?

___% within 100 miles ___% over 400 miles away

3. Primary type of construction performed by company?

__ Highway construction
__ Multi story buildings
__ Dam or Heavy earthwork construction
__ Bridge or other Steel construction
__ Utilities construction (water,sewer)
__ Power Plant construction
__ Other (please specify)
_____

4. Does your Company now use General Aviation aircraft (airplanes, helicopters, or lighter-than-air) in its construction operations or in support of its operations? ___ YES ___ NO

if "NO", go to question # 12

5. Please select from the following list of uses all that apply to your companies utilization of aircraft and circle the primary aircraft type used for that purpose and whether the aircraft are owned, rented or leased. If more than one type is used, indicate only the predominant type.

type of use	aircraft type* (see codes below)				O=Own R=Rent L=Lease
Direct Construction Operation					
__ Heavy Lift Operations	ASE	AME	HELI	LTA	O R L
Other (Please Specify)					
_____	ASE	AME	HELI	LTA	O R L
_____	ASE	AME	HELI	LTA	O R L
_____	ASE	AME	HELI	LTA	O R L
Indirect/Construction Support					
__ Job site investigation	ASE	AME	HELI	LTA	O R L
__ Photo/Observation Platform	ASE	AME	HELI	LTA	O R L
__ Parts & Equip Expediting	ASE	AME	HELI	LTA	O R L
__ Personnel Transportation	ASE	AME	HELI	LTA	O R L
__ Executive Mobility Tool	ASE	AME	HELI	LTA	O R L

Other (Please Specify)

_____ ASE AME HELI LTA O R L
_____ ASE AME HELI LTA O R L
_____ ASE AME HELI LTA O R L

*aircraft type codes: ASE--fixed wing airplane, single engine
AME--fixed wing airplane, multi engine
HELI--helicopter, single or multi engine
LTA--lighter-than-air or balloon

6. How has your use of aircraft changed in the last 5 years?
/__/ increased /__/ unchanged /__/ decreased

7. If usage increased or decreased, what was the primary reason for this change?
__ Economic conditions
__ Tax revisions
__ Change in company size/ number of jobs
__ Change in type of jobs undertaken
__ Change in job geographic diversity
__ Other _____

8. What changes in aircraft usage by your company do you anticipate for the next 3 years?
/__/ increase /__/ no change /__/ decrease

9. On which of the following reasons do you base this anticipated change?
__ Economic conditions
__ Tax revisions
__ Change in company size/ number of jobs
__ Change in type of jobs undertaken
__ Change in job geographic diversity
__ Other _____

10. If available, please provide average hourly costs your company uses for operating the following aircraft (include all direct and indirect operating costs and maintenance but do not include cost of pilot(s)).

aircraft type	owned	rented	leased
ASE	$_____	$_____	$_____
AME	$_____	$_____	$_____
HELI	$_____	$_____	$_____
LTA	$_____	$_____	$_____

11. Please provide in the space below any uses your company has made of general aviation aircraft which is not reflected in the above survey questions and/or aspects of aircraft use in construction which you feel are important.

_____
_____
_____
_____
_____

Please go to Question #15.

12. You have indicated that your company does not utilize aircraft in support of its construction operations. Please choose from the list below the primary reason(s) your company chooses not to utilize aircraft. If you choose more than one please rank in order of importance with 1 being most important)

__ had not considered using aircraft
__ do not see aircraft use as cost effective
__ concerned about liability associated with aircraft
__ concerned about safety associated with aircraft
__ no heavy lift operations requiring aircraft
__ no remote sites where aircraft would be of benefit
__ other (please specify)_____
__ _____

13. If your company were to consider the use of general aviation aircraft, what type of application would it be?

_____
_____

14. Does your company plan to consider use of general aviation aircraft in its future operations? __ YES __ NO

15. Thank you for your time and effort in completion of this questionnaire. If you are interested in receiving a summary of the results of this survey, please indicate in the space below the address to which the survey results are to be mailed.

company name-- _____
(ATTN:_____)
address------- _____
city, state--- _____,_____
zip----------- _____

Appendix G

Final Survey Questionnaire

- - - - SURVEY ON USE OF AIRCRAFT - - - -

Please answer the following questions:

1. Descriptive information about the Company:
   a. Approximate number of field employees? _____
   b. Approximate number of home office employees? _____
   c. Number of active projects at any one time? _____
   d. Approx. gross revenue for last tax year? _____

2. What portion of Company projects are typically located within the following distance of the home office?

___% within 100 miles ___% 100 to 400 ___% over 400 miles

3. Primary type of construction performed by the Company?

__ Highway Construction
__ Multi-Story Buildings
__ Dam or Heavy Earthwork Construction
__ Bridge or other Steel Construction
__ Utilities Construction (water,sewer)
__ Power Plant Construction
__ Other (please specify)
_____

4. Does your Company now use General Aviation aircraft (airplanes, helicopters, or lighter-than-air) in its construction operations or in support of its operations? This is intended to include typical subcontractors your company may employ in its operations. ___ YES ___ NO

If "NO", go to question # 12

5. Please select from the following list of uses all that apply to your companies utilization of aircraft and circle the primary aircraft type used for that purpose and whether the aircraft are owned, rented or leased. If more than one type is used, indicate only the predominant type.

type of use	aircraft type* (see codes below)				O=Own R=Rent L=Lease
Direct Construction Operation					
__ Heavy Lift Operations	ASE	AME	HELI	LTA	O R L
Other (Please Specify)					
_____	ASE	AME	HELI	LTA	O R L
_____	ASE	AME	HELI	LTA	O R L
Indirect/Construction Support					
__ Job site investigation	ASE	AME	HELI	LTA	O R L
__ Photo/Observation Platform	ASE	AME	HELI	LTA	O R L
__ Parts & Equip Expediting	ASE	AME	HELI	LTA	O R L
__ Personnel Transportation	ASE	AME	HELI	LTA	O R L
__ Executive Mobility Tool	ASE	AME	HELI	LTA	O R L
Other (Please Specify)					
_____	ASE	AME	HELI	LTA	O R L
_____	ASE	AME	HELI	LTA	O R L

*aircraft type codes: ASE--fixed wing airplane, single engine
AME--fixed wing airplane, multi engine
HELI--helicopter, single or multi engine
LTA--lighter-than-air or balloon

6. How has your use of aircraft changed in the last 5 years?
/__/ increased /__/ unchanged /__/ decreased

7. If usage increased or decreased, what was the primary reason for this change? (indicate primary one only)
__ Economic conditions
__ Tax revisions
__ Change in company size/ number of jobs
__ Change in type of jobs undertaken
__ Change in job geographic diversity
__ Other _____

8. What changes in aircraft usage by your company do you anticipate for the next 3 years?
/__/ increase /__/ no change /__/ decrease

9. On which of the following reasons do you base this anticipated change? (indicate primary one only)
__ Economic conditions
__ Tax revisions
__ Change in company size/ number of jobs
__ Change in type of jobs undertaken
__ Change in job geographic diversity
__ Other _____

10. If available, please provide average hourly costs your company uses for operating the following aircraft (include all direct and indirect operating costs and maintenance but do not include cost of pilot(s)).

aircraft type	owned	rented	leased
ASE	$_____	$_____	$_____
AME	$_____	$_____	$_____
HELI	$_____	$_____	$_____
LTA	$_____	$_____	$_____

11. Please provide in the space below any uses your company has made of general aviation aircraft which is not reflected in the above survey questions and/or aspects of aircraft use in construction which you feel are important.

_____
_____
_____
_____

Please go to Question #15.

12. You have indicated that your company does not utilize aircraft in support of its construction operations. Please choose from the list below the primary reason(s) your company chooses not to utilize aircraft. (If you choose more than one please rank in order of importance with 1 being most important)
__ had not considered using aircraft
__ do not see aircraft use as cost effective
__ concerned about liability associated with aircraft
__ concerned about safety associated with aircraft
__ no heavy lift operations requiring aircraft
__ no remote sites where aircraft would be of benefit
__ other (please specify)_____

13. If your company were to consider the use of general aviation aircraft, what type of application would it be; what would it be used for?

_____

_____

14. Does your company plan to consider use of general aviation aircraft in its future operations? __ YES __ NO

15. Thank you for your time and effort in completion of this questionnaire. If you are interested in receiving a summary of the results of this survey, please indicate in the space below the address to which the survey results are to be mailed.

company name-- _____
(ATTN:_____)
address------- _____
city, state--- _____,_____
zip----------- _____

Finally your assistance is requested in identifying other construction companies who are possibly utilizing aircraft in some aspect of their operations. If you know of one or more such companies, please provide their mailing addresses in the space below to enable their inclusion in this survey series.

Appendix H

Raw Survey Data

Appendix H

Coding Scheme Description

The following matrix is the coded information from the survey questionaires received in association with this research. Note that there are two groups of matrices-- the first for those responses indicating use of aircraft (containing parts I,II,III & IIII) and the second for those responses indicating not using aircraft (containing parts I & II). Within each group, the first part contains basic information which did not require descriptive information and the remaining parts within the group contain responses to questions which required descriptive or short answers. The code numbers are provided to allow easy tracking between parts of the same group.

The following code table describes the matrix column headings and coding of the matrix elements. Entries shown in braces ({}) in the following table are allowable entries in the matrix, italicised words are descriptive of the allowable answer choices.

CODE:	SURVEY ADDRESSEE CODE NUMBER
ST:	TWO LETTER ABREVIATION OF ADDRESSEE'S MAILING ADDRESS
1.A:	QUESTION 1A.-- NUMBER OF FIELD EMPLOYEES
1.B:	QUESTION 1B.-- NUMBER OF HOME OFFICE EMPLOYEES
1.C:	QUESTION 1C.-- NUMBER OF ACTIVE PROJECTS AT ONE TIME
1.D:	QUESTION 1D.-- GROSS REVENUE FOR LAST TAX YEAR
2.A:	QUESTION 2-- % OF PROJECTS WITHIN 100 MILES OF HOME OFFICE
2.B:	QUESTION 2-- % OF PROJECTS BETWEEN 100 AND 400 MILES
2.C:	QUESTION 2-- % OF PROJECTS BEYOND 400 MILES OF HOME OFFICE
3a:	QUESTION 3-- HIGHWAY CONSTRUCTION
3b:	QUESTION 3-- MULTI-STORY BUILDINGS
3c:	QUESTION 3-- DAM OR HEAVY EARTHWORK CONSTRUCTION
3d:	QUESTION 3-- BRIDGE OR OTHER STEEL CONSTRUCTION
3e:	QUESTION 3-- UTILITIES CONSTRUCTION (WATER,SEWER)
3f:	QUESTION 3-- POWER PLANT CONSTRUCTION
3g:	QUESTION 3-- OTHER CONSTRUCTION (TO BE SPECIFIED)
4:	QUESTION 4-- DOES COMPANY USE AIRCRAFT {YES/NO}
5a:	QUESTION 5-- HEAVY LIFT OPS {AIRCRAFT CODE/OWN,RENT,LEASE}
5b:	QUESTION 5-- OTHER DIRECT USE (TO BE SPECIFIED){SEE 5A}
5c:	QUESTION 5-- JOB SITE INVESTIGATION {SEE 5A}
5d:	QUESTION 5-- PHOTO/OBSERVATION PLATFORM {SEE 5A}
5e:	QUESTION 5-- PARTS & EQUIP EXPEDITING {SEE 5A}
5f:	QUESTION 5-- PERSONNEL TRANSPORTATION {SEE 5A}
5g:	QUESTION 5-- EXECUTIVE MOBILITY TOOL {SEE 5A}
5h:	QUESTION 5-- OTHER SUPPORT USE (SPECIFIED) {SEE 5A}
6:	QUESTION 6-- USE CHANGE PAST 5 YRS{INCR,UNCHANGED,DECREASE}
7a:	QUESTION 7-- REASON FOR CHANGE-ECONOMIC CONDITIONS
7b:	QUESTION 7-- REASON FOR CHANGE-TAX REVISIONS
7c:	QUESTION 7-- REASON FOR CHANGE-COMPANY SIZE/NUMBER OF JOBS
7d:	QUESTION 7-- REASON FOR CHANGE-TYPE OF JOBS UNDERTAKEN
7e:	QUESTION 7-- REASON FOR CHANGE-JOB GEOGRAPHIC DIVERSITY
7f:	QUESTION 7-- REASON FOR CHANGE-OTHER (TO BE SPECIFIED)
8:	QUESTION 8-- USE CHANGE NEXT 3 YRS{INCR,NO CHNG,DECREASE}
9a:	QUESTION 9-- REASON FOR CHANGE-ECONOMIC CONDITIONS
9b:	QUESTION 9-- REASON FOR CHANGE-TAX REVISIONS
9c:	QUESTION 9-- REASON FOR CHANGE-COMPANY SIZE/NUMBER OF JOBS
9d:	QUESTION 9-- REASON FOR CHANGE-TYPE OF JOBS UNDERTAKEN
9e:	QUESTION 9-- REASON FOR CHANGE-JOB GEOGRAPHIC DIVERSITY
9f:	QUESTION 9-- REASON FOR CHANGE-OTHER (TO BE SPECIFIED)
10a:	QUESTION 10- HOURLY COST ASE{OWN,RENT,LEASE-HOURLY COST}
10b:	QUESTION 10- HOURLY COST AME{OWN,RENT,LEASE-HOURLY COST}
10c:	QUESTION 10- HOURLY COST HELI{OWN,RENT,LEASE-HOURLY COST}
10d:	QUESTION 10- HOURLY COST LTA{OWN,RENT,LEASE-HOURLY COST}
11:	QUESTION 11- OTHER USES (TO BE SPECIFIED)
12a:	QUESTION 12- NON-USE REASON- HAD NOT CONSIDERED USE
12b:	QUESTION 12- NON USE REASON- BELIEVE NOT COST EFFECTIVE
12c:	QUESTION 12- NON USE REASON- CONCERNED WITH LIABILITY
12d:	QUESTION 12- NON USE REASON- CONCERNED WITH SAFETY
12e:	QUESTION 12- NON USE REASON- NO HEAVY LIFT OPERATIONS
12f:	QUESTION 12- NON USE REASON- NO REMOTE SITES
12g:	QUESTION 12- NON USE REASON- OTHER (TO BE SPECIFIED)
13:	QUESTION 13- APPLICATION COMPANY WOULD CONSIDER A/C FOR
14:	QUESTION 14- WILL COMPANY CONSIDER FUTURE USE {YES/NO}

Companies Using Aircraft-- Part I

CODE	ST	1.A	1.B	1.C	1.D	2.A	2.B	2.C	3a	3b	3c	3d	3e	3f	6	7a	7b	7c	7d					
5	AL	6000	300	15	756	20	60	20							I		X		X	N	X			
6	TN	600	60	50	90	10	70	20	X	X	X	X	X		D	X-1	X-2			I	X-1	X-2			0-450	
7	TN	95	20	12	17	60	20	20		X					U					N		X			0-260	
9	TN														U										0-280	
11	KY	60							X	X	X	X	X	X	I			X	X	N			X			
13	KY					40	60	0							I				X	I		X		0-100	0-200	
17	OH	550	160	20		50	25	25	X		X	X	X	X	D	X				I						
19	OH	250	150	11	215	60	40	0	X	X	X	X	X	X	I		X			I	X		X			0-250
24	IN	450	55	35	94	20	40	40		X			X		U					N						
27	IN	350	7	37	20	80	10	10	X						U					N						
31	SD	100	20	6	15	0	60	40	X						I		X		X	I	X	X		X	R-65	0-220	
33	SD	50	3	3	5	10	60	30	X		X				U					I		X	X				
34	SD	6	1	2	.2	90	10	0	X						D	X				D	X				0-25		
36	ND	150	25	14	12	30	30	40				X			I				X	D	X					0-220	
37	ND	230	10	7	25	10	80	10	X						U					I	X			X	0-65		
38	ND	600	25	10	50	30	40	30	X						I				X	N					0-70	0-100	
43	MT	400	30	25	80	5	20	75	X	X	X	X	X	X	D				X	N	X				0-80	0-175	
46	IL										X				I		X		X	N						0-1002	
48	KS	300	30	12	30	10	60	30					X		I				X	I		X		X		0-150	
49	KS	100	12	6	13	80	20	0	X						I				X	I				X			
50	KS	150	10	5	15	90	10	0	X						D				X	I	X	X		X	R-60	0-180	
51	KS	30	4	6	2.5	0	100	0					X		U					N						0-210	0-95
52	KS	75	6	4	15	50	30	20	X						I		X-1	X-2	X-3	I		X				0-275;R-300	
53	LA	20	4	4		100	0	0							I		X			I		X			0-100		
63	ME	1500	200	35	110	5	80	15			X	X	X	X	D	X			X	X	I		X		X	L-450	
65	TX	7000	475	175	700	10	50	40	X		X	X	X	X	U					I					X	0-475(JET;0-860)	0-450
66	CO	20	3	4	2	30	70	0	X						U					D					X	0-35	
68	CO	200	50	12		30	50	20	X						U					I					X	0-350	
70	CO	100	25	6	13	50	50	0	X		X	X			U					N						0-250	
74	NM	150	10	3	10	5	95	0	X						D		X			N			X			0-400	
76	NM	275	12	6		25	35	40	X						I				X	N	X						
80	CA	0	3	1	.3	100	0	0							U					N					0-150		

Companies Using Aircraft-- Part I

81	CA	2500	450	150	400	30	35	35	X		X		X	X	D	X			X	N					0-1104	R-280
84	WA	300	100			100	0	0	X						D	X				N	X				0-280	
90	ME	100	10	6	7	10	90	0		X	X				I		X			N				0-35	0-100	
92	ME	300	75	12	30	20	80	0	X		X		X		I				X	I			X		0-185	
94	AL	400	35	50	120	80	10	10	X						U					N						
98	WA	12	3	4		80	20	0					X		D			X		I			X	L-75	0-350	
114	OK	100	20	10	15	100	0	0	X						U					N	X	X		R-75		
115	ID	10000	5000	200	2000	0	1	99	X	X	X	X	X	X	U					N						
120	WA	50	8	3		80	20	0							D		X		X	N					0-250	
123	MN	300	20	20	40	50	30	20	X			X	X		I		X		X	N					0-350	
128	MN	800	60	10	60	0	30	70	X		X	X	X	X	D	X		X		X	N	X		X	X	0-250	
131	MN	100	25	10	25	100	0	0		X					U					N						
135	KS	75	10	5	5	100									D				X	D	X			0-150		
136	KS	40	4	5	7	0	100	0		X					U			X		N				0-60		
138	NY	93	7	5	13	50	50	0	X						D				X	N						
139	NY	900	150	12	200	80	20	0	X			X			I		X			I			X			
140	NY	500	40	5	25	80	20	0	X		X	X	X		U	X				I		X		X		
142	NY	200	20	20	20	95	5	0	X			X			I		X	X	X	I		X		X		
149	SC	250	18	14	15	40	60	0				X	X		D					N					L-80		
153	TX	700	60	12	75	60	40	0	X						U					N						
154	TX	100	12	25	12	95	5	0	X						D	X				I	X					
157	WA	50	6	8	3	60	40	0	X		X				U					I			X		R-243	
158	TX	100	5	3	12	10	87	3	X						I	X		X	X	N				0-60		
160	TX	180	10	12	12	60	40	0	X						U					N					0-175	
163	TX	60	10	7	4	40	50	10			X		X	X	D	X		X		I	X		X		0-100	
167	WV	40	3	3	3	67	33	0	X						D				X	N						
174	FL	200	35	10	25	50	50	0		X					U					N						
176	AL	300	112	35	100	26	50	24		X					U					N					0-310	R-200
178	TN	500	60	20	50	25	50	25	X		X	X	X		D	X				N	X					
179	TN	250	50	10	24	75	25	0				X	X		D				X	N				X		
183	TN	400	42	30	50	30	65	5							I		X			N	X				0-230	
184	MS	125	15	10		40	60	0	X		X	X			D	X				I		X			0-350	0-500
187	MI	360	140	120	850	30	30	40							U					N					0-325	
190	KS	125	7	10	10	60	40	0	X			X	X		U					I		X		0-52		

Companies Using Aircraft-- Part I

192	KS	80	20	3	11	50	30	20	X				U			N						0-175			
194	NE	100	6	15	10	10	80	10			X		U			D									
195	NE				30	70	0	X					U			N					0-125				
196	NE	125	10	5	15	25	75	0	X				I	X		1	X		X						
197	NE	150	30	27	20	65	35	0	X				I		X	I			X		0-50;R-75				
198	AR	175	11	6	12	0	50	50	X		X	X	D	X		X	N		X			0-275			
199	TX	400	25	100	30	60	39	1	X			X	1			X	1		X		L-100	0-500			
208	NV	300	20	6	100	100	0	0		X			U			N									
214	NV	50	20	10	32	50	50	0		X						I		X		X	R-150	0-300			
217	NV	30	6	3	5	100	0	0				X	D			X	N					0-100			
223	CA	250	60	15	55	60	10	30				X	U				N				0-90;L-110				
228	UT	50	5	6	6	100	0	0	X			X	I			X	N	X							0-150
248	GA	35	6	4	6	70	25	5					U				N				0-75				
249	GA		12	5		0	100	0		X			I		X	X	1		X		X	0-275			
260	IA	125	15	10	25	0	25	75					D	X			1	X				0-200			
263	LA	1200	75	80		75	28	2	X			X	U				N								
266	NE	300	20	25	20	20	80	0	X	X	X	X	1			X	N								
267	NY	125	15	9	10	75	25	0		X			D	X			N		X						L-400
271	OK	40	5	7	7	95	5	0		X			D	X			N	X							
274	TN	350	45	6		20	50	30	X		X	X	U				1			X	R-45	0-550			
279	UT	45	7	6	7.5	80	0	20		X			D				N								
283	WA	100	25	4	20	50	25	25			X		X	U			N				R-125	R-1000			R-950
286	WA	200	40	13		30	10	60	X		X		X	X	D		X	I		X					
297	WI	200	15	5	30	70	30	0		X			D			X	N								
301	WA	100	15	10	75	10	10	80		X			U				D		X	X	X	R-100	R-200		
P 2	OH	600	1200	90	500	2	0	98		X			U				N								
P10	MN	400	90	10	75	10	0	90				X	D		X		1		X			0-300			
P23	IN	3000	100	45	1200	40	0	60	X	X		X	U				N					0-1200			

Companies Using Aircraft-- Part II-- Aircraft Types

CODEST	5a	5b	5c	5d	5e	5f	5g	5h
5 AL			ASE/L;AME/L;HELI/L			ASE/R;AME/R;HELI/R	ASE/R;AME/R;HELI/R	
6 TN						AME/O	AME/O	
7 TN			AME/O			AME/O	AME/O	
9 TN			AME/O		AME/O	AME/O	AME/O	
11 KY	HELI/R		ASE/R	ASE/R			HELI/O	
13 KY					ASE/O;AME/O	ASE/O;AME/O	ASE/O;AME/O	
17 OH			HELI/O	HELI/O	HELI/O		HELI/O	
19 OH			HELI/O	HELI/O	HELI/O	HELI/O	HELI/O	
24 IN	HELI/R							
27 IN					AME/R			
31 SD			ASE/R;AME/O		ASE/R;AME/O	AME/O	ASE/R;AME/O	
33 SD			X-?/O		X-?/O	X-?/O	X-?/O	
34 SD			ASE/O	ASE/O	ASE/O	ASE/O	ASE/O	
36 ND			AME/O		AME/O	AME/O		
37 ND			ASE/O	ASE/O	ASE/O	ASE/O	ASE/O	
38 ND			AME/O;ASE/O			AME/O	ASE/O	
43 MT			ASE/O			AME/O	AME/O	
46 IL	AME/O		AME/O		AME/O	AME/O	AME/O	
48 KS							AME/O	
49 KS			ASE/O		ASE/O	ASE/O	ASE/O	
50 KS			AME/O				AME/O	
51 KS			AME/O;HELI/O		AME/O	AME/O;HELI/O		
52 KS			AME/O	AME/O	AME/O	AME/O	AME/O	
53 LA			ASE/O					
63 ME			AME/L		AME/L	AME/L	AME/L	
65 TX			HELI/O	HELI/O	AME/O	AME/O	AME/O	
66 CO						ASE/O	ASE/O	
68 CO			ASE/L,AME/O	ASE/L	AME/O	AME/O	AME/O	
70 CO			X		X	X	X	
74 NM							X	
76 NM			ASE/R;AME/O		ASE/R;AME/O	AME/O	AME/O	
80 CA			ASE/O	ASE/O	ASE/O	ASE/O	ASE/O	

Companies Using Aircraft-- Part II-- Aircraft Types

81	CA	HELI/R	AME/O			AME/O	AME/O	
84	WA	AME/O	AME/O			AME/O	AME/O	
90	ME		ASE/O;AME/O		ASE/O;AME/O	ASE/O;AME/O	ASE/O;AME/O	
92	ME		AME/O		AME/O		AME/O	
94	AL		ASE/O			ASE/O	ASE/O	
98	WA					ASE/O;AME/O	ASE/O;AME/O	
114	OK	ASE/R	ASE/R		ASE/R	ASE/R	ASE/R	ASE/R-ATTEND MACHNRY AUCTION
115	ID		ASE	ASE	ASE	AME	AME	
120	WA		AME/O		AME/O	AME/O	AME/O	
123	MN		AME/O			AME/O	AME/O	AME/O-BIDDING
128	MN	AME/O	AME/O	AME/O	AME/O	AME/O	AME/O	
131	MN	HELI/L		AME;HELI/L				
135	KS		ASE/O				ASE/O	
136	KS					ASE/O		
138	NY		ASE/O	ASE/O	ASE/O	ASE/O	ASE/O	
139	NY		HELI/O	HELI/O		HELI/O	HELI/O	
140	NY		AME/O			AME/O	AME/O	
142	NY						ASE/L	ASE/L-TAKING BIDS TO OPENING
149	SC		ASE/L	ASE/L		ASE/L		
153	TX		AME/O;HELI/O			AME/O;HELI/O	AME/O;HELI/O	
154	TX		AME/O					
157	WA		AME/R					
158	TX		ASE/O				ASE/O	
160	TX		AME/O		AME/O	AME/O	AME/O	
163	TX		AME/O			AME/O	AME/O	
167	WV		ASE/O		ASE/O	ASE/O	ASE/O	
174	FL		ASE			ASE	ASE	
176	AL		AME/O	HELI/R			AME/O	
178	TN		AME/O	AME/O		AME/O	AME/O	
179	TN				AME/O	AME/O	AME/O	
183	TN						AME/O	
184	MS		AME/O;HELI/O	AME/O;HELI/O	AME/O;HELI/O	AME/O;HELI/O	AME/O;HELI/O	
187	MI		AME/O	AME/O	AME/O	AME/O	AME/O	
190	KS		ASE/O		ASE/O		ASE/O	

Companies Using Aircraft-- Part II-- Aircraft Types

192	KS	AME/O	AME/O		AME/O	AME/O	AME/O
194	NE		AME/O		AME/O	AME/O	AME/O
195	NE		ASE/O		ASE/O	ASE/O	ASE/O
196	NE		AME		AME		AME
197	NE		ASE/O		ASE/O	ASE/O	ASE/O
198	AR		AME/O		AME/O	AME/O	AME/O
199	TX		AME/O		ASE/L	AME/O	AME/O
208	NV		ASE	AME/R;HELI/R			
214	NV		ASE/R;AME/O				ASE/R;AME/O
217	NV		AME/O			AME/O	
223	CA	HELI/R	ASE/OL				ASE/OL
228	UT		HELI/O	HELI/O	HELI/O	HELI/O	HELI/O
248	GA		ASE/O				
249	GA		AME/O			AME/O	AME/O
260	IA		AME/O			AME/O	AME/O
263	LA			AME			
266	NE		ASE/O;AME/O;HELI/O	HELI/O	ASE/O;AME/O;HELI/O	ASE/O;AME/O;HELI/O	ASE/O;AME/O;HELI/O
267	NY		HELI/L			HELI/L	HELI/L
271	OK		ASE/O	ASE/O	ASE/O	ASE/O	ASE/O
274	TN		AME/O	ASE/R	AME/O	AME/O	AME/O
279	UT		AME/O			AME/O	
283	WA	HELI/R	HELI/R	HELI/R		HELI/R	AME/R
286	WA		ASE		ASE	ASE	ASE
297	WI						ASE/R;AME/R
301	WA	HELI/L	ASE/L;AME/L		ASE/L;AME/L	ASE/L;AME/L	
P 2	OH	HELI/R					
P10	MN	HELI/R	AME/O	ASE/R		AME/O	AME/O
P23	IN	HELI/L	AME/O			AME/O	AME/O

Companies Using Aircraft-- Part III
Construction Type & Other Uses

CODE	ST	3g	11
5	AL	HEAVY INDUSTRIAL	
6	TN		TIME SAVING VERY IMPORTANT
7	TN	MULTI FAMILY COMMERCIAL PROJECTS	
9	TN	SINGLE STORY RESTAURANTS	
17	OH	ASPHALT	
19	OH		USE G.A. FIXED WING FOR TRIPS > 300 MI
24	IN	HEAVY INDUSTRIAL	
34	SD	SOIL CONS & OIL WELL LOCATIONS	
53	LA	COMMERCIAL CONSTRUCTION	TO GET TO BID OPENINGS
63	ME		MOBILITY;RESPONSE TO CNGING CONST SITUATIONS;BEST USE OF KEY PERSONNEL TIME
65	TX	MARINE; PROCESS	
76	NM	MINING	
81	CA	TRANSIT SYSTEMS	
84	WA	CONCRETE ASPHALT	
94	AL	COMMERCIAL BLDGS	
98	WA		CHARITY DONATIONS
114	OK	AIRPORTS	CUSTOMER SALES; SPECIAL TRIPS & MEALS
120	WA	WASTE-WTR TREAT;FISH HATCHERY RESERVS	
128	MN	SHIP LOADERS	
131	MN	COMMERCIAL INSTITUTIONAL	
135	KS	WAREHOUSE,COMMERCIAL,SCHOOLS,CHURCHES	
153	TX	STONE QUARRY,PITS,PRESTRESS CONC PROD	
160	TX		LACK OF COMMERCIAL AIR SERVICE MAKES OPERATING A/C BENEFICIAL
176	AL	HOSPITALS, HOTELS, GOVT CONTRACTS	
179	TN	TUNNELS	
183	TN	DESGN&BLD INDUST&WTR TRTMNT PLNTS	
187	MI	INSTITUTIONAL,COMM & CORP. BLDGS	MARKETING & SALES
192	KS	ASPHALT PAVING	
195	NE		ACCIDENT INVESTIGATION-ALLOWS 2 HR ACCESS TO ANY JOB
214	NV	COMM CONST-SHOPPING CNTRS,HOSPTLS	
248	GA	APARTMENTS,SHOPPING CENTERS	
249	GA	C.O.E. WORK ON BLDGS	BI-MONTHLY VIDEO TAPES OF EACH PROJECT

Companies Using Aircraft-- Part III
Construction Type & Other Uses

260 IA INDUSTRIAL/ AGRICULTURAL
267 NY 1-STORY HOUSING,WTR&SWR PLNTS,PRISONS ADVERTISEMENT
271 OK COMMERCIAL;INDUSTRIAL
274 TN JETTYS, RIVER DIKES, BANK STAB.
297 WI MULTI-FAMILY HOUSING
301 WA COMMERCIAL; INDUSTRIAL
P 2 OH MANUF PLANTS, NEWSPAPERS,
P10 MN INDUSTRIAL PROJECTS

Companies Using Aircraft-- Part IIII
Other Reasons Given For Use Increase & Decrease

CODE	ST	7¢	9¢
17	OH		UPDATE(MOVED UP TO LARGER A/C?)
46	IL		WORK INCREASED BUT USE A/C MORE(?)
81	CA	A/C OWNERSHIP & OPER COST;AIRLINE SERVICE IMPROVED	
84	WA	SOLD HELI	
135	KS		INTEREST DYING OUT
149	SC	SOLD COMPANY HELI	MANAGMENT DOESN'T WANT ANOTHER A/C
194	NE		REDUCED PILOT AVAILABILITY
279	UT	AIRLINE DEREGULATION	

CODE	ST	1.A	1.B	1.C	1.D	2.A	2.B	2.C	3a	3b	3c	3d	3e	3f	12a	12b	12c	12d	12e	12f	14
12	KY	100	30	15	15	90	10	0					X								N
62	TX	400	130	45	105	30	40	30		X						X					N
67	CO	500	100	5		90	9	1	X							X-1			X-2		N
88	MA	100	22	155	25	100	0	0													N
100	FL	12	2	5	1.5	90	10	0											X	X	N
101	WA	1500	250	20	900	5	25	70	X		X	X	X	X					X		N
113	KS	10	4	2	.5	100	0	0				X			X-1				X-3	X-2	
124	MI	50	50	6		30	70	0		X		X							X		N
127	MN	100	5	10	12	80	15	5	X		X				X-1				X-3	X-2	N
130	WI	125	8	5	10	90	10	0	X		X	X	X	X		X		X			Y
134	KS	1000	100	25		20	0	80	X	X	X	X	X	X		X					N
137	KS	250	25	10	50	10	0	90		X						X					N
141	NY	100	10	4	10	80	20	0	X							X-1			X-2	X-3	N
159	WA	100	19	12	25	75	25	0							X-6	X-1	X-5	X-4	X-2	X-3	N
161	MS	30	10	6	4.5	40	50	10								X					N
175	FL	200	70	18		90	10	0		X									X		N
182	TN	200	15	15	32	95	5	0		X						X-1				X-2	N
202	NV	6	3	6	1.9	100	0	0								X-2	X-4		X-3	X-1	N-N
203	NV	50	30	15	100	80	0	20		X				X		X-2				X-1	N
205	NV	30	7	8	10	100	0	0								X			X	X	N
206	NV	10	15	6	15	100	0	0		X			X							X	N
207	NV	4000	200	200		0	100	0			X		X			X					
226	OR	30	6	5	9	100	0	0		X										X	N
237	AR	400	40	30	25	85	10	5	X							X-2			X-1		N
239	AR	75	10	5	6	75	25	0	X							X-1		X-2		X-3	N
247	GA	150	15	15	18	60	30	10								X					Y
257	IA	20	3	6	3	100	0	0												X	N
285	WA	150	18	8	30	90	10	0		X									X-1	X-2	N
290	WA	200	30	10	40	90	10	0		X						X					N
294	WA	100				100	0	0		X						X	X		X	X	N
295	WA	150	50	12	35	100	0	0		X										X	N
298	WY	20	4	6	1	0	100	0	X			X				X					Y
299	WY	8	4	3	.6	70	30	0					X							X	Y
P 3	MA	300	12	6	20	0	0	100											X		N
P 7	CA	10000	700	8	600	0	0	100								X	X		X		N
P12	CT	300	600	20		5	20	75								X					Y
P14	PA	596	93	20	114.5	10	10	80						X		X					N
P25	NC	2000	200	75	800	2	93	5	X	X	X	X		X		X					N
P42	CA	200	60	10	70	80	0	20		X				X							
P43	WA	2500	150	6	300	80	0	20		X		X	X	X		X-1	X-2				N

Companies Not Using Aircraft-- Part II
Other Construction Type, Reasons for Non-Use & Where Would Use

CODE	ST	3g	12g	13
12	KY			F,G
62	TX			C
67	CO	ASPHALT PAVING	PREV OWNED ASE;SOLD WHEN HIWAY JOBS REDUCED	
88	MA	WASTE-WATER TREAT.; INDUSTRIAL BUILDS		G
100	FL	COMMERCIAL BLDGS		
101	WA	MARINE		A,C,F
127	MN	MINE SITES		H-AIR SURVEYS
130	WI			C
134	KS			F
137	KS	SHOPPING CENTERS		C,F
159	WA	SHOPPING CNTRS,BUSNS PRKS,LOW RISE OFF. BLDGS		F
161	MS	FAST FOOD, SERVICE STATIONS		
202	NV	INDUSTRIAL/COMMERCIAL BUILDING		G
203	NV	AIRPORTS,MFG FACILITIES,PARKING GARAGES		G
205	NV	COMMERCIAL,MEDICAL,RETAIL WAREHOUSING		A
239	AR	AIRFORCE BASE AND PRIVATE PROJECTS		C,E,F
247	GA	COMMERCIAL BUILDINGS	OWNED BONANZA FOR 5 YRS, REMOVED THIS YEAR	E,F
257	IA	SMALL COMMERCIAL		
285	WA			A
290	WA			F
295	WA			G
298	WY			C
299	WY			F
P 3	MA	PETROCHEMICAL		
P 7	CA	REFINERY, PETROCHEMICAL, FERTILIZER		
P12	CT	INDUSTRIAL		A
P14	PA			H-REMOTE SITES
P25	NC			H-SPEC COST EFFECTIVE SETTNG
P42	CA		PREVIOUSLY USED; LOW USE FORCED STOP	
P43	WA	MARINE		G

Appendix I

Addresses of Companies Surveyed

Co. Name	Mail Address	City	State	ZIP
B. E. & K. CONSTRUCTION CO	BOX 11676	BIRMINGHAM	AL	35202
BRASFIELD & GORRIE	729 SOUTH 30TH ST.	BIRMINGHAM	AL	35233
BRICE BUILDING CO	BOX 1028	BIRMINGHAM	AL	35201
DOSTER	BOX 77327	BIRMINGHAM	AL	35201
HARBERT INTERNATIONAL	BOX 1297	BIRMINGHAM	AL	35201
SULLIVAN, LONG & HAGERTY	BOX 2247	BIRMINGHAM	AL	35201
DOSTER CONST CO	BOX 66326	BIRMINGHAM	AL	35210
BLOUNT BROS CORP	BOX 949	MONTGOMERY	AL	36102
ECI CONSTRUCTION	BOX 963	FORT SMITH	AR	72902
BEN M. HOGAN CO	BOX 2860	LITTLE ROCK	AR	72203
CRANFORD CONST	3300 EUREKA GARDEN RD	N. LITTLE ROCK	AR	72117
FRESHOUR CONST CO	BOX 77	SWEET HOME	AR	72164
LITTLE ROCK ROAD MACHINRY	BOX 3140	LITTLE ROCK	AR	72203
PICKENS-BOND CONST CO	BOX 3505	LITTLE ROCK	AR	72203
REYNOLDS & DAVIS INC	BOX 1207	LITTLE ROCK	AR	72203
PULICE CONSTRUCTION	2033 W. MTN VIEW RD	PHOENIX	AZ	85021
THE ASHTON CO INC	BOX 26927	TUCSON	AZ	85726
SUNDT CORP	BOX 26685	TUSCON	AZ	85726
CONCRETE CORING COMPANY-LOS ANGELES	14005 ORANGE AVENUE	PARAMOUNT	CA	90723
GRIFFITH COMPANY	BOX 980	LONG BEACH	CA	90801
O"SHAUGHNESSY CONSTRUCTION COMPANY	BOX 217	GOLETA	CA	93116
GRANITE CONSTRUCTION COMPANY	BOX 900	WATSONVILLE	CA	95077
N.V.E.	BOX 13068	SACRAMENTO	CA	95813
BECHTEL CONSTRUCTION INC	BOX 3965	SAN FRANCISCO	CA	94119
DILLINGHAM CONSTR CORP	BOX 1089	PLEASANTON	CA	94566
HEALY TIBBITS CONSTR CO	411 BRANNAN ST	SAN FRANCISCO	CA	94107
UNDERGROUND CONSTR CO	BOX 2218	SAN LEANDRO	CA	94577
NIELSEN VASKO & EARL INC	BOX 13068	SACRAMENTO	CA	95813
TERCHERT CONST	BOX 15002	SACRAMENTO	CA	95813
CAMERON BROS CONST CO	7766 BALBOA AVE	SAN DIEGO	CA	92111
EDMOND J. VADNAIS CO	505 LOMAS SANTA FE DR	SOLANA BEACH	CA	92075
SAPPER CONST CO	BOX 20534	SAN DIEGO	CA	92120
V.R. DENNIS CONST CO	BOX 20068	SAN DIEGO	CA	92120
CIVIL CONSTRUCTORS	BOX 3908	ENGLEWOOD	CO	80155
FLATIRON PAVING OF BOULDER	BOX 229	BOULDER	CO	80306
STERLING COMPANIES	BOX 2187	FORT COLLINS	CO	80522
TEZAK CONSTRUCTION CO INC	1315 ROYAL GORGE BLVD	CANON CITY	CO	81212
BURNETT CONSTRUCTION CO	BOX 2707	DUANGO	CO	81302
KRAPF & SONS INC	307 A STREET	WILMINGTON	DE	19801
E.M. CHADBOURNE INC	4375 McCOY DRIVE	PENSACOLA	FL	32503
BRASWELL ELECTRIC	2310 NORTH FERNWOOD AV	PENSACOLA	FL	32505
TEX EDWARDS COMPANY	BOX 18270	PENSACOLA	FL	32523
ADCOX CONSTRUCTION CO INC	BOX 16485	JACKSONVILLE	FL	32245
BEAUCHAMP CONSTRUCTION CO	247 MINORCA AVE	CORAL GABLES	FL	33134
DANIEL INTERNATIONAL CONSTR DIV	BOX 161	GONZALEZ	FL	32560
THE HASKELL CO	720 GILMORE ST	JACKSONVILLE	FL	32204
BILTMORE CONST CO	1055 PONCE de LEON BLV	BELLEAIR	FL	33516
MATHEWS CORP	5644 N. DALE MABRY	TAMPA	FL	33614
ENTERPRISE BUILDING CORP	BOX 42600	ST. PETERSBERG	FL	33742
DRAKE CONSTRUCTION CO	1853-A PEELER RD	ATLANTA	GA	30338
BENNING CONST CO	BOX 724375	ATLANTA	GA	30339
BOB CARTER INC	BOX 6949	COLUMBUS	GA	31907

BODENHAMER BLDG CORP	P.O. DRAWER 7188	COLUMBUS	GA	31908
CARROLL DANIEL CONST CO	BOX 1438	GAINESVILLE	GA	30503
ED TAYLOR CONST	2400 PLEASANTDALE RD	ATLANTA	GA	30340
HARDIN INTERNATIONAL INC	1380 W. PACES FERRY RD	ATLANTA	GA	30327
M. HEAD CAMERON GEN CONTR	BOX 367	CAMILLA	GA	31730
MARVIN M. BLACK CO	BOX 888506	ATLANTA	GA	30356
SHEPHERD CONSTR CO	BOX 8088 STA "F"	ATLANTA	GA	30306
THE HARDAWAY COMPANY	BOX 1360	COLUMBUS	GA	31993
IRVING F. JENSEN CO	BOX 1618	SIOUX CITY	IA	51102
KING-BOLE INC	404 SHOPS BLDG	DES MOINES	IA	50309
OAKVIEW CONST CO	BOX 450	RED OAK	IA	51566
SIOUX CONTRACTORS INC	BOX 3037	SIOUX CITY	IA	51102
YOUNGLOVE	BOX 8800	SIOUX CITY	IA	51102
MORRISON-KNUDSEN CO INC	BOX 7808	BOISE	ID	83729
BOISE-CASCADE	1 JEFFERSON SQ	BOISE	ID	83702
WESTERN CONSTRUCTION CO	BOX 5403	BOISE	ID	83705
BROWN & LAMBRECHT EARTHMOVERS	RTE 30 AND GOUGAR RD	JOLIET	IL	60432
LURH BROS INC	BOX 69	COLUMBIA	IL	62236
BOYD BROS	BOX 347	SESSER	IL	62884
HUBER, HUNT & NICHOLS INC	BOX 128	INDIANAPOLIS	IN	46206
BRANT CONSTRUCTION CO INC	2001 N. CLINE AVE	GRIFFITH	IN	46319
CALUMET CONSTRUCTION CORP	1247 169TH STREET	HAMMOND	IN	46324
RIETH-RILEY CONSTR CO INC	BOX 477	GOSHEN	IN	46526
JAMES S. JACKSON CO INC	BOX 455	BLUFFTON	IN	46714
McMAHAN-O'CONNOR	BOX 588	ROCHESTOR	IN	46975
BAYSTONE CONSTRUCTION INC	BOX 2568	MUNCIE	IN	47302
ROGERS GOURP INC	BOX 849	BLOOMINGTON	IN	47401
BRB CONTRACTORS INC	BOX 8128	TOPEKA	KS	66608
BLACKTOP CONSTRUCTION COMPANY	BOX 549	EMPORIA	KS	66801
STANNARD CONSTRUCTION	BOX 4064 N. WICHITA ST	WICHITA	KS	67204
STEVENS CONTRACTORS	BOX 6197	SALINA	KS	67401
POPEJOY	BOX 385	ULYSSES	KS	67880
KNUTSON CONSTR CO	4500 W 90TH TERRACE ST	SHAWNEE MISSION	KS	66207
MARTIN K. EBY CONST CO	BOX 1679	WICHITA	KS	67201
HAHNER FOREMAN & HARNESS	BOX 1921	WICHITA	KS	67201
E.W. JOHNSON CONSTR CO	BOX 11453	WICHITA	KS	67202
THE LAW COMPANY INC	BOX 1139	WICHITA	KS	67201
RUSSELL & SONS CONST	BOX 535	EUREKA	KS	67045
RHOADES CONST CO	BOX 365	NEWTON	KS	67114
SHERWOOD CONST CO	BOX 9163	WICHITA	KS	67277
VENTURE CORP	BOX 1486	GREAT BEND	KS	67530
LaFORGE & BUDD CONSTR	BOX 833	PARSONS	KS	67357
E. H. HUGHES CO INC	BOX 17552	LOUISVILLE	KY	40217
OHBAYASHI CORPORATION	880 CORPORATE DR. SUIT	LEXINGTON	KY	40503
W. ROGERS COMPANY	BOX 11640	LEXINGTON	KY	40576
WESTERN KENTUCKY SPRINKLER CO	BOX 1037	PADUCAH	KY	42002
CRAWFORD CONSTRUCTION CO	P.O. DRAWER 240	PADUCAH	KY	42002
JIM SMITH CONTRACTING CO	HIGHWAY 453	GRAND RIVERS	KY	42045
JAMES N. GRAY CONST CO	BOX 6	GLASGOW	KY	42142
DON M. BARRON CONTRACTOR INC	P.O. DRAWER 399	FARMERVILLE	LA	71241
LINCOLN BUILDERS OF RUSTON INC	BOX 400	RUSTON	LA	72370
ATLAS CONST CO	BOX 760	VIDALIA	LA	71373
BOH BROS CONSTR	P.O. DRAWER 53266	NEW ORLEANS	LA	70153
FORDICE CONST CO	BOX 37	DELTA	LA	71233

T.L. JAMES & CO	BOX 1260	RUSTON	LA	71273
PERINI CORP	73 MT WAYTE AVE	FRAMINGHAM	MA	01701
GOURDEAU CONSTRUCTION CO INC	203 WILLOW ST	SO. HAMILTON	MA	01982
A P WHITAKER & SONS INC	652 WEST CENTER ST	WEST BRIDGEWATE	MA	02379
WESTCOTT CONSTR CORP	BOX 671	NO. ATTTLEBORO	MA	02761
CIANBRO CORP	BOX 220	PITTSFIELD	ME	04967
BANCROFT CONTRACTING	BOX 165	SOUTH PARIS	ME	04281
HOWARD BUILDERS	RT 1 BOX 585	AUGUSTA	ME	04330
H E SARGENT INC	101 BENNOCH ROAD	STILWATER	ME	04489
CHAMPION INC	BOX 490	IRON MOUNTAIN	MI	49801
WALBRIDGE, ALDINGER CO	38099 SCHOOLCRAFT	LIVONIA	MI	48150
BARTON-MALOW CO	BOX 5200	DETROIT	MI	48235
S.J. GROVES & SONS	BOX 1267	MINNEAPOLIS	MN	55441
KRAUS-ANDERSON CONSTRUCTION	525 S. 8TH ST.	MINNEAPOLIS	MN	55404
OPUS CORP	BOX 150	MINNEAPOLIS	MN	55440
PARK CONSTRUCTION	7900 BEECH ST N.E.	MINNEAPOLIS	MN	55432
PROGRESSIVE CONTRACTORS INC	BOX 407	OSSEO	MN	55369
AMES CONSTRUCTION INC	14420 COUNTY RD 5	BURNSVILLE	MN	55337
HARDRIVES INC	720 HEMLOCK LANE N.	MAPLE GROVE	MN	55369
HOOVER CONSTRUCTION CO	BOX 1007	VIRGINIA	MN	55792
JOHNSON BROTHERS CORP	BOX 1002	LITCHFIELD	MN	55355
AL JOHNSON CONSTR CO	3209 WEST 76TH ST.	MINNEAPOLIS	MN	55435
KNUTSON CONSTRUCTION CO	5301 RIVER RD E. #101	MINNEAPOLIS	MN	55421
BULLOCK CONST CO	BOX 4628	JACKSON	MS	39216
KEY CONSTRUCTORS	BOX 16256	JACKSON	MS	39236
COP CONSTRUCTION CO	BOX 20913	BILLINGS	MT	59104
UNITED INDUSTRY INC	BOX 30238	BILLINGS	MT	59107
HILDE CONSTRUCTION CO INC	BOX 2287	GREATFALLS	MT	59403
SLETTEN CONSTRUCTION CO	BOX 2467	GREAT FALLS	MT	59403
WASHINGTON CORPORATIONS	BOX 8182	MISSOULA	MT	59807
DILLINGHAM CONSTRUCTION CO	BOX 216	ASHEVILLE	NC	28805
McDEVITT & STREET	BOX 32755	CHARLETTE	NC	28232
J.A. JONES CONST CO	6060 ST. ALBANS ST.	CHARLETTE	NC	28287
RODGERS BUILDERS INC	BOX 18446	CHARLETTE	NC	28218
DAVIDSON & JONES CONST CO	BOX 19067	RALEIGH	NC	27619
MILLER BUILDING CORP	BOX 2046	WILMINGTON	NC	28402
JOHNSON CONSTRUCTION INC	BOX 5547 UNIVERSITY ST	FARGO	ND	58105
INDUSTRIAL BUILDERS INC	BOX 406	FARGO	ND	58107
BORDER STATES PAVING INC	BOX 3162	FARGO	ND	58108
NORTHERN IMPROVEMENT CO	BOX 2846	FARGO	ND	58108
WAGNER INC	BOX 128	REEDER	ND	58649
HAWKINS CONST CO	2512 DEER PARK BLVD	OMAHA	NE	68105
BEATRICE CONST CO	BOX 397	BEATRICE	NE	68310
BIBA ENGINEERING CO	BOX 309	GENEVA	NE	68361
WERNER CONSTRUCTION	BOX 2003	HASTINGS	NE	68901
PAULSEN BLDG & SUPPLY	DRAWER "H"	COZAD	NE	69130
JAMES E. SIMON CO	BOX 130	N. PLATTE	NE	69103
SEAWARD CONSTRUCTION	BOX 1011	PORTSMUTH	NH	03801
PIKE INDUSTRIES	RD #2 BOX 91	CHILTON	NH	03276
ARTHUR WHITCOMB INC	BOX 747	KEENE	NH	03431
SCHIAVONE CONSTR CO	BOX 1179	SECAUCUS	NJ	07094
J. W. JONES	8800 SUSAN AVE S. E.	ALBUQUERQUE	NM	87123
T. BROWN CONSTRUCTORS INC	BOX 26508	ALBUQUERQUE	NM	87125
MOUNTAIN STATES	BOX 6098 STATION B	ALBUQUERQUE	NM	87197

JAMES HAMILTON CONSTRUCTION CO INC	BOX 1287	SILVER CITY	NM	88062
K. BASWETT & SONS	BOX 960	CLOVIS	NM	88101
FREHNER CONST CO	124 W. BROOKS AVE	N. LAS VEGAS	NV	89030
GROVE INC	3325 W. DESERT INN RD	LAS VEGAS	NV	89102
DARLING DEVELOPMENT INC	4625 WYNN RD #102	LAS VEGAS	NV	89103
MARNEL-CORRAO ASSOC	4495 S. POLARIS	LAS VEGAS	NV	89103
MARDIAN CONSTR CO	BOX 11147 AIRPT STA	LAS VEGAS	NV	89111
COOKE & KERZETSKI CONST	BOX 15010	LAS VEGAS	NV	89114
J.A. TIBERTI CONST CO	BOX 14722	LAS VEGAS	NV	89114
REYNOLDS ELECT & ENGR CO	BOX 14400	LAS VEGAS	NV	89114
SIERRA CONST CORP	BOX 14306	LAS VEGAS	NV	89114
WELLS CARGO INC	BOX 14037	LAS VEGAS	NV	89114
ROBERT L. HELMS CO	DRAWER 608	SPARKS	NV	89431
SHAVER CONST INC	9 GREG ST.	SPARKS	NV	89431
SOUTHWEST BUILDERS & DEVELOP.	490 SUNSHINE LANE	RENO	NV	89502
McKENZI CONST CO	BOX 1209	RENO	NV	89504
CLARK & SULLIVAN CONSTR	BOX 7100	RENO	NV	89510
CORRAO CONSTRUCTION	BOX 12907	RENO	NV	89510
GERHARDT & BERRY CONST	BOX 7637	RENO	NV	89510
H.M. BYARS CONST	BOX 10047	RENO	NV	89510
KRUMP CONST	BOX 7357	RENO	NV	89510
Q & D CONSTRUCTION CO	BOX 10865	RENO	NV	89510
MEISER ENTERPROSES	BOX 5805	RENO	NV	89513
T.W. CONSTRUCTION	BOX 6239	RENO	NV	89513
COLDSPRING CONSTRUCTION CO	BOX 358	AKRON	NY	14001
YONKERS CONST CO	BOX 39	YONKERS	NY	10704
ABC PAVING CO	BOX 350	BUFFALO	NY	14224
BARRETT PAVING MATERIALS	1508 GENESSEE ST	UTICA	NY	13502
A.L. BLADES & SON	BOX 190	HONELL	NY	14843
V.J. GAUTIERI INC	BOX 322	BATAVIA	NY	14020
KOKOSING CONSTRUCTION CO INC	BOX 226	FREDERICKTOWN	OH	43019
SHELLY & SANDS INC	BOX 950	ZANESVILLE	OH	43701
RUHLIN COMPANY	200 N. CLEVELAND-MASSI	AKRON	OH	44313
JURGENSON COMPANY	11641 MOSTELLER RD	CINCINNATI	OH	45241
DAVIS COMPANY	1518 E. FIRST STREET	DAYTON	OH	45401
B.G. DANIS CO	BOX 1722	DAYTON	OH	45401
JOHN R. JURGENSEN CO	BOX 41350	CINCINNATI	OH	45241
AMIS MATERIALS COMPANY	BOX 1871	OKLAHOMA CITY	OK	73101
HONEGGER CONSTRUCTION COMPANY	BOX 22965	OKLAHOMA CITY	OK	73123
BEMIS CONSTRUCTION INC	2324 WEST 7TH PLACE	SUSTILLWATER	OK	74074
MUSKOGEE BRIDGE CO INC	P.O. DRAWER 798	MUSKOGEE	OK	74401
WISE SULLIVAN CONST CO INC	BOX 1490	DURANT	OK	74702
LEMON, HASKELL CONSTR CO	BOX 24044	OKLAHOMA CITY	OK	73124
BRAZIAL MASONRY INC	1136 N. PENNSYLVANIA	OKLAHOMA CITY	OK	73107
THE CONSTRUCTORS CO INC	2608 WALNUT RD	NORMAN	OK	73072
THE JIM COX CO	BOX 82988	OKLAHOMA CITY	OK	73148
WYNN CONSTRUCTION CO	BOX 26565	OKLAHOMA CITY	OK	73126
DONALD M.. DRAKE CO	1740 NW FLANDERS	PORTLAND	OR	97209
BROCKAMP & YEAGER INC	15796 S. BOARDWALK	OREGON CITY	OR	97045
BAUGH CONST CO	BOX 767	BEAVERTON	OR	97075
HAGEMAN BROS CONST	11965 HERMAN RD	SHERWOOD	OR	97140
HOFFMAN CONST CO	1300 S.W. 6TH AVE	PORTLAND	OR	97201
WESTWOOD CORP	3030 S.W. MOODY	PORTLAND	OR	97201
H.A. ANDERSEN CO	BOX 6712	PORTLAND	OR	97228

MASHUDA CORP	RD #1 21101 RT 19	EVANS CITY	PA	16033
THE CONDUIT & FOUNDATION CORP	33 ROCKHILL RD	BALA CYNWYD	PA	19004
GLASGOW INC	BOX 248	GLENSIDE	PA	19038
EAGLE CONSTR CO INC	BOX 132	NEWBERRY	SC	29108
SUMWALT CONSTRUCTION CO	BOX 6576	COLUMBIA	SC	29260
REPUBLIC CONTRACTING GROUP	BOX 9167	COLUMBIA	SC	29290
J.L. HEALY CONST. CO	BOX 512	SIOUX FALLS	SD	57101
ANNETT CONST INC	1011 SOUTH VIOLA	MILBANK	SD	57252
A-G-E CORPORATION	BOX 597	FT. PIERRE	SD	57532
KEITH L. CARR CO INC	P.O. BOX "O"	PRAIRIE CITY	SD	57649
CARTER LTD. (CEW CONST CO)	P.O. DRAWER O	FAYETTEVILLE	TN	37334
T. U. PARKS CONSTRUCTION CO	BOX 3159	CHATTANOOGA	TN	37404
BENCOR CONSTRUCTION CO	BOX 4203	CHATTANOOGA	TN	37405
HUDSON CONSTRUCTION CO.	1615 SHALAR AVENUE	CHATTANOOGA	TN	37406
OMAN CONSTRUCTION CO	BOX 146	NASHVILLE	TN	37202
W.L. HAILEY & CO	BOX 40646	NASHVILLE	TN	37204
HARDAWAY CONSTR CO	BOX 60464	NASHVILLE	TN	37206
JOHNSON & GALYON INC	BOX 160	KNOXVILLE	TN	37901
FORCUM-LANNOM ADDOC	BOX 768	DYERSBURG	TN	38024
FOLK CONST CO	BOX 13428	MEMPHIS	TN	38113
FORD CONST CO	BOX 527	DYERSBURG	TN	38024
YOUNG BROS INC CONTRACTORS	P.O. DRAWER 1800	WACO	TX	76703
BROWN & ROOT USA	BOX 3	HOUSTON	TX	77001
LINBECK CONSTRUCTION CORP	BOX 22500	HOUSTON	TX	77227
WILLIAMS BROS CONST. CO	BOX 66428	HOUSTON	TX	77266
H.B. ZACHRY COMPANY	BOX 21130	SAN ANTONIO	TX	78285
BAILEY BRIDGE CO INC	BOX 3115	ABILENE	TX	79604
BAXTER CONSTRUCTION CO	BOX 7744	HOUSTON	TX	77270
RAYMOND INTERNATIONAL	BOX 27456	HOUSTON	TX	77227
UTILITIES CONSOLIDATED INC	BOX 700	BANDERA	TX	78003
DEAN WORK CO	BOX 330	NEW BRAUFFELS	TX	78131
HELDENFELS BROS INC	BOX 4957	CORPUS CHRISTI	TX	78469
JONES BROS DIRT & PVG	BOX 3983	ODESSA	TX	79760
ALLEN KELLER CO	BOX 393	FREDRICKSBURG	TX	78624
F.R. LEWIS CONST CO	P.O. DRAWER 1878	NACOGDOCHES	TX	75961
STRAIN BROTHERS	BOX 1631	SAN ANGELO	TX	76902
J.H. STRAIN & SONS	BOX 277	TYE	TX	79563
BROWN-McKEE INC	BOX 3279	LUBBOCK	TX	79408
ZACK BURKETT CO	BOX 40	GRAHAM	TX	76046
J.D. McNEIL CONST CO	BOX 15655	SALT LAKE CITY	UT	84115
ALDER CONST CO	3939 S. 500 WEST	SALT LAKE CITY	UT	84107
ALLEN YOUNG CONST	BOX 520	RICHFIELD	UT	84701
ELBERT LOWDERMILK INC	BOX 509	HELPER	UT	84526
GIBBONS & REED CO	BOX 30429	SALT LAKE CITY	UT	84125
HALES SAND & GRAVEL INC	BOX 257	ELSINORE	UT	84724
HERM HUGHES & SONS INC	BOX 256	W. BOUNTIFUL	UT	84087
OKLAND CONST CO	BOX 15448	SALT LAKE CITY	UT	84115
FRANK W. WHITCOM CONST CORP	BOX 429	BELLOWS FALLS	VT	05101
PIZZAGALLI CONST CO	BOX 2009	S. BURLINGTON	VT	05402
N.A. DEGERSTRON INC	BOX 425	SPOKANE	WA	99210
CENTRAL PRE-MIX CONCRETE CO	BOX 3366	SPOKANE	WA	99220
NORTHWEST BORING	13248 NE 177TH PL	WOODINVILLE	WA	98072
KIEWIT PACIFIC CO	BOX 1769	VANCOUVER	WA	98668
GUY F. ATKINSON CO.	BOX 1158	MERCER ISLAND	WA	90004

GUY F. ATKINSON CO.	BOX 1158	MERCER ISLAND	WA	90004	
DAVID A. MOWAT CO	BOX 1201	BELLEVUE	WA	98009	
SELLEN CONSTRUCTION CO INC	BOX 9970	SEATTLE	WA	98109	
VENTURE CONSTRUCTION INC	BOX 878	AUBURN	WA	98002	
SELLAND CONSTRUCTION	BOX 119	WENATCHEE	WA	98801	
SUPERIOR ASPHALT & CONCRETE	BOX 10268	YAKIMA	WA	98909	
STRAND INC	BOX 546	BELLEVUE	WA	98009	
BAUGH CONSTR CO	BOX 14135	SEATTLE	WA	98114	
CONSTRUCTORS-PAMEO	3600 FREMONT AVE NO.	SEATTLE	WA	98103	
FERGUSON CONSTR	BOX 80867	SEATTLE	WA	98108	
GALL-LANDAU-YOUNG CONSTR	BOX 6728	BELLEVUE	WA	98008	
GOODFELLOW BROS INC	BOX 598	WENATCHEE	WA	98801	
HALVORSON OSBORNE CONST CO	BOX 97010	KIRKLAND	WA	98033	
HANSEL PHELPS CONST	BOX 3007	SEATTLE	WA	98114	
HOWARD S. WRIGHT CONSTR	BOX 3764	SEATTLE	WA	98124	
LEASE-CRUTCHER CONST	BOX 817	REDMOND	WA	98052	
O.M. HENDRICKSON & CO	BOX 938	SEQUIM	WA	98382	
R.G.LEARY CONST CO	65 BAY ST	SEATTLE	WA	98121	
PASCHEN CONTRACTORS	1530 EASTLAKE AVE E. #	SEATTLE	WA	98102	
SDL CORP	BOX 1685	BELLEVUE	WA	98009	
ROBERT E. BAYLEY CONSTR	ONE UNION SQ SUITE 160	SEATTLE	WA	98101	
WICK CONSTR CO	BOX 31509	SEATTLE	WA	98103	
REUBEN JOHNSON & SON INC	5300 STINSON AVE	SUPERIOR	WI	54880	
J.P. CULLEN & SON CONSTR	BOX 1957	JANESVILLE	WI	53545	
MADSEN CORP	BOX 7720	MADISON	WI	53707	
RBS INC	DRAWER "S"	WHT. SULFUR SPG	WV	24986	
UNION BOILER CO	BOX 425	NITRO	WV	25143	
CECIL I. WALKER MACHINERY	BOX 2427	CHARLESTON	WV	25329	
VECELLIO & GROGAN INC	DRAWER "V"	BECKLEY	WV	25801	
HUSMAN INC	BOX 6127	SHERIDAN	WY	82801	
LAMAX CONSTR	RT 1 BOX 8A	BASIN	WY	82410	
THREE RIVERS CONST INC	BOX 258	ALPINE	WY	83128	
MURPHY & LYLES		PHEONIX CITY	AL		NEW
THE CASHION CO	5TH & SHERMAN ST	LITTLE ROCK	AR	72203	NEW
NIELSONS INC	BOX 1660	CORTEZ	CO	81321	NEW
FLOURNOY CONST		COLUMBUS	GA		NEW
B.M.S. ARCHITECTS		COLUMBUS	GA		NEW
A.M. COHRON & SON INC	BOX 479	ATLANTIC	IA	50022	NEW
T.L. JAMES CO		RUSTON	LA		NEW
MASSMAN CONST CO	201 LOU HOLLAND DR	KANSAS CITY	MO	64116	NEW
MOORES-NEVON INC	BOX 434	PORTSMOUTH	NH	03801	NEW
HAMILTON BORS INC	BOX "HH"	GALLUP	NM	87301	NEW
MARNELL CORRAO ASSOCIATES		LAS VEGAS	NV		NEW
CORNELL CONST CO	BOX 189	CLINTON	OK	73601	NEW
U.S. CONSTRUCTION CO	BOX 21234	COLUMBIA	SC	29221	NEW
THE SOLOFF COMPANIES	2833 CALHOUN AVE	CHATTANOOGA	TN	37407	NEW
DEAN WORK CO	BOX 310330	NEW BRAUNFELS	TX	78131	NEW
AMARILLO ROAD CO	BOX32975	AMARILLO	TX	79120	NEW
J.J. WELCOME CONST		REDMOND	WA		NEW
KNOWLES CONSTR		KENMORE	WA		NEW
FRIEND & RIKALO CONST		ABERDEEN	WA		NEW
SNELSON CONSTRUCTION		SEDRO WOOLEY	WA		NEW
QUIGG BROS		ABERDEEN	WA		NEW
BOLLES CONSTRUCTION		REDMOND	WA		NEW

Appendix J

Summary of Research Findings

June 23, 1987

Dear Sir,

Recently your company responded to a survey questionnaire entitled "Utilization of Aircraft in Construction". This was part of my research project conducted at the University of Washington in pursuit of a Masters Degree in Construction Engineering and Management.

In your response, you indicated a desire to receive a summary of the results of this research which is enclosed. The complete text of this research will be on file with the University of Washington Library after a short time period to allow for processing.

Your assistance in completing the survey is appreciated. It is hoped that the information resulting from the research will be of assistance to your company in the future.

Sincerely,

Gary W. Femling

enclosure: Summary of Research Findings

Summary of Research Findings

The review of literature and results of the survey associated with this research lead to several conclusions related to general aviation aircraft utilization in the construction industry.

There is little literature dealing specifically with the use of aircraft in the construction industry. The predominant uses described in the literature were determined to be heavy lift operations and photo and observation uses with only a few articles related to each. The aircraft manufacturers appear to be doing very little in the way of marketing their products for use in the construction industry. No association or organization was able to be identified which maintained records or data associated with the extent of use of aircraft by construction companies or information on names of companies using aircraft in their businesses.

This research has revealed that general aviation aircraft are a useful tool in the construction industry. Many construction companies throughout the nation are employing aircraft in the performance of their daily operations and business. The following uses in order of frequency of reported use were revealed:

*Executive Mobility
*Site Investigation
*Personnel Transport
*Parts & Equipment Expediting
*Photo & Observation Platform
*Heavy Lift Operations

Of these, the first five fall generally in the construction support function while the last is the only direct construction operational use identified for aircraft. This is not to imply that heavy lift use is less important than the other uses, but only that of the amount of use is less. Where it is applicable, heavy lift operations is uniquely beneficial to the construction project. The majority of the responses indicated using aircraft for more than one purpose.

The type of projects for which aircraft are most often reported being used includes highway, dam and heavy earthwork projects. Correspondingly, companies which typically undertake multi-story building and power plant projects tend to report not using aircraft in their operations. Companies performing utility construction and bridge or heavy steel construction were determined to be fairly evenly divided on use and non-use of aircraft.

Of the different types of aircraft, the predominant type being used was the multi-engine airplane followed in frequency by the single-engine airplane and then followed by the helicopter. No use of lighter-than-air craft was observed in the survey results, however, the development of this capability within the logging industry

was identified in the literature review. Propelled lighter-than-air craft for heavy lift operations may prove to be applicable to the construction industry in the future.

The reported operating costs of aircraft, excluding pilot costs, varied somewhat for each type of aircraft but general cost ranges were identified. Multi-engines aircraft owned by the company could be expected to cost in the area of $156 to $376 per hour; single-engine aircraft from $41 to $115 per hour; and helicopters from $110 to $468 per hour. These ranges include sixty-eight percent of the total range of responses observed and are expected to encompass the most usual range of prices to be expected. There are expected to be instances where costs may be either above or below these ranges due to unique situations or abnormally expensive aircraft.

Companies using aircraft appeared to prefer outright ownership. This is followed in reported frequency by rental. Very few companies reported leasing aircraft. In the area of heavy lift use, rental dominated. This is perhaps due to tendencies for firms to contract (a form of rental in this instance) for heavy lift operations.

The use of aircraft in the past five years was observed to be fairly constant with the majority of companies indicating no change and an even distribution of the remaining responses being between increased and decreased usage. The primary reasons cited for increased usage was change in geographic diversity and company size/number of jobs. The reasons given for decreased usage were changes in geographic diversity and economic conditions. There was little indication that tax revisions played a significant part in the past changes.

The anticipated use of aircraft over the next three years was generally optimistic with very few companies forecasting a decrease in use. The reasons most often cited for the increases was change in geographic diversity and company size/ number of jobs.

Aircraft use by construction companies was reported from all areas of the nation. There was no conclusive indication of use distribution by state due primarily to lack of representation from some states and an uneven distribution of survey addressees on a national basis. A tentative conclusion based on the data and conversations with AGC Chapter officials from throughout the nation is that indeed the use of aircraft is higher in those areas where distances between population centers is greater and commercial airline service is perhaps less. Regions with the highest apparent use of aircraft include the Pacific Coast and Great Plains areas.

Most companies not using aircraft rationalized non-use because aircraft use was not considered to be cost effective. This is somewhat rebutted by the number of companies successfully using aircraft in their operations. A more meaningful, though less often cited, reason for

non-use was lack of heavy lift requirements and not having remote sites where aircraft were needed. Little concern was expressed regarding the safety or liability issues involved with using company-operated aircraft. Companies not using aircraft in their current operations do not appear to even consider the use of aircraft in future operations.

Conclusion

The general aviation aircraft is a potentially useful tool for the construction company. It has been shown by this research to be much more than the commonly-perceived perquisite for the company executive. Construction companies are urged to view the use of aircraft with an open mind and to consider its use as a tool to expand their market area, to increase the productivity of their personnel, and to better support company operations. Business aviation is more than the corporate jet-- it is or can be an extension of the company car or pickup for the visionary and aggressive construction company. This information should prove to be valuable to those companies interested in the use of general aviation aircraft. It is hoped that interest in this area will result in increased utilization of aircraft for the advancement of the industry.

Thesis
F25465 Femling
c.1 General aviation aircraft utilization in the construction industry.