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PLANNING FOR THE USE OF STOL AND VTOL AIRCRAFT IN METROPOLITAN REGIONS

A THESIS

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IN METROPOLITAN REGIONS

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Chairman

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ABSTRACT

The purpose of this study is to describe and evaluate the elements important to planning for Vertical and Short Take-off and Landing (V/STOL) aircraft as a transportation mode within and between metropolitan areas.

The characteristics of V/STOLs, the support facilities necessary for operations, the types of services and the capital and operating costs are described herein. They are based on information received from the investigation of existing helicopter operation, the manufacturers and the publications concerned with V/STOL development.

V/STOLs for short-haul inter-urban transportation are emerging as vehicles that can fill the gaps in the short-haul market (100-500 miles). As an operation, they can use existing facilities and may be instituted rapidly and, therefore, are an important mode of transportation to be considered either for interim or scheduled service where there is a dire need or extreme pressure for quick relief of a problem.

Rapid urban development and changing technology are taken into account as the factors involved in planning for the use of V/STOLs. These are enumerated and discussed.

Finally, it is recommended that greater inter-governmental coordination and planning of transportation and urban development take place than that which presently exists.

INTRODUCTION

The intention of this thesis is to examine, describe and evaluate the existing body of knowledge pertaining to Vertical Take-off and Landing (VTOL) aircraft and their scheduled operations as well as the status of Short Take-off and Landing (STOL) aircraft. In preparing this paper, the author investigated existing operations and anticipated technological developments. The literature was reviewed and firms involved in the production of V/STOLs and the publication of V/STOL data were contacted, both, by telephone and correspondence.

These data were compiled for the purpose of relating them to planning for the use of Vertical and Short Take-off and Landing (V/STOL) vehicles for scheduled intra- and inter-urban transportation in metropolitan regions.

To provide more effective service, planners must consider all modes of transportation, their interaction and the role each mode plays in the development of solutions to urban transportation problems. The problem of adequately moving people and goods within and between modern urban complexes becomes greater with the ever-increasing densities and population growth. It is suggested herein that, when transportation problems are being examined and solutions are being sought, V/STOLs be studied in light of their potential contribution as a valuable element in the total transportation picture.

Chapter I presents the characteristics of V/STOLs, the support facilities that are needed and the costs involved.

A description and evaluation of the present short-haul V/STOL services, the revenues and operating expenses are encompassed in Chapter II.

Planning studies, which should be considered for any V/STOL development program are covered in Chapter III. It should be noted that some of the studies are needed for all types of transportation planning, while others are designed specifically for V/STOL planning and development. The studies are designed to identify the habits of the traveling public, their desires and needs in terms of transportation, and the specific characteristics of those travelers who would use V/STOLs. When completed, the results of the planners' investigations should reveal the types of services actually in demand.

CHAPTER I

CHARACTERISTICS OF VTOL AND STOL AIRCRAFT, SUPPORT FACILITIES AND THEIR COSTS

Vertical Take-off and Landing (VTOL) aircraft include such types as the helicopter, which takes off vertically and flies by rotors (see Figures 1 and 4), and the Compound VTOL, which takes off vertically, converts and flies in the conventional manner (see Figures 2 and 3). STOLs (Short Take-off and Landing vehicles) look and operate like conventional aircraft (see the McDonnell Douglas 188 in Figure 7). VTOLs and STOLs differ in both general characteristics and type of support facilities required. Consequently, each is considered separately below. Features that are important in planning for the development of intra- and inter-urban transportation are covered in the first section of this chapter.

The second section deals with varied types of support facilities and their costs as related to the operation of each type of service.

Vertical and Short Take-off and Landing Aircraft (V/STOLs)

Not all of the V/STOLs described and discussed in the following pages are operating in commercial services. Some of the vehicles are used exclusively by the military, some are being tested and others are still on the design boards. The data on the costs and performance are, in most instances, derived from information available from operating services. However, since some descriptions come from other sources, they are not comparable. For example: data on planes used by the military

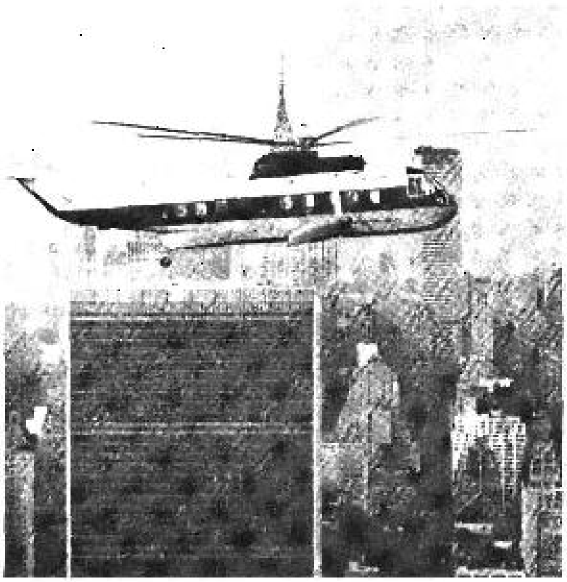


Figure l. Sikorsky S-61 Helicopter.

Source: Heliport Design Guide, November, 1969.
Department of Transportation, Federal Aviation Administration.

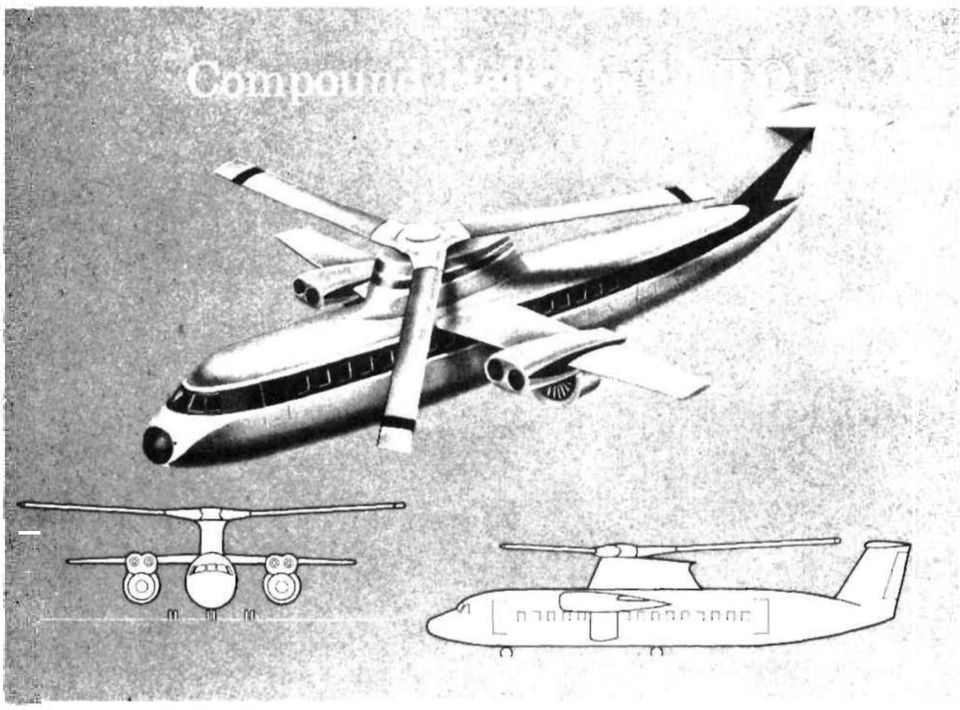


Figure 2. Compound Helicopter VTOL.

Source: McDonnell Aircraft Corporation.

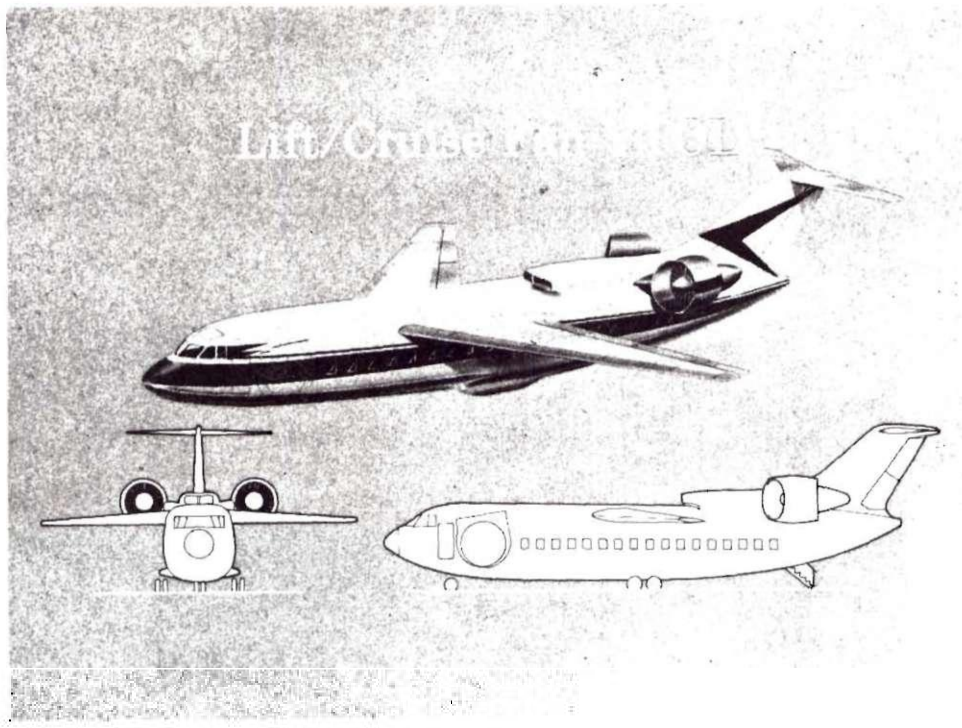


Figure 3. Lift/Cruise Fan VTOL.
Source: McDonnell Aircraft Corporation.

Figure 4. Sikorsky S-64 'Skycrane'.
Source: Rotor & Wing

are: 1) often restricted, therefore, unavailable, or 2) available, but oriented largely to military needs and requirements. Consequently, these data are not necessarily comparable with the records of costs and performance of commercial operations. As a result, this paper is confined to the actual operations data obtained from commercial services and to costs and performance estimates provided by the aircraft manufacturers.

In some ways, V/STOLs have capabilities similar to Conventional Take-off and Landing (CTOL) aircraft. One similarity that is pertinent for short-haul use is the ability of the V/STOLs to carry cargo as well as passengers. V/STOLs generally have a cargo section so that mail and other cargo may be carried along the same routes as passengers. Some V/STOLs have seats which may be removed quickly thereby providing a vehicle that may be put to all-cargo use. In the Twin Otter (see Figure 11) the switch from passenger luxury to cargo utility takes but a few minutes. An operator, therefore, can use his equipment and personnel during off-peak hours by offering special services to low-passenger, but high-cargo, producing segments of the region.

The 'Skycrane' (see Figure 4) is a VTOL that requires no seat removal or other changes to function as a passenger vehicle or a cargo vehicle. For example: If the 'Skycrane' is making a passenger run, it can pick up an already loaded passenger module at the terminal and then transport it to its destination. The pickup may take place at an airport with delivery to a nearby city's heliport at a transportation center where the major modes of public transportation such as buses, subways and commuter railroads convene. The passenger section may be similar to a bus-trailer or portable waiting room. When operating as a cargo-carrier, the

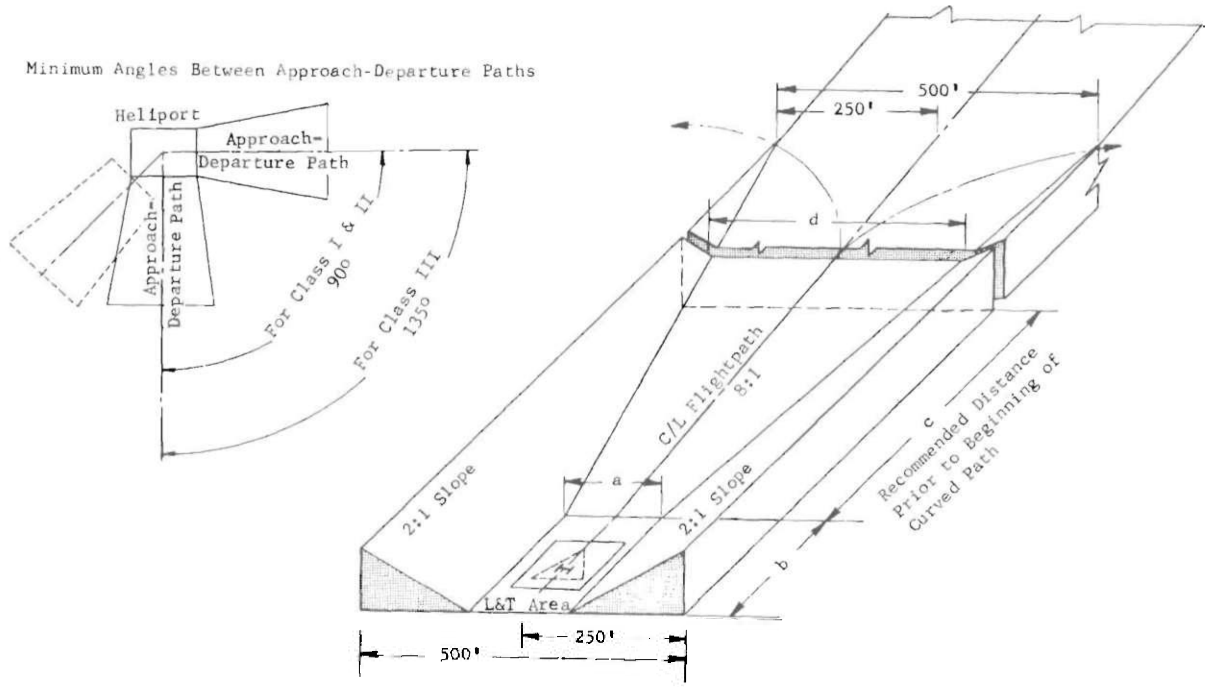
'Skycrane' picks up and delivers the cargo, either by the piece or by carrying a loaded cargo-trailer. The 'Skycrane' will probably be used to a greater extent for cargo deliveries when the C5A and other hugh cargo transports are operating. It is anticipated that the airports for the latter vehicles may be some distance away from many of the industrial parks of large cities. With the traffic congestion that takes place in most metropolitan areas on the routes to major airports, ground level cargo delivery may take longer from the point of delivery to the firm than from the point of departure 2,000 miles away to the delivery area. As a result, it is reasonable to expect that additional transportation modes will be needed.

Because of the differing characteristics, the VTOLs and STOLs will each be discussed according to type in the following section.

VTOL Characteristics

Although the design of VTOLs varies considerably, as seen in Figures 1 through 4, they all achieve flight approximately the same way--vertically--to gain altitude, then convert to foreward flight. The capacity to lift off vertically makes it possible for VTOLs to take off safely from areas just slightly larger than the vehicle itself. Normally VTOLs rise vertically above the landing pad, then accelerate forward and upward on a sloping path until they reach cruising altitude. Figure 5 points out the approach-departure paths recommended by the Federal Aviation Agency (FAA).

Two types of VTOLs are the helicopters and the compound vehicles. As mentioned earlier, Figures 1 and 4 are examples of helicopters, and Figures 2 and 3 of compound aircraft. No effort is made to cover all the



PERSPECTIVE VIEW OF APPROACH-DEPARTURE PATH

Heliport Class	FAR Category Helicopter	a	b	c	d	Minimum Angle Between Approach-Departure Paths
I Private	FAR Part 27, 29 (CAR 6 & 7)	1.5	1.5	300'	200'	90°
II Small Public	FAR Part 27 (CAR 6)	1.5	2.0	300'	300'	90°
III Large Public	FAR Part 27, 29 (CAR 6 & 7)	* 1.5	* 2.0	400'	300'	135°

Dimensions a and b:
(1) are expressed as multiples of overall helicopter length.
(2) may be increased or decreased upon evaluation of the site by FAA.

*For scheduled airline operations, other factors, related to a specific site would need to be considered.

Figure 5. Approach-Departure Path and Obstruction Clearance Diagrams.
Source: Heliport Design Guide, Federal Aviation Agency, November, 1964.

types. However, some additional vehicles are noted in the appendices.

Helicopters in civil use vary in the number of main rotors, the number and type of engines, and in size and weight. The large transport type helicopter (less than five percent of the civil helicopter fleet) is used by the scheduled helicopter airlines.

Normal speeds for a helicopter range from zero (when hovering) to about 140 miles per hour for smaller ones and from zero to about 180 for larger vehicles. Table 1 presents examples of passenger capacity, cruising speed, range and service ceiling of selected helicopters with capacities of from three to 30 passengers.

Table 1. Passenger Capacity, Cruising Speed, Range and Service Ceiling for a Variety of Helicopters

Aircraft	Passenger Capacity	Cruising Speed (mph)	Maximum Range (miles)	Service Ceiling (feet)
Enstrom, F-28A	3	98	235	11,000
Bell, 206A JetRanger	5	140	460	20,000
Gates Twinjet Helicopter	10-14	180	415	over 13,000
Bell 205A	15	127	404	20,000
Boeing Vertol 10711	25	155	760	16,000
Sikorsky S-61 L/N	30	139	265	12,500
SA-321J	27	162	584	13,100

Source: Rotor & Wing, June, 1971.

The Hughes three-passenger and the Bell JetRanger five-passenger aircraft are used by many of the air taxi companies. For instance, Executive Helicopters, Inc., of Atlanta, Georgia, uses Hughes-300 vehicles and Executive Air Service of Santa Ana, California, uses the JetRangers.

New York Airways uses Boeing Vertols for their schedules operation between La Guardia and Kennedy International and Newark Airports and Wall

Street. Los Angeles Airways is presently operating S-61 helicopters. San Francisco and Oakland Helicopter Airlines uses four S-61s, one S-62A and an 11 passenger amphibious helicopter for their services from the many small cities in the San Francisco region that are served by San Francisco's International Airport.

Unlike other aircraft, helicopters seldom fly more than 3,000 feet above the ground. This characteristic is important as no other vehicle uses the airspace between ground level and 3,000 feet. The helicopter, however, does have the ability to operate safely at altitudes well over 10,000 feet (see Table 1).

The VTOL has unique safety features not possessed by CTOL aircraft. The major one is the ability of the vehicle to hover a few feet above the ground permitting the pilot to conduct a number of safety checks in order to make certain that all is functioning properly before committing the machine to full flight. Another safety feature is the ability of the vehicle to land quickly on a great variety of sites other than airports.[1]

Because of its safety components, maneuvering characteristics, external load carrying or crane capabilities (see Figure 4), and relatively low speed potential, the helicopter is desirable as a short-haul vehicle between city-centers of less than 500 miles.

Compound VTOLs provide greater speeds, and function more efficiently at ranges over 300 miles. However, they are not as efficient in hovering capabilities and are noisier than helicopters.

Table 2 compares maximum pay loads (in pounds), ranges (in statute miles), and cruising speeds (in miles-per-hour) of two types of VTOLs.

Table 2. Maximum Payload, Range and Speed for Two Types of VTOLs

Aircraft	Type	Maximum Payload* (pounds)	Range* (statute miles)	Cruising Speed (Miles-per-hour)
Sikorsky S-61L	VTOL (helicopter)	4,300	265	139
LTV-C)142A	VTOL (compound)	8,200	460	253

*The maximum payload and range indicate the most efficient economical functioning range of the vehicle with maximum revenue-producing load.

Source: Lockheed-Georgia.

Distinctions between these types do not make one vehicle better than another *per se*. In the early stages of planning the functions and the available locations needed for a potential service should be evaluated in order to determine the appropriate vehicle to produce the most efficient operation. For example: if a service were needed from Gainesville, Georgia, to the center of downtown Atlanta, Georgia, the more efficient type of vehicle would be a helicopter, as it operates more efficiently in the shorter ranges. However, if a large volume of cargo and passengers were anticipated, for example, from Mobile, Alabama, to a site located at a transportation exchange (a bus and railroad terminal) in Atlanta, the Compound VTOL would be more efficient.

Noise is a very important design consideration in VTOLs which operate in densely populated areas. Methods are available to anticipate and partially control the noises and enhance passenger and public acceptance of the future VTOL aircraft. Noise generated by VTOLs is greatest directly underneath the flight path on take-off and landing and is of short duration. Figure 6 indicates the comparison of the perceived noise levels in decibels (Pndb) between some VTOLs and four-engine piston aircraft. The noise of VTOLs is greatest at the point of departure or landing; whereas conventional aircraft noise is a nuisance over a longer distance in the take-off and landing modes.

STOL Characteristics

STOLs, in appearance, are like conventional aircraft, but they are capable of taking off and landing on short runways which may range from 600 feet to 3,000 feet in length. Therefore, STOLs may be used in more densely developed areas closer to the center of a city than most of today's commercial aircraft. As an example, Beech Aircraft Corporation sees, in the future, a 40-passenger, 2-crew STOL with a cruising speed of 210 miles-per-hour and an operational range of 680 miles that can take off and land on a runway of 600 feet. There are many types of STOLs and they vary in size and performance.

The varied ways in which STOLs and VTOLs resemble and differ from each other must be considered when selecting vehicles for a specific route or performance. The McDonnell STOL, for instance, has a cruising speed of 248 mph as compared to the LTV's (VTOL) 253 mph. The STOL, however, does have an efficient operating range of 620 miles as compared to the VTOL's 460 miles and it carries a maximum payload of 12,100 pounds as compared to the 8,200 pound carrying capacity of the VTOL. In this instance, the speed of the vehicles is insignificant but the range and payload factors are the major determinants when selecting the vehicle.

On take-off and landing, the noise created by STOLs emanates along the line of flight and is spread over a longer distance than that of VTOLs.

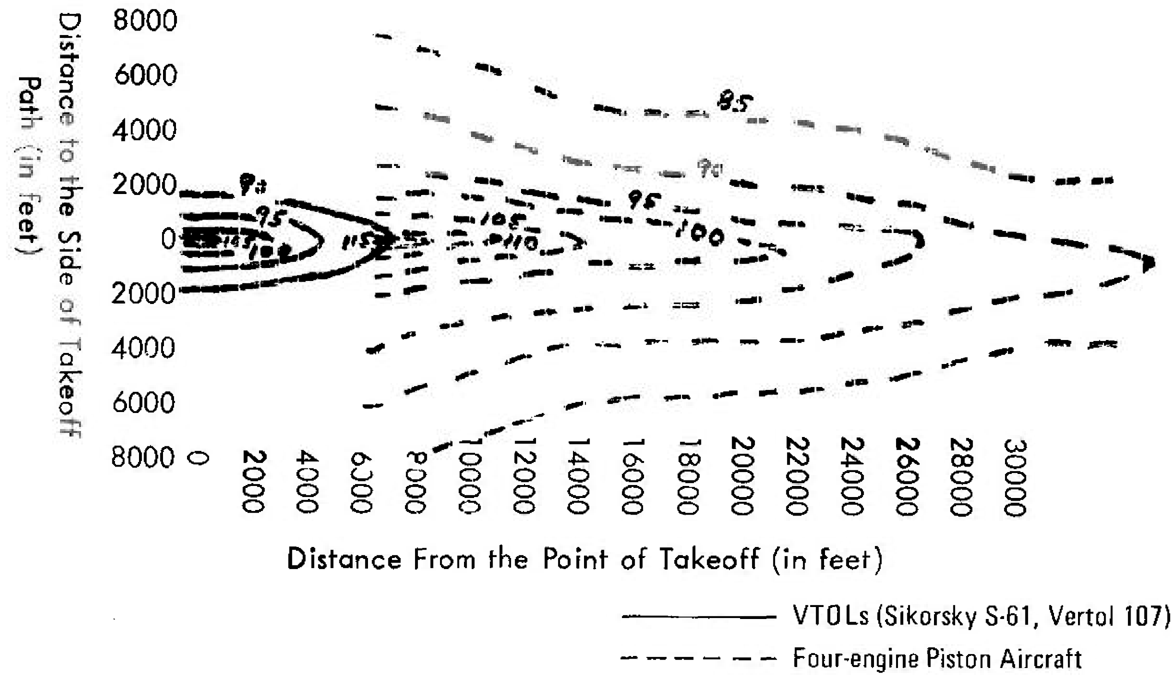


Figure 6. Comparison of Perceived Noise Levels (Pndb) Contours for Takeoffs Between Some VTOLs and 4-Engine Piston Aircraft.*

*Source: Bolt, Beranek & Newman, Inc., Los Angeles, California
<u>Analysis of Community and Airport Relationships/Noise Abatement.</u>

Figure 7. McDonnell Douglas 188 STOL.
Seats up to 64 passengers, cruises at 250 miles per hour.

Source: Courtesy of Rotor & Wing.
(Photographed: July, 1968)

Conventional and STOL aircraft noises follow similar patterns, but the STOL noise is of relatively brief duration due to the shorter distance needed for take-off at low levels.

V/STOL Support Facilities

V/STOLs require direct support facilities which vary with the development, the location of the facility, and the type of V/STOL using it. In discussing support facilities for V/STOLs, it is necessary to separate those needed for VTOLs from the type needed for STOLs. If the VTOL or STOL facility is large enough both types of service may be accommodated at the same location. Generally, though, each has its own requirements, and except for airport locations, they have been built, in most instances for either VTOL or STOL use.

VTOL Facilities

Because VTOLs require relatively little space for take-off and landing, the pad (the portion of the facility used for the actual take-off and landing) need be only as large as the aircraft using it. The size of the direct support facility (port or stop), therefore, is dependent upon the amount of space available and the plans for the facility in terms of proposed auxiliary services.

The Federal Aviation Administration (FAA) has three classifications for VTOL facilities as follows: Class I - Private; Class II - Public (small); and Class III - Public (large). All three are further subclassified: Subclass A - is a minimum support facility--no buildings, maintenance or fueling, and it is known as a helistop; Subclass B - is limited to support facilities such as a waiting room--with no maintenance or fueling. It is also known as a helistop. Sublcass C - encompasses complete support facilities--waiting rooms and their concomitant features, maintenance and fueling, and whatever else is deemed necessary. This latter facility is known as a heliport.

Support facilities generally refer to passenger and cargo facilities, helicopter parking, fueling, and maintenance provisions on the heliport. A helistop has none of these facilities except that it may be a pickup and discharge points for passengers or cargo.[2] Additional facilities, not required or classified by the FAA, may be supportive at either a helistop or heliport. For example: If the facility is not located in the downtown business district, in all probability it will need parking facilities for the passenger's automobiles. A helistop or heliport located on the top of a parking facility, in the middle of a parking lot, or on top of a hotel, may not require additional parking facilities.

Because the noise of VTOL operation is unfamiliar to people, they tend to notice it more at the time of initiation of an operation, than later. When a sound becomes familiar, it generally goes unnoticed beyond the immediate location of the port or stop. Noise problems can be lessened in areas adjacent to helicopter facilities by using sound absorbent materials, shrubbery and trees as a buffer around the pad.[3]

(For further details involving the construction of a heliport or helistop, see FAA publication Heliport Design Guide.)[4] This information changes as new vehicles are developed and additional guidelines are needed. Figures 8 and 9 are examples of a heliport and helistop, respectively.

STOL Facilities

STOLs use the more conventional landing strip. The runway lengths needed for operation are dependent upon the size, weight and length best

Figure 8. Rooftop Heliport.
World's Fair 1964, New York. Landing and Takeoff Area is 200' X 150' and is 120' Above the Ground.*

Figure 9. Rooftop Helistop.
Bellevue, Washington. Showing 24' X 24' Load Distribution Pad on Built-up Roof and Handrails or Safety Barriers.*

*Source: <u>Heliport Design Guide</u>, FAA, November, 1964.

suited for the individual aircraft. STOL sites may be located over water (such as the site under study in New York City), on water (see Figure 11), on elevated structures over railroad yards or expressways (see Figure 10), or on ground level such as the locations and runways used by conventional aircraft.

Tentative FAA recommendations for STOL facilities include minimum runways of 1,500 feet long and 100 feet wide, taxiways 60 feet wide and pavements strong enough to support 150,000 pound STOL transports. An additional 150 feet on each end of the runway and 50 feet of paved 'shoulder' surface are also required. These basic criteria are subject to change as more technical data and operational experience are obtained.

Due to the fact that noise from STOLs is spread over a distance--along the flight path--much care must be taken when considering the location of STOLports. The surrounding land uses are of more concern when planning for a STOLport than for a heliport.

Capital Costs of Vehicles and Support Facilities

The capital investment in small V/STOL aircraft starts at about $18,000 for a four-passenger vehicle. The estimated cost of a 60-passenger VTOL is about $12,000,000 as compared with an approximate cost of $4,000,000 for a 60-passenger conventional aircraft. Because 60-passenger STOLs have no operating history, best estimates put their costs in the 6 to 9 million dollar range depending upon the runway constraints--the shorter the runway, the more sophisticated the aircraft. As a STOL approaches the need to rise in shorter distance, it approaches the refinements needed in VTOLs.*

*Costs estimated by people working in the field of V/STOL development.

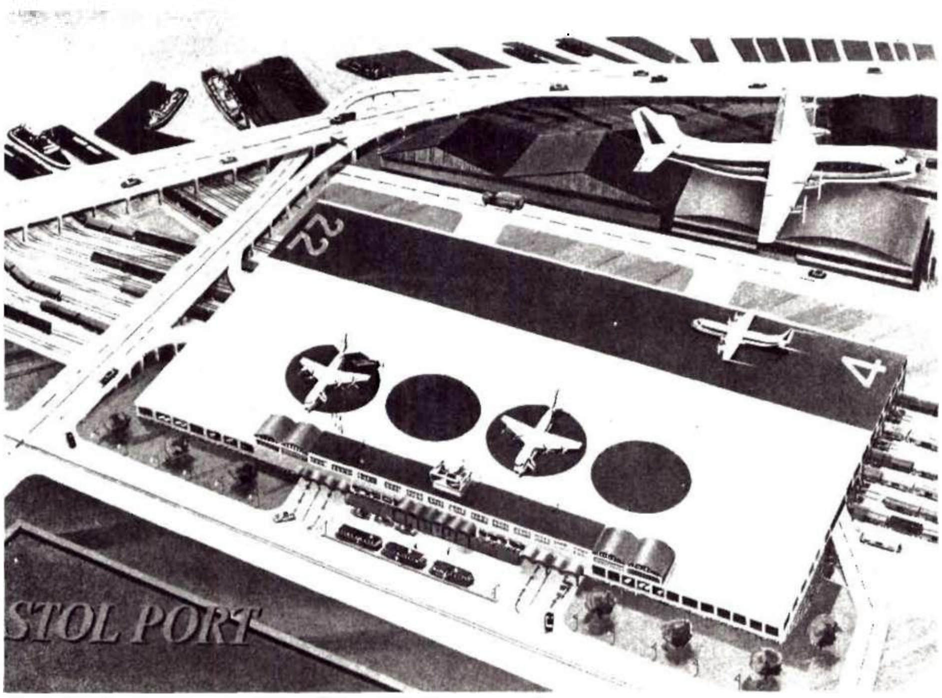


Figure 10. Proposed STOL PORT Location - - Over Railroad Yards.
Source: McDonnell Aircraft Corporation.

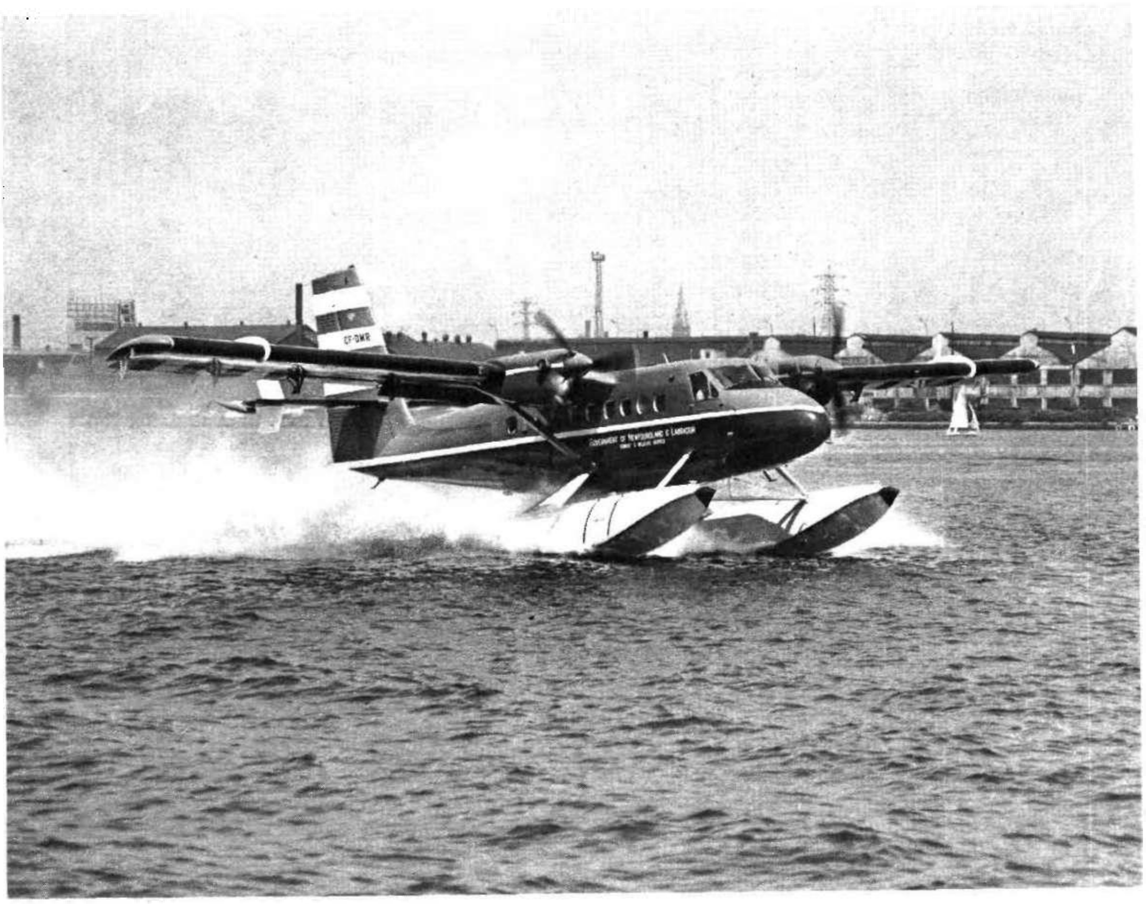


Figure 11. Twin Otter (STOL) Takes Off From Toronto Harbor.
Source: Rotor & Wing

Support facilities for VTOLs are generally leased. Los Angeles Airways leases its sites from the communities it serves and amortizes its capital investment over the life of the lease, whereupon the facility reverts to the community. San Francisco-Oakland Helicopter Airlines acquires sites under long-term, low-cost lease operating arrangements. Other sites are furnished free of charge or inexpensively leased by major traffic generators such as some of the major trunk airlines and downtown motels and hotels. Pan American, for a time, leased space to New York Airways in the interest of providing service to Pan Am's clientele.

Facilities vary in size and costs according to development. Helistops without waiting rooms are relatively inexpensive. In fact, Helicabs, Inc. of Chicago set the cost of ground-level helistops (without waiting rooms) at about $3,000 each.[5] On the other hand, rooftop installations on existing building are usually more expensive--ranging from $10,000 to $35,000--depending upon the modifications needed in the structural support. If incorporated into the design of a new building, for example, a helistop on its rooftop may cost as little as $4,500. (Estimate is based on 1966 figures.) In some instances, no structural modifications are needed if the vehicle is not too heavy for the existing supports (see Figure 9). The costs might then run as low as $2,000 or less for the facility--not including the use of the rooftop or waiting rooms. More fully developed facilities, such as heliports with waiting rooms, are more expensive. San Francisco-Oakland estimates the costs of its heliports averaged about $25,000.[6] The average capital expenditure by Los Angeles Airways has been about $30,000 per facility.

The cost of STOLport facilities is much greater than that of

VTOLport facilities. A STOLport, for example, may cost as high as $40,000,000 or more, depending upon the auxiliary development desired, the types of vehicles to be accommodated and the availability of land. Because STOLport sites are difficult to locate, existing airport facilities--whether civil or military--that are due to be phased out of operation should be considered for possible future use for STOL services.

CHAPTER II

SHORT-HAUL PASSENGER SERVICE AND RELATED FACTORS

The experience of VTOL operators provide a basis for comparing and evaluating the effectiveness and costs of short-haul operations.[7] Chicago Airways (CA), Los Angeles Airways (LAA), New York Airways (NYA) and San Francisco and Oakland Helicopter Airlines (SFO) render VTOL scheduled passenger services between downtown, suburbs and airports. Mail and cargo are scheduled with these passenger flights. Other helicopter operators offer short-haul passenger air-taxi services.

VTOL Services

VTOLs are used to perform many services such as: scheduled passenger, scheduled air cargo, non-scheduled taxi, hospital emergency, police emergency and surveillance, traffic reports, branch-bank money pick-ups, construction in relatively inaccessible areas and charter services for other specific uses. This paper, however, is concerned primarily with scheduled passenger services in metropolitan regions. Scheduled air cargo and taxi services are mentioned where they are relevant.

VTOL passenger services have been initiated because of the dense development of the urban areas, the relative inadequacy of existing metropolitan or regional transportation facilities and the existence of a relatively affluent society which can afford such services.

In most metropolitan areas, peak-hour traffic is very slow. Streets and expressways are overloaded and congested. Travelers moving to and from airports and between the business districts of nearby cities must use these clogged arteries, consequently it often takes as long to get from the airport to downtown as it does from city to city or airport to airport. As a result, people, who place a premium on their time, find VTOL services between airports and downtown an efficient means of avoiding time-consuming congestion. For example: It takes approximately two hours to go from the center of New York to the center of Philadelphia--a distance of 93 miles--by conventional aircraft. A VTOL aircraft can perform this service in less than 40 minutes if located in close proximity to its passenger market.

VTOL Scheduled Passenger Services

Scheduled passenger services offer convenience, comfort and reduced travel time between: 1) downtown and suburbs of cities, 2) downtown and the commercial airport(s) serving the area, and 3) between airports. An example is the service offered by NYA involving Newark, Kennedy International and La Guardia airports and midtown and downtown Manhattan. Figure 12, below, is an approximation of the routes:

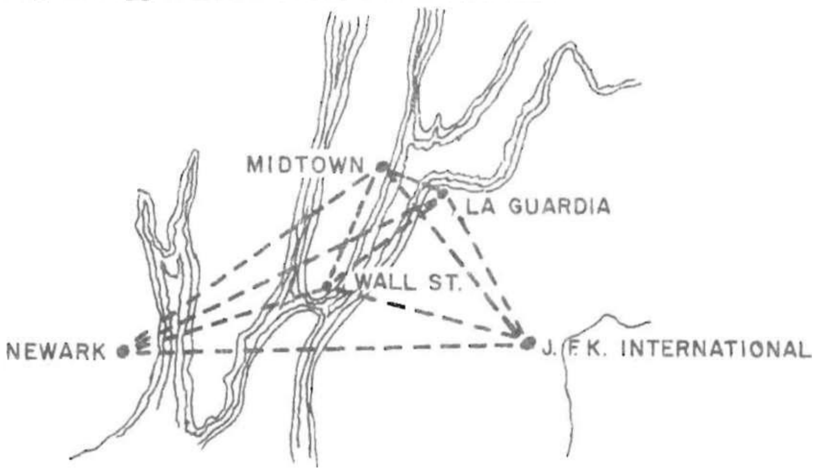


Figure 12. New York Airways Service Routes.
Source: New York Airways Schedule

Flights in the New York area may take as little as six minutes between Newark Airport and Wall Street-- a non-stop flight--or as long as 26 minutes on a two-stop flight between Newark and Kennedy International airports.

In 1969, from the newest heliport at 60th Street and York Avenue to Kennedy Airport, the cost was $15.75 and the trip took about ten minutes. In contrast, the bus service fare from the East Side Airlines Terminal (38th Street) was $2.50 and the trip took a minimum of 40 minutes. Cab fare ran about $10.00 to Kennedy International. However, more than one person can ride in the taxicab on one fare.

Despite high operating costs, VTOL service to areas can be a temporary solution to a short-lived problem because it may be initiated quickly and relatively inexpensively. A prime example was the schedule service performed by Chicago Helicopter Airways between the terminal point of the rapid transit system and the airport. After the opening of the extension of the transit system to the airport, CA discontinued scheduled services between these points.

Airline traffic figures of three scheduled VTOL systems are listed in Table 3, on the next page. The revenue passenger miles, the number of originating passengers, the passenger load factor, the scheduled miles, and the performance factors are compared between November, 1966, March and April, 1969, for the three helicopter scheduled services: Los Angeles Airways, New York Airways and San Francisco and Oakland Helicopter Airlines.[8]

Referring to Table 3, SFO shows consistent gains throughout. Statistics for the other two airways vary. Between 1966 and 1969 LAA showed consistent loss of Revenue Passenger Miles, Originating Passengers,

Table 3. AIRLINE TRAFFIC FOR NOVEMBER, 1966, MARCH, 1969 AND APRIL, 1969

	Revenue Passenger Miles (000)			Originating Passengers (000)			Passenger Load Factor*(%)			Scheduled Miles (000)			Performance Factor**(%)		
	11/66	3/69	4/69	11/66	3/69	4/69	11/66	3/69	4/69	11/66	3/69	4/69	11/66	3/69	4/69
LAA	957	563	640	25.5	14.6	17.0	48.3	30.0	35.1	96	89	88	86.1	90.2	91.9
NYA	711	438	431	40.5	22.3	22.8	54.4	56.2	57.7	65	41	40	85.3	91.1	86.8
SFO	385	462	484	19.9	23.7	24.8	31.0	33.5	35.2	54	59	60	92.1	95.8	94.3

*Passenger Load Factor refers to the percentage of the capacity of the plane that is occupied for trips. For example, if the vehicle holds 30 passengers and it flies its schedule with only 15, then the load factor is 50 per cent.

**Performance Factor refers to the ability of the service to perform according to schedule. This is also a percentage. For example, if a service has 500 flights a month scheduled and fog or other factors interfere with the flights during ten trips during the month, then the performance factor for that month is 98 per cent for only 2 per cent of the flights were not made.

Source: Aviation Week and Space Technology, November, 1966, p. 32; March, 1969, p. 33; April, 1969, p. 34.

Passenger Load Factor and Scheduled Miles. NYA showed losses in all but the Passenger Load Factor. These losses resulted from some of the following circumstances:

- High operating costs caused 'belt-tightening.' Operations were closed at stops that did not provide adequate revenues.
- Additional forms of transportation made routes or services unnecessary. (The extension of transit service in Chicago was a major reason CA discontinued scheduled operations.)
- New generation aircraft were developed rapidly and were costly in light of the fact that existing vehicles were not fully depreciated.
- Federal subsidies, important sources of revenues of LAA and NYA, were discontinued.
- The anticipated passenger growth for the entire airline industry failed to keep pace with earlier years. As a result, projections were too high.

SFO avoided losses because it began operations with the intention of being self-sufficient. Its publicity program took this into account and reflected prime considerations of saving time and providing convenience and comfort to their flying clientele. SFO did not receive any subsidies from the Federal government. However, SFO services will bear watching for change when BART (Bay Area Rapid Transit system) begins functioning or major airlines discontinue providing helicopter service for their passengers.

Under study, are ways and means of instituting downtown to downtown service using VTOLs for the short-haul passenger (under 200 miles) and STOLs for the medium-haul passenger (200-500 miles). As mentioned previously, it takes two hours to go from the center of New York to the center of Philadelphia--a distance of 93 air miles. However, it takes only 6 hours to travel between New York and Los Angeles--a distance of almost 2,500 miles. The new vertical-lift aircraft can reduce the total travel time between the city centers of New York and Philadelphia to less than 40 minutes. A similar situation exists between the city centers of Chicago and Detroit--a mere 237 air miles. Based on Boeing 727 jet operations, it takes about 3 hours and 34 minutes (an average of 70 miles-per-hour), with the passenger spending about 65 per cent of his time on the ground.[9] This situation will worsen with new airports that will be constructed 50 miles or more from the city centers.

V/STOL service, between airports and city centers, and between city centers, hits at one of the weakest links in national air transportation--the long surface time to and between airports.

Scheduled Air Cargo Service

The first scheduled use of the helicopter came about with the need to save time when delivering air mail. In 1947, Los Angeles Airway began delivery of mail within a 50-mile radius from the Los Angeles Post Office Terminal annex building. Air express/cargo service came in 1953.[10] Most of the scheduled VTOL services began their operations with mail delivery contracts from which they derived their income. Today, however, only about two percent of the scheduled VTOL services' revenues comes from delivering mail, and approximately three percent from cargo delivery.

The existing scheduled services operate between airports and also between the central city, industrial areas, cities contiguous to the central city and airports serving the area or the region.

Non-scheduled Helicopter Taxi Service

Just as the taxicab, operating along the streets of a city, offers flexibility (no time schedule) as to the time and destination (door to door service) of its passengers, so the air taxi performs a similar function using the air lanes and available landing facilities. VTOL air taxi service is available in one or more cities in every state except Missisippi and the District of Columbia (1969).[11]

Helicopter taxis operate in several metropolitan areas, serving a multitude of locations and justifying their existence by offering rapid connections between airports, downtown locations, outlying industrial plants, as well as towns on the metropolitan periphery. Helicabs, Inc., operating in Los Angeles, for example, flies directly from a number of downtown hotels. Helicopter Air Lift, in Chicago, serves a large number of surburban communities and outlying industrial properties.

Air taxi fares are usually about double the cost of ground taxicab fares. Los Angeles' Helicabs charge $11 per passenger from downtown to the airport, compared to an average of $6.50 by taxi for one or more passengers.

VTOL charter flights are used for special jobs and for businessmen and vacationers. The 'special jobs' category, mentioned at the beginning of this chapter, are out of the realm of a transportation service *per se*, consequently they are not covered in this paper. The charter flights used by the businessmen and the vacationers generally involve a short-haul function within a 200-mile range. The services are many. They may be between two plants owned by the same management, between two cities, or to out-of-the-way destinations such as those for hunting and fishing in mountain or wooded areas of the country. Service is also provided for development of inaccessible areas. The helicopter is the one mode of transportation and operation that can enter freely into virtually any undeveloped area.

STOL Services

At the present time, there is little data available on the operations of STOL service. NYA is the first certified U. S. carrier to institute STOL aircraft service. The operations cover the greater New York metropolitan area. This STOL operation used 18-passenger de Havilland Twin Otters. The operating costs of STOLs, when compared to helicopters, are lower and a higher frequency of service was available between the three major airports serving New York. A more extensive STOL operation was carried out on an experimental basis by Eastern Airlines with the McDonnell STOL (see Figure 7). It operated between New York and Washington, D.C.

In addition, STOL service is being considered for the inter-urban routes of Washington, New York and Boston. It is being planned, also, to service the new Disney development in Florida.[12]

Aspects of Operating Costs and Revenues

The costs of operating V/STOL services are greater than those of urban transportation modes which function on the conventional road or highway. Because of the poverty of data, the following discussion of operating costs and revenues is limited to VTOLs. There are many reasons for the high cost of operating VTOLs, however, a few, discussed here, seem paramount.

VTOL scheduled passenger service is relatively new--with little historical trend data on performance due to rapid change within a newly developing technology. New generation aircraft are researched and developed before the existing ones are sufficiently amortized to realize a profit from their use. Concomitantly, the comparatively few passengers served by VTOLs prevent the companies from using the vehicles more intensively.

In addition to the pioneering of new aircraft, three important factors contribute to the high cost of operating a service:

1) The innovation of new types of services re locations such as that from the top of the Pan Am Building.

2) The high cost of training pilots to use such locations and new techniques. For example: The use of instruments for take-off and landing of VTOLs is relatively new, therefore all pilots had to have special training in their use.

3) The operation of a service under inappropriate regulations is costly. Those rules, for instance, under which VTOLs have had to operate for many years, were conceived for controlling conventional take-off and landing aircraft. Regulations on location, flight patterns, safety and nuisance have often been rigid and inapplicable.

> ...the full benefits from helicopter operations cannot be realized unless the helicopter has direct access to highly congested, downtown areas, with landing facilities in proximity to passenger origins and destinations. Few potential passengers are likely to pay the premium fare of helicopter flight without convenient access to its take-off point...[13]

Local and FAA regulations are updated periodically. However, this takes place slowly. At times these regulations place constraints upon operations using more advanced vehicles--causing high operating costs.

As an example, operating costs were, in 1966, estimated at $153 to $190 per hour by SFO. Total operating expenses computed by United Research on the basis of passenger miles flown in 1963 ranged from a high of $1.28 per-passenger-mile for CAA to 90 cents for NYA; 60 cents for SFO; and 50 cents for LAA.

Table 4 presents the operating revenues and expenses for the year 1968. The table shows that all three (LAA, NYA and SFO) are operating at a loss.

Table 4. Total Operating Revenues and Expenses for 1968*

Airline	Total Operating Revenues	Total Operating Expenses	Net Loss
LAA	$3,848,000	$5,377,000	$ 887,000
NYA	5,258,000	6,682,000	1,632,000
SFO	3,285,000	3,414,000	568,000

*Source: Aviation Week and Space Technology, May 1969, pp. 52-53.

Operating revenues came from several sources: scheduled passenger, U. S. Mail, cargo, charter, other transport services and incidentals. Of the $12,391,000 in revenues, 76 percent came from passengers, 2 percent from from U. S. Mail, 3 percent from cargo, 1 percent from charter, and 18 percent were incidental and other transport revenues.

Of the total operating expenses ($15,473,000) approximately 18 percent were from flying operations, 32 percent were maintenance expenses, 40 percent were used for general and administrative costs, and 10 percent were accounted for in depreciation and amortization. The helicopter services did not spend money for any special promotion or sales publicity in 1968.

CHAPTER III

PLANNING FOR V/STOLS

Rapid transportation within and between metropolitan regions appears to be crucial to the maintenance and survival of a viable urban life. When the need for additional transportation facilities seems apparent, consideration should be given to V/STOLs as concomitant modes of transportation. It is the intention of this chapter to provide guidelines to the varied studies appropriate to planning for these services.

Planning for VTOL Service

Two factors--excessive travel time and a sizable market consisting of business and professional people with relatively high incomes--must exist for support of economically viable, scheduled VTOL services. The causes of excessive travel time include: dense development, long distances to or between air facilities and unusual topography which forces the ground transportation to be routed through potential bottlenecks such as bridges and tunnels. In the New York area, for example, there is dense development. In addition, connections between Manhattan, Newark Airport in New Jersey, and Kennedy International and La Guardia airports in Queens and Brooklyn, respectively, cover long distances with traffic routed through tunnels and over bridges. A similar condition exists in the San Francisco region. In the Los Angeles area, travelers frequently must cover long distances in order to get from the major airports to home and work centers within this region.

Planning Studies

In planning for VSTOL operations a number of studies and surveys are needed to provide information on the habits of the traveling public and on attitudes toward VTOLs.

Origin and Destination (O & D) Survey. An origin and destination survey for VTOL services is conducted in much the same way as O & D surveys for surface transportation. Since the portion of the public to be tapped is much smaller and has a greater variety of specific characteristics than the public at large queried for mass transportation data, more information should be gathered. VTOL planning, therefore, requires that the surveyor be more selective in choosing cordon-line locations and collect more specific data than are gathered by surface transportation investigators. Using existing maps and census data, the planner should designate cordon lines on on the perimeter of: A) higher-income residential areas, B) industrial and office park areas, C) airport centers, D) downtown financial areas, and E) existing transportation centers or terminals.

The O & D survey generally elicits: 1) where people go--their orgin and destination regardless of the route of travel; 2) how they travel--via public transit, private automobile or railroad; 3) when they travel--data by hour of day and by direction; 4) why they travel--the purpose of the trip (commuting, business, transfer); 5) where they stop--their destination (including the accumulation of parked vehicles for estimated parking demands); 6) the time-distance of each trip--the mileage and how long it takes to make the trip; and 7) the regularity of each trip type--daily or weekly.[14] 8) The estimated cost of each trip and 9) the use and cost of auxiliary help, such as a chauffeur should be investigated.

The O & D survey should include, also, a request for the approximate age, education, type of work and income range. It should also contain questions aimed at attitudes such as: "Do you have any reservations about the use of VTOLs?" "How important do you think the VTOL can be in helping you meet your daily transportation needs if you were convinced that it would cut your traveling time in half?" Another question might be: "Who pays for your transportation (by type of trip) you or your firm?" An evaluation of the information received from these questions would furnish a basis for: 1) seeking new prospects for VTOL service, and 2) determining the kind of public information and education that should be forthcoming. Such evaluation should be made prior to initiating a service in order to allay fears and explain the value of VTOLs.

Other Surveys. Within the downtown area, other surveys are more appropriate than the O & D survey. A great deal of useless information would result from an O & D survey of the downtown of large cities. More appropriate surveys would use data sources such as: the City Directory and the Chamber of Commerce to locate firms that are likely to employ executives who may need the service. Branches of national organizations should be contacted to determine the number of people serving as troubleshooters or advisors to either the home-based office or other branches.

Data on flying clientele also can be obtained from large trunk airlines. These data may prove useful in determining the needs of travelers from other cities who conduct business or visit within the region.

The above-mentioned surveys should indicate the clientele from whom answers to the following questions should be obtained. 1) How many prospective passengers are indicated? 2) Between what points do passengers need service? 3) Will it be worthwhile to the passenger to save time? and 4) What are the attitudes of prospective clients toward using VTOLs? With these answers and those from the other aforementioned surveys, the planner of a VTOL operation would be able to determine the type of service that is most desirable; for whom the service will operate; where the service is desired (between what points); some of the functions it will perform (commuter, etc.); where to seek locations for stops or ports; and the unique characteristics of prospective VTOL users.

Land Use Study. Since most of the potential users of VTOLs are people from the higher-income brackets, the previous surveys of selected areas have pointed out the residential and employment centers of this group. If VTOL service is to be of special value for intra- as well as inter-urban operations, some land must be set aside in the aforementioned centers for helistops. Therefore, it is important to know how valuable the service would be to the residents of each of the high-income areas in order to evaluate the degree to which they would resist nearby locations for helistops.

A study should be made of the impact of transportation terminals on high-income residential and employment areas. This study should indicate the proportion of the people likely to use these terminals as surface-to-air transfer points. It should indicate the attitudes toward the terminal of those located in the immediate area. Finally, it should estimate the economic impact of the terminal on adjacent development.

Additional Studies

Additional studies should determine the feasibility of: providing interim service, moving cargo and developing future locations. They should provide the operator with knowledge of the type of service that would be most valuable to potential users.

Interim service may be of value to a group such as a rapid transit authority to complement rapid transit service. The operator could, for instance, provide a scheduled service from outlying areas to stations along the rapid transit lines. Its purpose could be two-fold: 1) It could provide the means whereby people become accustomed to using the rapid transit service before lines are extended to developing areas; and 2) It could provide a subsidy from the rapid transit authority to make VTOL service feasible.

The planner of VTOL scheduled airline should consider additional services that would operate during slack times such as between rush hours. Moving cargo from industrial parks to downtown or the airports would be an example of such a service.

In determining the feasibility of an airline, the planner should evaluate possible future expansion of operations. This expansion should include services to additional higher-income residential developments and traffic generators, such as industrial, office and research parks, and transportation and shopping centers. An evaluation of future operations is an essential part of determining the feasibility of proposed VTOL services.

Planning for STOL Service

As stated earlier in this report, except for STOL service recently instituted in the densely populated northeast corridor of the United States, there is no history of STOLs as a scheduled mode of transportation. The results, successful or otherwise, of this relatively new service, are important to the future use and development of STOLs as a vehicle and as an an operation. Planning for this type of service differs from planning for VTOLs. It follows more closely along the lines of planning for the conventional types of aircraft for the following reasons:

1) The clientele encompasses a larger portion of the population than that of VTOL users due to the fact that the trip distances are longer and the operating costs of the service are projected to be less expensive. Consequently, the fare structure will be more competitive when related to the other modes of transportation than the fares of VTOL operations.
2) The locations of STOL facilities, in some instances, may not be as crucial as those of VTOL's. Where it is feasible to have landing strips within downtown areas, such as over a pier where there is a possibility of at least 600 feet (depending upon the demands of the aircraft to be use) for a runway along with a glide path clear of obstruction, this service, undoubtedly, will be desirable. Existing close-in airport facilities that are not overcrowded or that may now, or in the near future become obsolete or phased out (whether in civil or military use) seem to be the best prospects for locating STOL facilities.
3) The STOL passenger will be traveling longer distances than the average VTOL passenger. Consequently, it will be possible for him to save time using this service even if the facility-location is slightly less convenient. The facilities for trunk airlines will undoubtedly be much farther from town than they exist today and will probably service the long-distance travelers. The STOL

traveler will be served in the manner that medium-distance air travelers are presently accommodated.

The primary procedures necessary for planning conventional operations are available from many sources such as the FAA. These provide the bulk of the important criteria that require consideration for STOL service. Additional considerations for STOL planners are provided below and in the pages following. However, when analyzing the data gathered to determine the feasibility of using VTOLs, STOLs should be considered as an alternative or concomitent mode of travel.

Additional V/STOL Planning Considerations

The following investigations should be made for both VTOLs and STOLs. These considerations are involved with site selection, economic feasibility and investigation of the technology.

Site Selection and Evaluation

The prospective planner or operator should enlist the cooperation of local governmental agencies to provide the kind of assistance necessary in locating prime sites. This help is especially important when selecting sites in residential areas where resistance may be encountered. In addition, said agencies can furnish information on the existing and planned transportation projects, regardless of status, that may affect or be affected by V/STOL services. The governmental agencies can be a determining factor in the success or failure of an operation since they probably will be involved in the land-lease arrangements and the site development. For effective development, it is necessary that the transportation planners and governmental agencies closely relate their activities. Both should be concerned with and closely allied to any prospective transportation and building projects within the region.

The planner should consider land use patterns. He should be aware of height limitations for buildings going up in the downtown. Without advance planning, it may be more expensive to innovate service and sites at less desirable locations may result.

Before locating facilities, the requirements of the Federal agencies such as the Civil Aeronautics Board (CAB) and the FAA should be consulted. The planner, also, should investigate existing local public policies pertaining to aircraft.

The places from which people arrive and depart, the use of automobiles and other transportation modes, along with the time savings and convenience of V/STOLs are all factors which must be taken into account. They interact in such a way that the planner must be aware of the role V/STOLs can play at transportation centers, for example, where ground-to-air transition takes place.

VTOL, STOL and Conventional take-off and landing (CTOL) aircraft are compatible. All three may have terminal facilities (where the data prove that such are feasible) within the same complex. For example: La Guardia Airport has facilities for all and each complements the other by providing a unique service.

The use of air space is an important factor influencing the feasibility of a particular location for V/STOLs. For instance: If a major airport is close to the downtown and is overcrowded due to an excessive amount of air traffic (which appears to be the case in many metropolitan regions), the resulting holding patterns influence V/STOL landing site selection. This situation must be examined carefully before a final decision is reached for sites desired within such an area.

Studies of the traveling public, transportation plans, land use and land development proposals are all used in the evaluation of locations for helistops, heliports and stolports.

Investigation of transportation habits and needs of the traveling public should determine, for the planner, the following:

1) The type of service that will be needed-

   permanent, interim, scheduled, non-scheduled or a combination.

2) For whom the service will operate--

   commuters, out-of-town businessmen, shoppers and others.

3) The function the service will perform--

   move communters, vacationers, shoppers, cargo, etc. between central cities, airports, industrial or office parks, shopping centers, transportation centers, suburbs and other points.

4) The approximate locations that will be desirable and useful--

   downtown office building rooftops or hotel roofs, air-rights over expressways or waterways, transportation centers where highway, rapid transit, buses or other modes of transportation come together, industrial or office park sites, suburban locations at shopping centers or subway stations, bus or other stops.

5) The appropriate vehicle to be used, based on the types of service needed--

   the functions to be performed by the service, the location of ports, stops or airstrips and investigation of the technology available help in selecting those vehicles that will produce the most efficient and effective means of operation.

6) The time saved for selected types of trips--

   between central cities, airports, resort areas, industrial or office parks and other locations.

7) The rates to be charged for each type of trip--

Existing Technology

An investigation of existing technology should include: the cost of vehicles re size (capacity); the performance of vehicles re speed, safety and maintenance; the cost of operations, such as gasoline, oil, repairs, etc., and the ability of the aircraft to take-off and land from the types of facilities to be served. Proposed aircraft development also should be examined re type of aircraft, estimated performance, stage of development, anticipated date of production and probable reliability of delivery commitments. Data on the existing and proposed technology can be acquired by contacting aircraft manufacturers, aviation journals and sources such as Rotor & Wing, and Aviation Week & Space Technology, magazines encompassing V/STOL aviation and the state of development. Rotor & Wing compiles lists of manufacturers, types of vehicles, sizes of vehicles and other data which may be used to obtain more detailed information.

The existing and proposed development of other transportation vehicles should also be examined so that the future of the service may be evaluated not only in terms of existing and potential aircraft, but in terms of future transportation modes and their interaction with the proposed VTOL or STOL service.

Economic Feasibility

A cost-benefit analysis should be undertaken to provide answers to the following questions: 1) Will the time saved be worth the cost of the trip? 2) Will the price be too exhorbitant for the user to bear alone? 3) Will reduced congestion and improved overall transportation system justify the required public investment? 4) Who should bear the costs of the system?

In conducting a cost-benefit analysis, capital outlays and potential operating costs should be estimated. These costs should be evaluated in terms of the needs, desires and ability of the proposed market to sustain the service. In addition, costs should be evaluated in terms of the benefit of the service both to users and to the general community within the area under consideration.

Conclusions

Both, VTOLs and STOLs, as an operation, can use existing facilities and may be instituted more rapidly and less expensively than other modes of transportation, such as rapid transit, which do not use existing roadways. This characteristic is important in establishing either interim or scheduled service where there is dire need or extreme pressure for quick relief of a problem.

VTOLs, at present, appear to have a limited application in terms of intra-urban use due to several factors:

1) The high-fare structure can be borne primarily by upper-income business and civic leaders;

2) Deduction of the cost of travel as a legitimate business expense is available to a relatively small number of people; and

3) The individuals to whom a significant reduction in daily travel time is an important economic consideration make up a small segment of the population.

Where conditions warrant scheduled service, VTOLs offer fast travel and convenience for the traveling public whose time is a valuable commodity. Despite relatively high fares, VTOL services are not generally profitable at the present time.

In addition to income from scheduled services, VTOLs derive revenues from taxi, cargo, emergency or fast transport, charter use and transportation to poorly accessible areas, such as isolated hunting and fishing resorts or construction sites just being developed.

Air technology has developed larger and faster planes than ever before. These planes, the 747, for example, must fly long distances to operate economically. The STOL is an exception. It is economical to operate on short trips (100-500 miles) and has great potential for the medium-haul market. It also can use many facilities that become obsolete and overcrowded for long-haul use.

Planning for air travel and supporting facilities is particularly difficult because of rapidly changing technology. The helicopter was an experimental model a few decades ago. Today it is a fully operational vehicle in commercial and military use. Improvements in technology are continuing at a fast pace. Most vehicles are outdated before they can be amortized to the point where they are economical. STOL models are coming into use for specialized segments of the transportation market. In 1963, for example, there were at least 75 different types of V/STOLs being developed. As a consequence, the planner must update his knowledge of vehicles at the time the need exists.

V/STOLs for short-haul inter-urban transportation are emerging as vehicles that can fill gaps in the short-haul market. This is especially true where major airports are scheduled for expansion or development at increasingly longer distances from the central city being served. (New York City is planning to develop a major airport 65 miles from Manhattan.)

V/STOL services should be developed as part of an urban transportation system satisfying three tests proposed by Wilfred Owen, of the Brookings Institute in Washington, D. C.:[15]

1) The transportation system should be functionally comprehensive by including all forms of transportation applicable to the problem.
2) The transportation system should be comprehensive geographically by including both the metropolitan area and the affected region.
3) The transportation system should be comprehensive from a planning standpoint by assuring that transportation is used to promote community goals, and that community plans make satisfactory transportation possible.

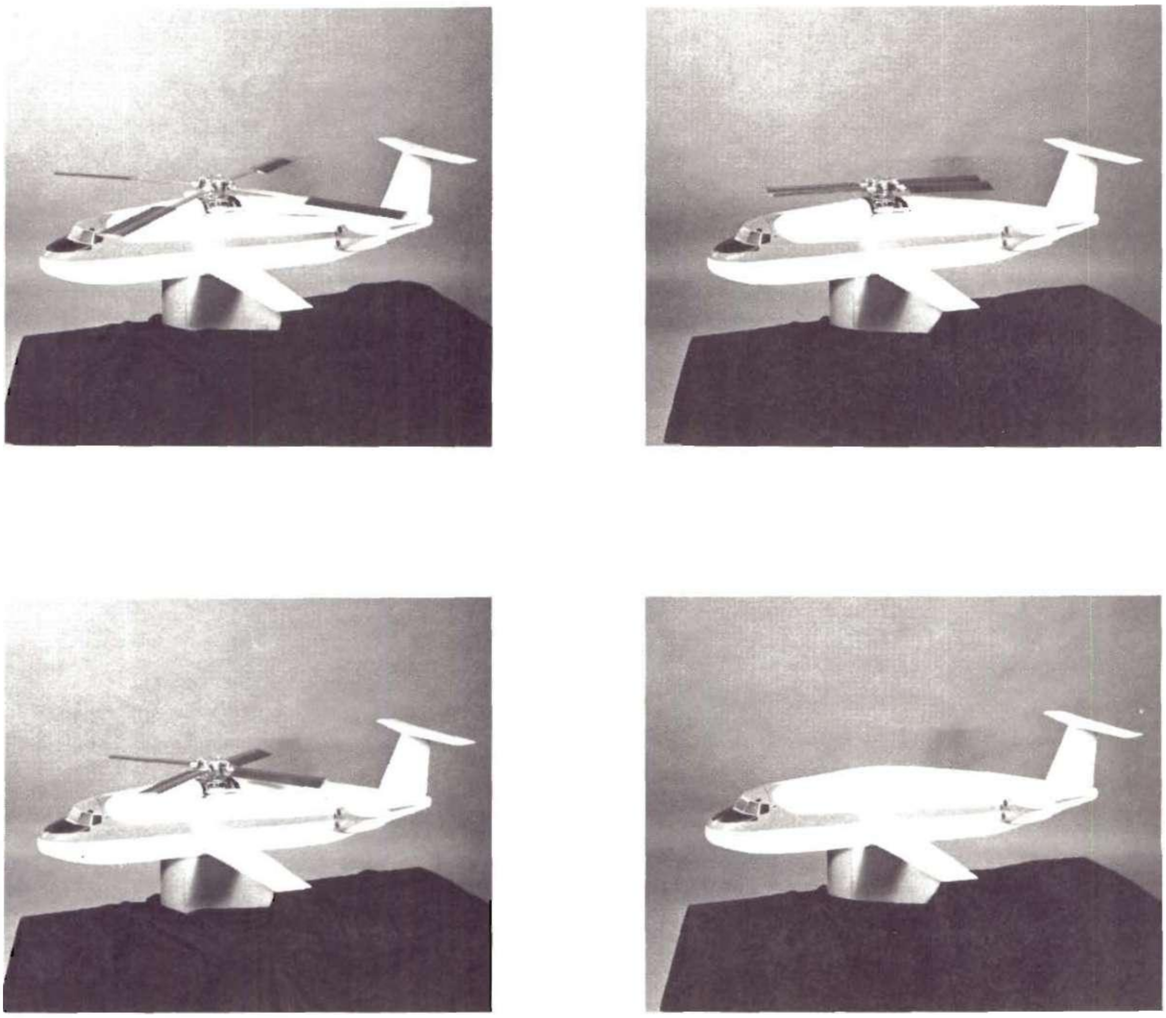
In implementing the V/STOL portions of the comprehensive transportation plan, the planner should keep in mind several factors: the potential need for close-in airport sites for V/STOLs as plans to abandon existing facilities are revealed; the possibility of using VTOLs as interim or short-term means of transportation; and the desirability of planning approaches over waterways, beaches, industrial yards and other non-congested areas. The latter lessens the effect of noise on the surrounding.

A larger variety of fine aircraft are available today than ever before. In most instances, however, cities are served by inadequate airways, overcrowded airport facilities, outmoded processing systems to move passengers, baggage and cargo within the airport facility, and obsolete ground transportation to and from airports. As larger planes, carrying over 250 passengers each, come into use, the problem of moving the travelers (30 to 60 percent of whom are making connections between airports and central cities) becomes more difficult to resolve. In addition, airport facilities and satellite activities act as major employment centers, which, in turn, generate more traffic within the airport environs. Solutions such as rapid transit and highways take a long time. VTOL services can be initiated rapidly and STOLs can often use existing facilities.

Metropolitan and urban planners have a responsibility to consider all appropriate modes of transportation in the solution of area-wide transportation problems. Development of a comprehensive plan will, of necessity, involve detailed understanding of the social, physical and economic needs and desires of all the people residing in the area.

APPENDICES

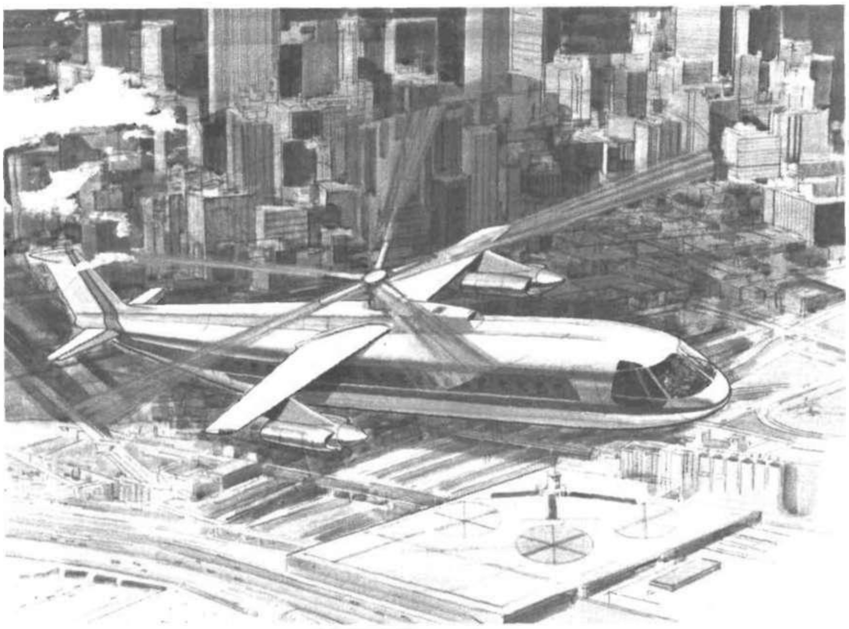
APPENDIX A
SIKORSKY'S TRAC



TRAC system is shown on stowed rotor model above. At upper left, blades are fully extended; at lower left, blades are telescoped to 60 per cent of original length. At upper right, blades are positioned for stowing and at lower right, they are stowed and aircraft continues fixed-wing flight.*

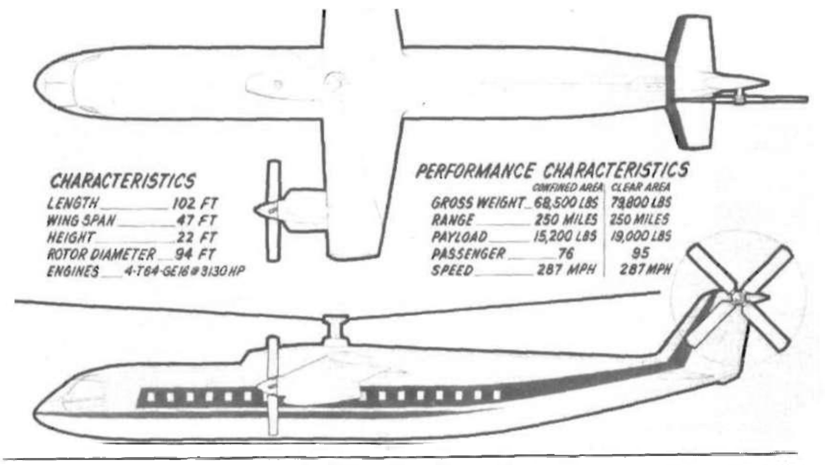
*Source: Photographs: Courtesy of Rotor & Wing.
Explanation: Rotor & Wing, August 1968, p. 46.

APPENDIX B
LOCKHEED'S MODEL CL-879



CL-879

DASH 8 CONFIGURATION



This model is in the preliminary design stage and will be used in airport shuttle, city to city, and for utility purposes. It will carry between 75–90 passengers and will cost several million dollars. This model will not convert to cargo, but cargo versions will be produced if the market develops. If lockheed proceeds with this concept, deliveries will begin in the middle 70's.

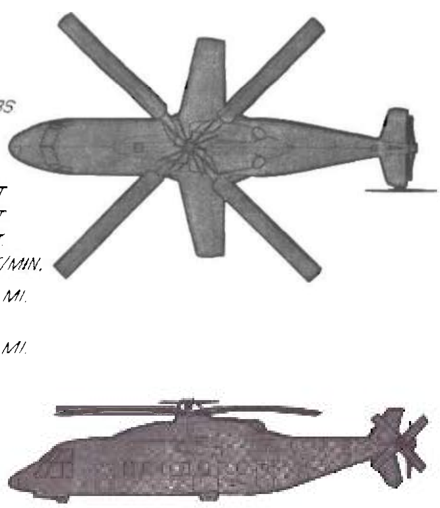
Source: Lockheed-California Company, Burbank, California.

APPENDIX C
LOCKHEED'S INTERURBAN TRANSPORT
(CL-1026)

CL-1026

LYCOMING T55-L-7
TURBOSHAFT ENGINES

GROSS WEIGHT		22,500 LBS
USEFUL LOAD		8,200 "
PAYLOAD	5800 LBS	
FUEL	2400 LBS.	
CRUISE SPEED (NRP) @ S L.		200 KT
MAX. SPEED @ 15,000 FT		230 KT
HOVER CEIL. (O.G.E.) STD DAY		4,000 FT.
RATE OF CLIMB		4,300 FT/MIN.
RANGE (5800 LBS. PAYLOAD) (2400 LBS FUEL)		200 N MI.
MAX RANGE (4286 LBS PAYLOAD) (MAX INTERNAL FUEL 3640 LBS)		340 N MI.



Lockheed is conducting preliminary design studies on the CL-1026. This vehicle is to be used for the same purposes as pointed out in Appendix B. The capacity of this plane is 30 passengers and it is convertible to cargo in a matter of minutes.

Source: Ibid.

APPENDIX D
NEW YORK AIRWAYS
(Fall Schedules, 1966)

THE SKYLINE ROUTE

PLEASURE

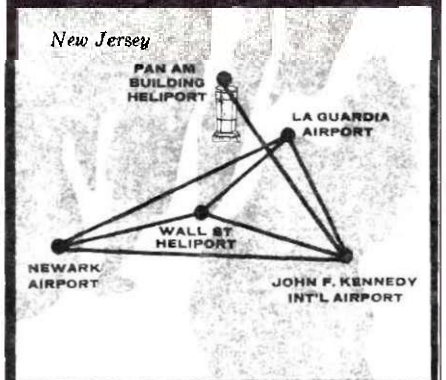
The new Boeing Vertol 107 turbocopter features spacious seating for 25 in a luxurious interior by the designer of the Boeing 707 jets. There is a window by every seat, individual light and ventilation controls, and a stewardess in attendance.

SPEED

The Boeing Vertol 107 is jet powered by two General Electric T-58 turbine engines. It takes just 8 or 10 minutes from downtown or midtown Manhattan to the New York Metropolitan Airports.

CONVENIENCE

NYA provides its own free bus service for passengers and their baggage at John F. Kennedy Int'l, thus insuring airline care direct to connecting flights. There are also convenient stops for passengers wishing transportation to NYA.



COMPLETE AIRLINE SERVICES

RESERVATIONS.

Reservations may be made at any airline ticket office, through your travel agent or by calling New York Airways at IL 8-7400; in Newark call MA 3-2590.

TICKETS.

Tickets may be bought from any scheduled airline, your travel agent or at any New York Airways' ticket counter. Flight coupons or exchange orders from all scheduled airlines to NYA are accepted.

BAGGAGE.

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Airline trip insurance may be purchased for all scheduled NYA flights.

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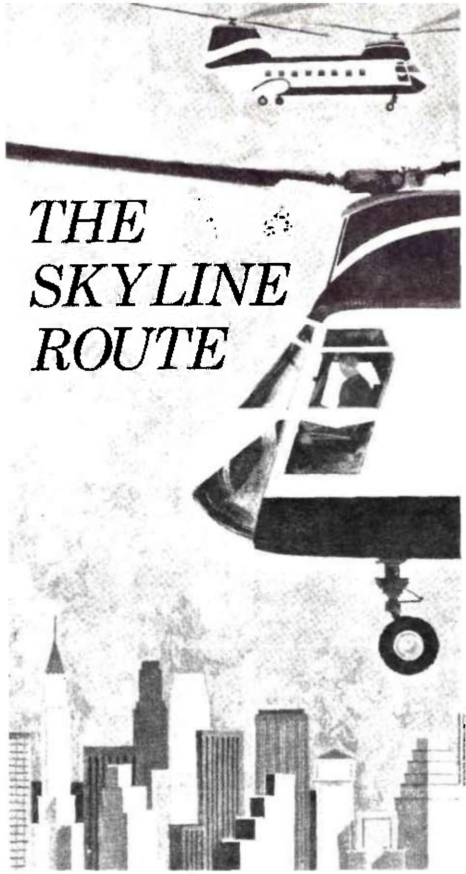
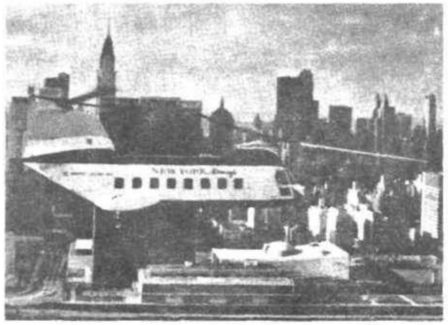
FALL SCHEDULE
EFFECTIVE OCTOBER 1, 1966





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New York Airways serves the heart of Manhattan through the Pan Am Building Heliport. Located over Grand Central Station, the Heliport is within minutes of all important midtown hotels and major office buildings. Frequent flights to J. F. Kennedy International Airport via the Pan Am Unit Terminal connect with all domestic and international airlines. Now mid Manhattan is only 10 minutes by helicopter from J. F. K. Int'l. Airport and all New York Airways flights offer unsurpassed picture-taking opportunities.

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Pan Am Bldg.	8.00	—	—
Newark	12.00	—	—
LaGuardia	7.00	10.00	—
Wall St.	10.00	10.00	7.00

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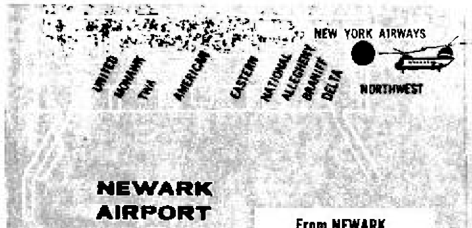
Service from Newark



Light figures A.M.
Dark figures P.M.
All times are local times

From NEWARK to KENNEDY INT'L

Leaves Newark	Arrives JFK	Stops	Flight No.
7:09	7:30	1	358*
7:45	8:06	1	364*
8:15	8:27	0	368
8:45	9:06	1	370*
9:15	9:27	0	372
9:40	10:06	2	378*
10:15	10:41	2	384
11:15	11:41	2	390
12:15	12:27	0	394
12:40	1:06	2	400
1:15	1:27	0	404
1:40	2:06	2	412
2:15	2:27	0	414
2:40	3:06	2	416
2:48	3:14	2	420†
3:15	3:27	0	422
3:40	4:06	2	424
3:55	4:12	1	426†
4:15	4:27	0	428
4:40	5:06	2	430
4:55	5:21	2	438†
5:15	5:27	0	440
5:40	6:06	2	442
5:55	6:21	2	444†
6:15	6:27	0	448
6:40	7:01	1	450
7:15	7:27	0	458
7:55	8:16	1	460
8:20	8:32	0	462
8:55	9:16	1	464
9:20	9:32	0	470
10:20	10:32	0	476

From NEWARK to WALL STREET

WEEKDAYS ONLY (Ex. Nov. 24, Dec. 26, Jan. 2, and Feb. 22)

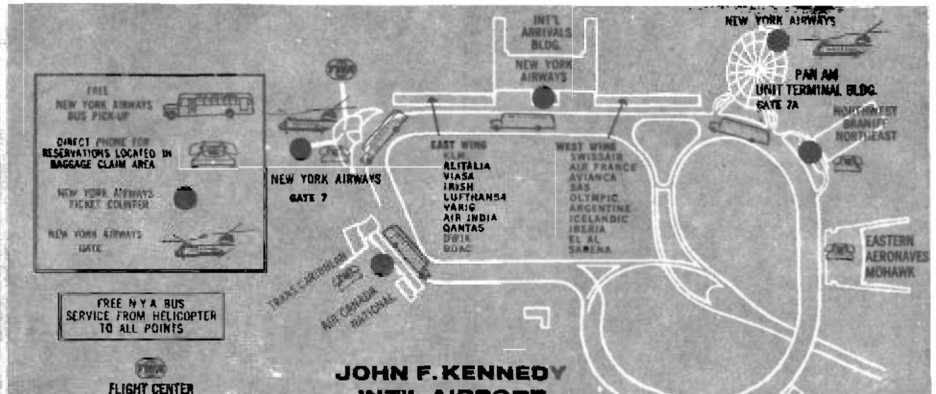
Leaves Newark	Arrives Wall St.	Flight No.
9:40	9:46	378
10:15	10:21	384
11:15	11:21	390
12:40	12:46	400
1:40	1:46	412
2:40	2:46	416
2:48	2:54	420
3:40	3:46	424
3:55	4:01	426
4:40	4:46	430
4:55	5:01	438
5:40	5:46	442
5:55	6:01	444

From NEWARK to LA GUARDIA

Leaves Newark	Arrives LaGuardia	Stops	Flight No.
7:09	7:19	0	358*
7:45	7:55	0	364*
8:45	8:55	0	370*
9:40	9:55	1	378*
10:15	10:30	1	384
11:15	11:30	1	390
12:40	12:55	1	400
1:40	1:55	1	412
2:40	2:55	1	416
2:48	3:03	1	420
3:40	3:55	1	424
4:40	4:55	1	430
4:55	5:10	1	438†
5:40	5:55	1	442
5:55	6:10	1	444†
6:40	6:50	0	450
6:50	7:00	0	454
7:55	8:05	0	460
8:55	9:05	0	464
9:55	10:05	0	474†
11:18	11:28	0	480†

* Daily Except Saturdays, Sundays and Holidays

Service from John F. Kennedy Int'l Airport



FLIGHT CENTER

From KENNEDY INT'L to NEWARK

Leaves JFK	Arrives Newark	Stops	Flight No.
7:40	8:01	1	564
8:20	8:32	0	566*
8:40	9:06	2	570
9:20	9:32	0	572*
9:40	10:06	2	578
10:20	10:46	2	584
11:20	11:46	2	590
12:20	12:32	0	598
12:40	1:06	2	600
1:20	1:32	0	610
1:40	2:00	2	612
2:20	2:32	0	614
2:40	3:06	2	618
3:20	3:32	0	620
3:24	3:41	1	622†
3:40	4:06	2	624
4:20	4:32	0	626
4:24	4:44	1	628†
4:40	5:06	2	630
5:20	5:32	0	638
5:30	5:47	1	642†
5:40	6:06	2	645
6:20	6:32	0	648
6:30	6:42	0	650†
6:40	7:01	1	654
7:25	7:37	0	658
7:50	8:11	1	660
8:30	8:42	0	662
8:50	9:11	1	670
9:30	9:42	0	672*
9:50	10:11	1	674
10:50	11:11	1	678†

PAN AM UNIT TERMINAL BLDG.

From KENNEDY INT'L to PAN AM BLD'G.

Leaves JFK	Arrives Pan Am	Flight No.
9:01	9:11	0901†
9:16	9:26	0916†
9:46	9:56	0946†
10:01	10:11	1001†
10:16	10:26	1016†
10:46	10:56	1046†
11:16	11:26	1116
12:16	12:26	1216
1:16	1:26	1316
2:16	2:26	1416
2:46	2:56	1446
3:16	3:26	1516
3:46	3:56	1546
4:16	4:26	1616
4:41	4:51	1641
5:01	5:11	1701
5:16	5:26	1716
5:41	5:51	1741
5:53	6:03	1753
6:16	6:26	1816
6:41	6:51	1841
7:01	7:11	1901
7:16	7:26	1916
7:31	7:41	1931
7:46	7:56	1946
8:16	8:26	2016

FLIGHT CENTER

From KENNEDY INT'L to LA GUARDIA

Leaves JFK	Arrives LaGuardia	Flight No.
7:40	7:47	564
8:40	8:47	570
9:40	9:47	578
10:20	10:27	584
11:20	11:27	590
12:40	12:47	600
1:40	1:47	612
2:40	2:47	618
3:40	3:47	624
4:40	4:47	630
5:40	5:47	645
6:40	6:47	654
7:50	7:57	660
8:50	8:57	670
9:50	9:57	674
10:50	10:57	678

FLIGHT CENTER

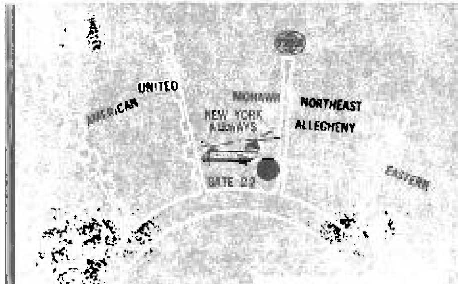
From KENNEDY INT'L to WALL STREET

WEEKDAYS ONLY (Ex. Nov. 24, Dec. 26, Jan. 2, and Feb. 22)

Leaves JFK	Arrives Wall St.	Stops	Flight No.
8:40	8:57	1	570
9:40	9:57	1	578
10:20	10:37	1	584
11:20	11:37	1	590
12:40	12:57	1	600
1:40	1:57	1	612
2:40	2:57	1	618
3:24	3:32	0	622
3:40	3:57	1	624
4:24	4:32	0	628
4:40	4:47	1	630
5:30	5:38	0	642
5:40	5:57	1	645

† Daily Except Saturdays, Nov. 24, Dec. 25, Jan. 1, and Feb. 22

Service from LaGuardia



LA GUARDIA AIRPORT

Light figures A.M.
Dark figures P.M.

All times are local times

From LA GUARDIA to WALL STREET

WEEKDAYS ONLY (Ex. Nov. 24, Dec. 26, Jan. 2, and Feb. 22)

Leaves LaGuardia	Arrives Wall St.	Flight No.
8:51	8:57	570
9:51	9:57	578
10:31	10:37	584
11:31	11:37	590
12:51	12:57	600
1:51	1:57	612
2:25	2:31	616
2:51	2:57	618
3:51	3:57	624
4:51	4:57	630
5:51	5:57	645

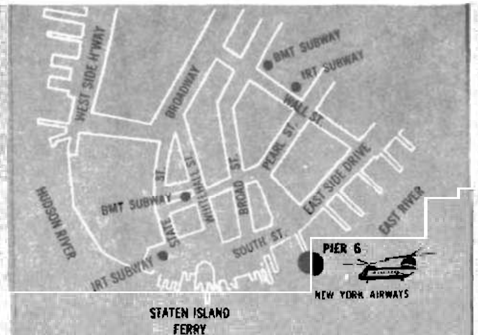
From LA GUARDIA to KENNEDY INT'L

Leaves LaGuardia	Arrives JFK	Flight No.
7:23	7:30	358
7:59	8:06	364*
8:59	9:06	370*
9:59	10:06	378
10:34	10:41	384
11:34	11:41	390
12:59	1:06	400
1:59	2:06	412
2:59	3:06	416
3:07	3:14	420†
3:59	4:06	426
4:59	5:06	430
5:14	5:21	438†
5:59	6:06	442
6:14	6:21	444
6:54	7:01	450
8:09	8:16	460
9:09	9:16	464†

From LA GUARDIA to NEWARK

Leaves LGA	Arrives Newark	Stops	Flight No.
6:50	7:00	0	550*
7:30	7:40	0	552*
7:51	8:01	0	564
8:51	9:06	1	570
9:51	10:06	1	578
10:31	10:46	1	584
11:31	11:46	1	590
12:51	1:06	1	600
1:51	2:06	1	612
2:25	2:40	1	616†
2:51	3:06	1	[illegible]
3:51	4:06	1	624
4:51	5:06	1	630
5:51	6:06	1	645
6:51	7:01	0	654
8:01	8:11	0	660
9:01	9:11	0	670
10:01	10:11	0	674
11:01	11:11	0	[illegible]

Service from Wall Street



WALL STREET HELIPORT

*Weekdays only**

*Except Nov. 24, Dec. 26, Jan. 2, and Feb. 22

From WALL STREET to LA GUARDIA

Leaves Wall St.	Arrives LaGuardia	Flight No.
9:49	9:55	378
10:24	10:30	384
11:24	11:30	390
12:49	12:55	400
1:49	1:55	412
2:49	2:55	416
2:57	3:03	420
3:49	3:55	424
4:49	4:55	430
5:04	5:10	438
5:49	5:55	442
6:04	6:10	444

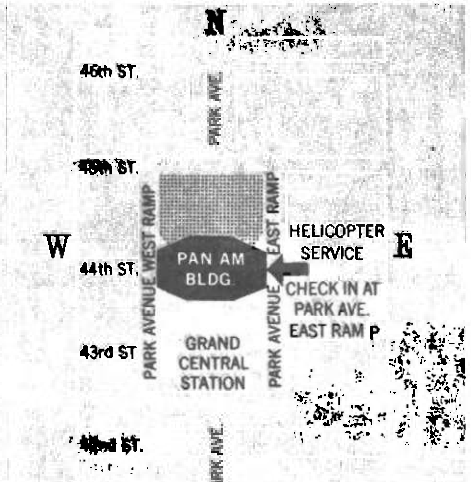
From WALL STREET to KENNEDY INT'L

Leaves Wall St.	Arrives JFK	Stops	Flight No.
9:49	10:06	1	378
10:24	10:41	1	384
11:24	11:41	1	390
12:49	1:06	1	400
1:49	2:06	1	412
2:49	3:06	1	416
2:57	3:14	1	420
3:49	4:06	1	424
4:04	4:12	0	426
4:49	5:06	1	430
5:04	5:21	1	438
5:49	6:06	1	442
6:04	6:21	1	444

From WALL STREET to NEWARK

Leaves Wall St.	Arrives Newark	Flight No.
9:00	9:06	570
10:00	10:06	578
10:40	10:46	584
11:40	11:46	590
1:00	1:06	600
2:00	2:06	612
2:34	2:40	616
3:00	3:06	618
3:35	3:41	622
4:00	4:06	624
4:35	4:41	628
5:00	5:06	630
5:41	5:47	642
6:00	6:06	645

Service to and from Pan Am Building



From PAN AM BLD'G. to KENNEDY INT'L.

Leaves Pan Am	Arrives JFK	Flight No.
8:30	8:40	0830‡
8:55	9:05	0855‡
9:30	9:40	0930‡
10:00	10:10	1000‡
10:30	10:40	1030‡
11:00	11:10	1100‡
11:30	11:40	1130
12:30	12:40	1230
1:30	1:40	1330
2:30	2:40	1430
3:00	3:10	1500
3:30	3:40	1530
4:00	4:10	1600
4:30	4:40	1630
4:55	5:05	1655
5:15	5:25	1715
5:30	5:40	1730
5:54	6:04	1754
6:07	6:17	1807
6:55	7:05	1855
7:30	7:40	1930
7:45	7:55	1945
8:00	8:10	2000
8:30	8:40	2030

From KENNEDY INT'L. to PAN AM BLD'G.

Leaves JFK	Arrives Pan Am	Flight No.
9:01	9:11	0901‡
9:18	9:26	0916‡
9:46	9:56	0946‡
10:01	10:11	1001‡
10:16	10:26	1016‡
10:46	10:56	1046‡
11:16	11:26	1116
12:16	12:26	1216
1:16	1:26	1316
2:16	2:26	1416
2:46	2:56	1446
3:16	3:26	1516
3:46	3:56	1546
4:16	4:26	1616
4:41	4:51	1641
5:01	5:11	1701
5:16	5:26	1716
5:41	5:51	1741
5:53	6:03	1753
6:16	6:26	1816
6:41	6:51	1841
7:01	7:11	1901
7:16	7:26	1916
7:31	7:41	1931
7:46	7:56	1946
8:16	8:26	2016

‡ Daily Except Sundays and Holidays

APPENDIX E
FLYING-SAUCER TYPE MACHINE

ANSWER TO MANY PROBLEMS

DeKalb-Based Research Group Developing Revolutionary Flying-Saucer Type Machine

VEHICLE WILL GIVE PEOPLE ACCESS TO REMOTE SPOTS

An easy-to-operate, safe, economical flying-saucer type aircraft, priced within the reach of anyone who can own a car, is being developed by a DeKalb-based research group.

Before you laugh, listen to this.

Lockheed engineers and a Georgia Tech aerodynamics professor say the "design is feasible and the principle is sound" and that it should work.

One Lockheed man, E. E. Scroggs, Jr., is vice-president and chief of design for the company with headquarters on Candler Road.

It is headed by D. R. Heaton, president, a pilot for many years, operator of an exterminating firm and a man who has been dreaming and working on the unique project for many years.

A small scale model of the craft looks like a flying saucer.

It is designed to operate on a simple principle of counter-rotating lifting fans, powered by three free-piston turbine type, pollution-free engines of nine pounds each which are powered by butane, propane or acetylene gas, and developing 50 pounds of thrust each.

It is designed to be economical (price of an auto), lightweight (900 pounds) and capable of quietly hovering at a standstill or cruising 120 mph with a five-hour range.

Other than some bearings, there are only five moving parts on the entire ship.

Mr. Scroggs said the principle is "nothing new" and that the engine to be used has been around in one form or another since 1925.

"It combines several sound principles already in use into one machine. The great thing is the propulsion system and power-to-weight ratio...something which has never been achieved before."

He said it eliminates the complicated, heavy and expansive transmission and engine which has prevented the price and operation of the helicopter from coming within reach of the average family.

Mr. Heaton has written President Nixon of his machine suggesting it can help overcome the problems of transportation, air pollution, water pollution, overcrowded cities, subway and freeway development and sparsely populated rural areas--all of which are inter-connected, he says.

The machine is being developed by the Aerospace Research & Development Corporation and is in the "detail design stage" at present.

To be called the Aerocommuter, the machine will be built, test-flown and franchised here for further manufacture and distribution.

Mr. Heaton recently taped an hour-long TV show for the University of Georgia to be shown in the summer. Mr. Heaton said, "We've talked to a lot of engineers. All of them point out some problem or weakness in their own special idea, but none of them say it won't work. All say it will work and that the concepts are basic and sound."

The craft will be 11 feet in diameter and will enable the owner to have access to a job, a vacation or a visit to any remote site without the need for roads or freeways.

It will, the developers say, permit people to move back to the countryside and still work in the city--or vice versa.

Those involved are, or were, Lockheed scientists and engineers. J. H. Sams, the vice president and chief engineer for structures is a scientist and team leader on aircraft structures and a Ph.D candidate.

Dr. R. M. Scruggs, the vice-president and chief engineer for flight sciences is an aeronautical engineer in the vertical take-off and aerodynamics field.

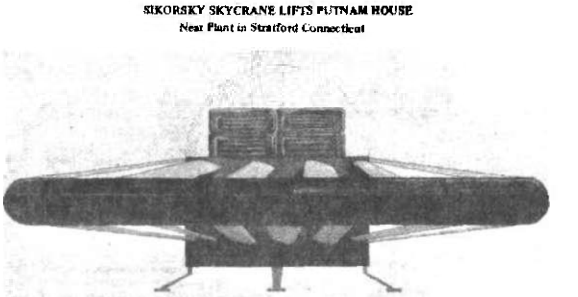
J. S. Wallace, vice-president and chief of manufacturing, is a loads aerospace scientist.

J. B. Mills is vice-president and advertising director. He is a weights scientist with Lockheed.

DeKalb Rep. Jim Westlake, as a risk and management consultant, is assisting the group in setting up its corporate structure and the firm is looking for investors.

SIKORSKY SKYCRANE LIFTS PUTNAM HOUSE
Near Plant in Stratford Connecticut

Scale Model of Machine



ARTIST'S RENDERING OF MR. HEATON'S INVENTION

Source: Decatur-DeKalb News, March 24, 1971, pp. 1 & 12A.

It appears urgent that some form of short-haul air transportation be innovated in densely populated regions before the available airspace resembles express-ways during rush hour.

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