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STOL Aircraft for Urban Transport In the Long Island-New York City Area

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ABSTRACT

The reduction of noise and air pollution contributed by the urban transportation system is a prime objective of urban mass transit. However, previously studied mass transit systems have required ground corridors to link the trip origins and destinations. These corridors restrict the system speed, are disruptive to the community, and tend to concentrate the environmental impact of that system. The purpose of this paper is to investigate the feasibility of a commuter transport system utilizing Short Take-off and Landing (STOL) aircraft operating in the Long Island-New York City area. Comparisons between the STOL system, the Long Island Railroad, and automotive modes of travel were made. These systems were compared on the basis of door-to-door trip times and costs. The STOL system was found to be technically feasible in that an airplane was designed so that its characteristics were consistent with commuter operations. However, it was concluded that the system is not economically feasible without substantial subsidies from outside sources.

Introduction

A high percentage of urban noise and air pollution is caused by its transportation systems. Automobiles and trucks have the greatest environmental impact because of their dependence on the internal combustion engine.

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Attempts to reduce the number of motor vehicles entering the central business districts of urban complexes have focused upon the need for the development of advanced transportation systems. Most vehicles usually considered in the search for new systems are dependent upon ground corridors. The extensive use of ground corridors is recognized as harmful to the land resources of the area and they are costly to develop. Underground vehicles, while having the advantage of preserving land usage, are even more costly.

Recently the concept of developing an intraurban mass transportation system based upon V/STOL* aircraft has been advanced by NASA.[1,2] Among the characteristics which make the V/STOL airplane attractive for this purpose are its high cruise speed and its freedom from ground corridors. The applicability of such a system to the transportation needs of the Long Island-New York City area seems worthy of consideration and hence was investigated by the authors.

The Long Island-New York City area represents a special case in that good rail and auto ground corridors abound. Nevertheless, during the hours of peak commutation, the railroad is not capable of handling passenger demand quickly or efficiently. The average trip is made at a speed of 26 mph; according to Reference 3, the railroad is not operating as efficiently as it did in 1930. The expressways have become choked to the point where traffic moves at 20 mph or less during the peak traffic hours. When traffic stalls, the internal combustion engine works at its poorest efficiency and a tremendous amount of pollution is generated. The V/STOL airplane, thus, has the potential for removing a large number of autos from the roads by presenting the commuter with a fast and relatively pollution-free alternative for getting to work.

The airplane used for intracity transportation must be designed with the community/environment as a prime consideration from the outset. An air transport system must be acceptable to the community as well as to its passengers. The reduction of air pollution levels, as well as halting the incursion of undesirable ground corridors, offer strong arguments in favor of such a system.

The purpose of the subject was threefold: a) to determine which types of aircraft are most suited to the intracity mass transit role, b) to design an aircraft specifically for this role, and c) to determine the potential for the operation of a mass transit system based around the STOL aircraft through a cost analysis study.

The first parts of this study, a) and b), are reported in Reference 4. It was found that a turbo-propeller powered aircraft using the deflected

*Vertical and/or Short Take-off and Landing Aircraft.

slipstream principle is probably the type of aircraft most suitable for mass transit role. The overriding considerations which led to this choice are:

a. This type of aircraft has a high payload capability compared to a turbojet powered airplane or other V/STOL types.
b. The STOL runway requirements (field length of 2,000 ft.) can be achieved by this aircraft while meeting the noise restrictions.
c. The turboprop powerplant is relatively pollution free. The conclusions given here are supported by the results of Reference 1 and to a lesser extent by Reference 2.

The third objective, the cost analysis, was reported on in Reference 5. This report is a summary of both References 4 and 5, but special emphasis has been given to the cost analysis study.

Aircraft Characteristics

The STOL airplane which was designed for this study is a high-wing transport similar in geometric characteristics to some of the more successful military cargo airplanes of recent years. It was decided that a conventional design featuring a fixed wing and fixed powerplant would represent the best configuration for the 1970-1980 time period. The more advanced V/STOL features such as tilting wing and/or power plants were avoided because these features conflict with safety and generally reduce the payload capability of the airplane.

The basic design criteria for the STOL airplane was that it should have a maximum range of 500 miles, carry around 300 passengers, and be able to use the 1,800 foot runways specified by the FAA for STOL aircraft. Figure 1 presents a three-view drawing of the airplane designed to meet these criteria. The airplane weighs approximately 221,000 lb, has a wing span of 200 feet and area of 5,750 square feet (Aspect Ratio 7), has a fuselage length of 158 feet, and is powered by four turboprop engines developing over 6,000 HP each. The fuselage features a large number of doors for rapid loading and unloading of passengers; a set of oversized doors is provided just aft of the cockpit for cargo loading. The preliminary design analyses which substantiate the configuration are presented in References 4 and 5.

The high density seating capacity of the airplane is 304 passengers, which is the equivalent of two and one-half railroad cars. A "quick-change" capability is incorporated in order to convert the aircraft to an all-cargo version with a capacity of 11,340 cubic feet. This latter feature is provided to increase the utilization of the airplane during the periods of time between the peak hours of commuter transportation. An alternative use of

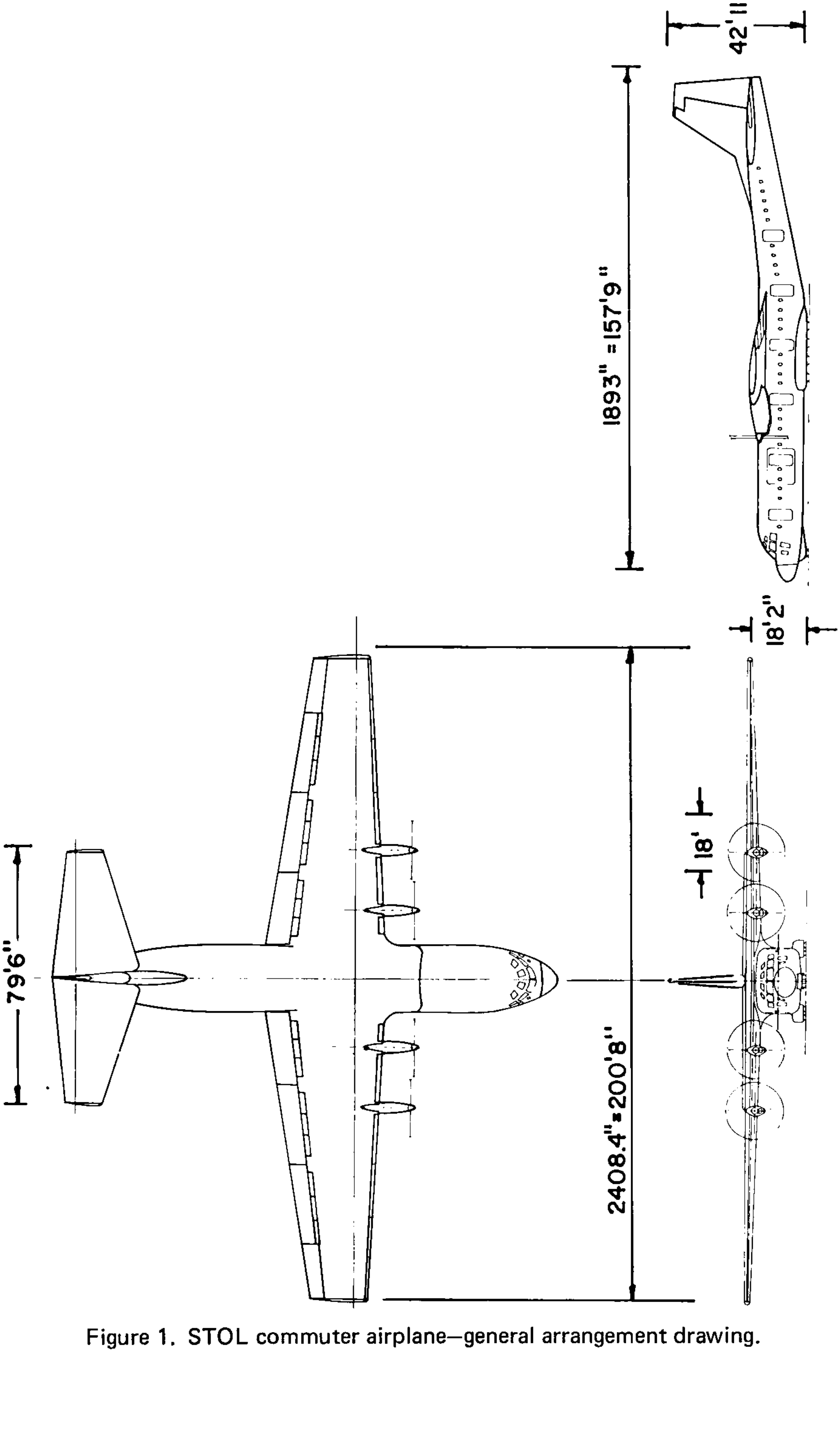

Figure 1. STOL commuter airplane—general arrangement drawing.

the aircraft during these off-peak periods would be to carry a combination of passengers and freight on intercity routes using STOL ports or conventional airports.

The noise generated by the airplane during take-offs and landings would have to be kept below 90-95 PNdb at 500 feet by treating the ducts acoustically and by reducing the propeller tip speeds below current values. A considerable amount of attention was given to the noise problem; it decided the choice of powerplant and, together with the runway length requirements, decided the wing and power loading of the airplane.

The turboprop engine is relatively pollutant-free compared with the internal combustion engine. Sawyer[6] estimates the pollution yield of aircraft turbine engines at about 36 lb of pollutants per 1,000 lb of fuel consumed, as compared with about 390 lb per 1,000 lb of fuel consumed for motor vehicles. Hence, the use of aircraft as commuter transports could potentially reduce air pollution levels.

The size of the subject aircraft is large compared to those considered in References 1 and 2 and a more detailed analysis might prove that the size chosen is not optimum. Certainly, airplane size would have to be considered in a more detailed study than was possible here.

Airplane Performance

The design of a conventional transport airplane is usually based upon four fundamental specifications. Three of these have already been given; namely, the range, passenger capacity (or payload weight), and the landing field lengths. The fourth specification is usually the cruising speed. In the subject study it was decided to relax the cruising speed requirement altogether. There are two reasons why this was done and these are: 1) a high cruising speed requirement is in direct conflict with the field length requirement, 2) a high cruising speed is not as critical to the commuter STOL as to the longer range transport because the trip distances involved are much shorter. Fortunately, a design which meets the field length requirements having the highest wing loading* possible also achieves a moderately high cruising speed.

The detailed performance analysis of the STOL design is given in Reference 5. All of the performance calculations were performed by a high speed digital computer so that it was possible to evaluate the performance fairly extensively.

Table 1 presents the general performance of the STOL design using a nominal wing loading (W/S) of 38.5 lb/ft^2, W = 221,000 lb. Values are

*Wing loading is defined as the airplane weight divided by the wing area. The maximum wing loading permissible with the powerplants selected was about 40 lb/ft^2.

Table 1. Summary of Aircraft Performance Characteristics

Takeoff weight	*Sea Level* =	*190,000 lb*	*220,000 lb*
STOL-Take-off ground run		615 ft	723 ft
STOL-Take-off distance to 50 ft		755 ft	885 ft
STOL-Landing ground run		660 ft	763 ft
STOL-Landing distance from 50 ft		940 ft	1,044 ft
FAR 25-Take-off distance to 50 ft		813 ft	950 ft
FAR 25-Landing distance from 50 ft		960 ft	1,060 ft
Minimum field length required		1,600 ft	1,768 ft
Stall speed (landing configuration)		55 kts	59 kts
Rate of climb			
4 engines at Military Power		2,278 ft/min.	1,800 ft/min.
3 engines at Military Power		1,480 ft/min.	1,150 ft/min.
Maximum rate of climb speed		140 kts	145 kts
Time to climb to 5,000 ft		2.2 min.	2.4 min.
Service ceiling			
4 engines at Military Power		35,800 ft	29,600 ft
3 engines at Military Power		23,000 ft	18,800 ft
Cruising ceiling (commuter mode)		10,000 ft	10,000 ft
Maximum speed (normal power at 5,000 ft)		269 kts	266 kts
Cruise speed (75% normal power at 5,000 ft)		237 kts	232 kts
Speed for maximum fuel economy at 5,000 ft		130 kts	150 kts
Range with maximum fuel at 5,000 ft			
Reserves for 30 min.		541 mi	520 mi
Ferry range		830 mi	725 mi

shown for 190,000 lb also, which is the lowest take-off weight considered realistic. The landing field length usable is 1/(0.6) times the take-off or landing distances, whichever is longer. It can be seen from Table 1 that the largest ground distance required by the airplane under normal operating conditions is approximately 760 ft, and that the maximum field length required is below 1,800 ft as specified by the FAA. The rate of climb performance, which affects cruising altitudes, the times required to reach them, and hence, the direct operating costs, is seen to be satisfactory.

The in-flight performance capability of the airplane is demonstrated by the maximum speed, the cruise speed, the speed for maximum fuel economy, and the ranges obtainable. The maximum and cruising speeds are seen to be moderately high; 266 and 232 kts respectively (306 mph and 267 mph). Various means of increasing the speed of the airplane were studied and it was found that the cruise speed performance could be improved by about 10 per cent by increasing the wing loading from the design loading (38.5 lb/ft^2) to an optimum value of approximately $W/S = 65\ lb/ft^2$. However, a large increase in the installed horsepower, or preferably a change in the type of power plant to the prop-fan or turbofan variety, would be required to produce a significant increase in the cruise performance. These latter types of powerplants are noisier during terminal operations which would have an adverse affect upon the community acceptance of the STOL transportation system.

The turning capabilities of the airplane were evaluated and it was found that the approach flight to a midtown STOL port located on the Hudson River could be made entirely over the river. Noise can, thus, be kept at a minimum which could be less distracting to residents in the central business district (CBD).

The performance evaluation shows that the present design is able to achieve the STOL performance specified by the FAA and is able to meet the range requirements. Cruise performance is less than optimum but the short trip distances encountered in commuter operations minimizes the effects of the lower cruise speeds. It would appear then that a satisfactory compromise between the diverse requirements of runway lengths and cruise speed has been affected, while creating the least disturbance to the environment.

Direct Operating Costs

The feasibility of a STOL airplane mass transportation system is highly dependent upon the operating costs of such a system. Approximately half of the major operational costs of an air transport system are contained in the direct operating costs (DOC) and these are summarized below. Further discussion of this material may be found in Reference 5.

A method developed by the Air Transport Association (ATA)[7] was used to estimate the DOC. However, since the DOC depends very strongly upon the airplane block times and block speeds, these quantities had to be evaluated. Block time is defined as the total trip time per flight. It is the sum of the times spent in climb, cruise, and descent, as well as the times spent in approach maneuvers and taxiing to and from the terminals. The block speed is simply the average speed attained during the flight. Although these values are easy to compute, care must be taken to select values for the constants and parameters that are appropriate to a STOL system.

Figure 2 presents the variation of block speed and time with trip distance for the STOL design using a cruise speed of 220 knots and a cruise altitude of 2,000 feet. It can be seen from the lower graph that

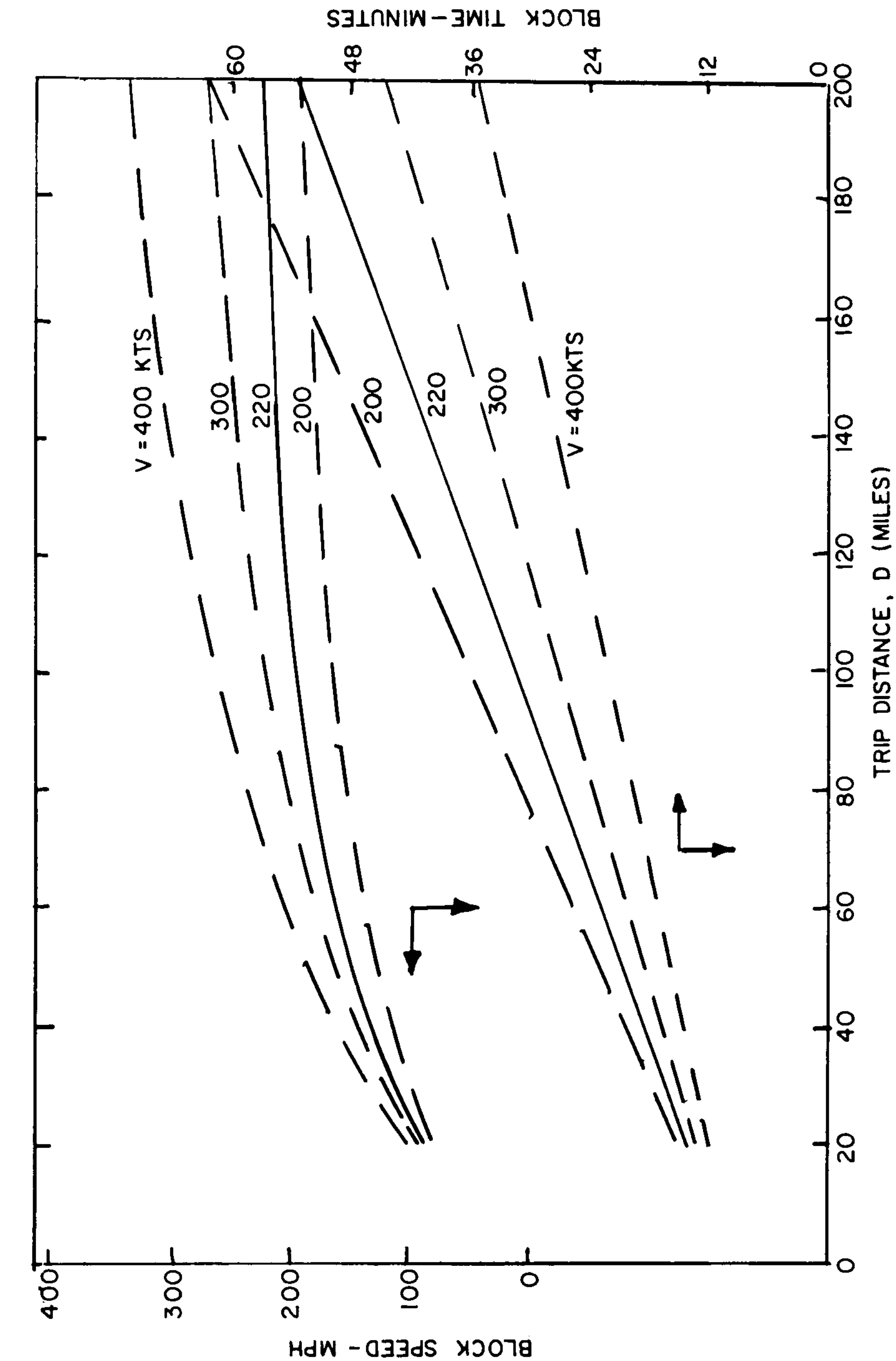

Figure 2. Block speed and block time vs. distance—effect of cruise speed.

effectively nine minutes are "lost" in various activities. Thereafter, the block time is linear with trip distance. The block speeds at the minimum and maximum commuter distances considered, D = 30 and 100 miles, are seen to be only 115 mph (approximately one-half the cruise speed) and 170 mph (approximately two-thirds the cruise speed) which demonstrates that the time lost is not inconsequential.

Figure 2 also indicates the effect of arbitrarily changing the cruise speed to different values. Increasing the cruise speed to 400 knots would only reduce the block time 4.4 minutes at 30 miles, and 13.5 minutes at 100 miles. Since most commuter flights would originate less than 80 miles from New York City, an average block time reduction of only eight minutes could be expected by increasing the cruise speed to 400 knots. This higher performance could only be obtained by changing the wing loading and the powerplant, as discussed previously, which is not warranted considering the small improvement in travel time possible. It is indicated, therefore, that the present STOL design represents a good compromise of the noise and performance problems while not sacrificing trip times inordinately in the commuter ranges. If the airplane were used for intercity flights at distances of 200 to 300 miles, the lower cruise speeds would be less competitive than conventional short haul air transports which cruise around 500 knots, but which do not have STOL performance.

The DOC for the STOL design (cruise speed 220 knots) as a function of distance are shown in Figure 3 using 1967 dollars, according to the method given in Reference 7. This method was modified as necessary so that it would apply more directly to a STOL airplane flying on a route typical to the Long Island-New York City area. The effects of inflation were considered and these will be discussed below.

The computation of DOC versus D depends upon a large number of base parameters.[5,7] For purposes of documentation, the values used to generate Figure 3 are presented below:

Cruise Speed	=	220 knots
Take-off Weight	=	190,000 lb
Cruise Altitude	=	2,000 feet
Ground Maneuver Time	=	4 minutes
Airplane Purchase Price	=	$6 million
Labor Rate	=	$4 per hour
Annual Utilization	=	1,500 hours per year
Depreciation Period	=	12 years

The shape of the DOC versus D curve is similar to that for a conventional airplane, which shows a continuously decreasing cost per available seat-mile as D increases. The STOL airplane's curve is shifted to the left in comparison to the conventional airplane; it achieves the same cost at a lower value of D. The STOL direct operating costs are seen to rise very rapidly for distances less than 30 to 40 miles, which is indicative of the poor efficiency of the airplane when flying extremely short ranges.

Figure 3 also shows the effect of cruising speed on DOC. Increasing the cruising speed to 400 knots was found to cause a 30% reduction in the direct operating costs. However, these savings could only be realized if the cruise speed could be increased without affecting other DOC parameters, such as the aircraft purchase price.

Figure 4 presents the base DOC broken down into its various components using 1967 dollars. Breakdowns for various trip distances in the commuter range are shown. It can be seen that the labor and materials costs comprise about 45% of the total DOC. Since, for the purposes of costs reductions, the remaining components can be considered to be fixed percentages, the potential for operating cost reductions lie almost entirely with the maintenance costs. This potential has a good chance of being realized due to advanced maintenance procedures and the relative simplicity of the airplane design considered.

There has been significant inflation since 1967 and, in order to make certain economic comparisons between the STOL airplane and competing modes of travel, the 1967 values had to be adjusted. Inflation costs were estimated on the basis of the consumer price indices (CPI) as given in Reference 8. Figure 5 presents three CPI's as a function of year and shows linear extrapolations of these indices to the year 1980. The figure shows that during the past five years the indices have been increasing at a rate which exceeds a linear rise. With inflation controls, it is hoped that the rate of rise can be held to the linear rise (or less) in the future. The purpose here is not to predict the economic future of the country, but rather to show how inflation might affect the direct operating costs. Reference 9 indicates that the DOC rises at a rate which is proportional to the "all services" CPI, rather than the "public transporation" CPI. Hence, the "all services" CPI was used for estimating the DOC inflationary trend.

Figure 6 presents the effect of inflation on the DOC of the STOL airplane assuming an annual utilization of 2,000 hours. Figure 6 reflects the fact that the 1972 DOC values are up 132% compared to the 1967 values, and that by 1980 the DOC values may be approximately 180% of the 1967 values. The cost per available seat mile is shown to be approximately 4.8¢ for a trip distance of 30 miles at the 1972 economic level, which compares very favorably with out-of-pocket expenses for the single occupant automobile. However, this assumes a 100% load factor for the airplane which is an unduly optimistic value. The comparison does serve to indicate that the STOL airplane is not unreasonably expensive as one might first suppose. It should also be noted that the inclusion of inflationary effects

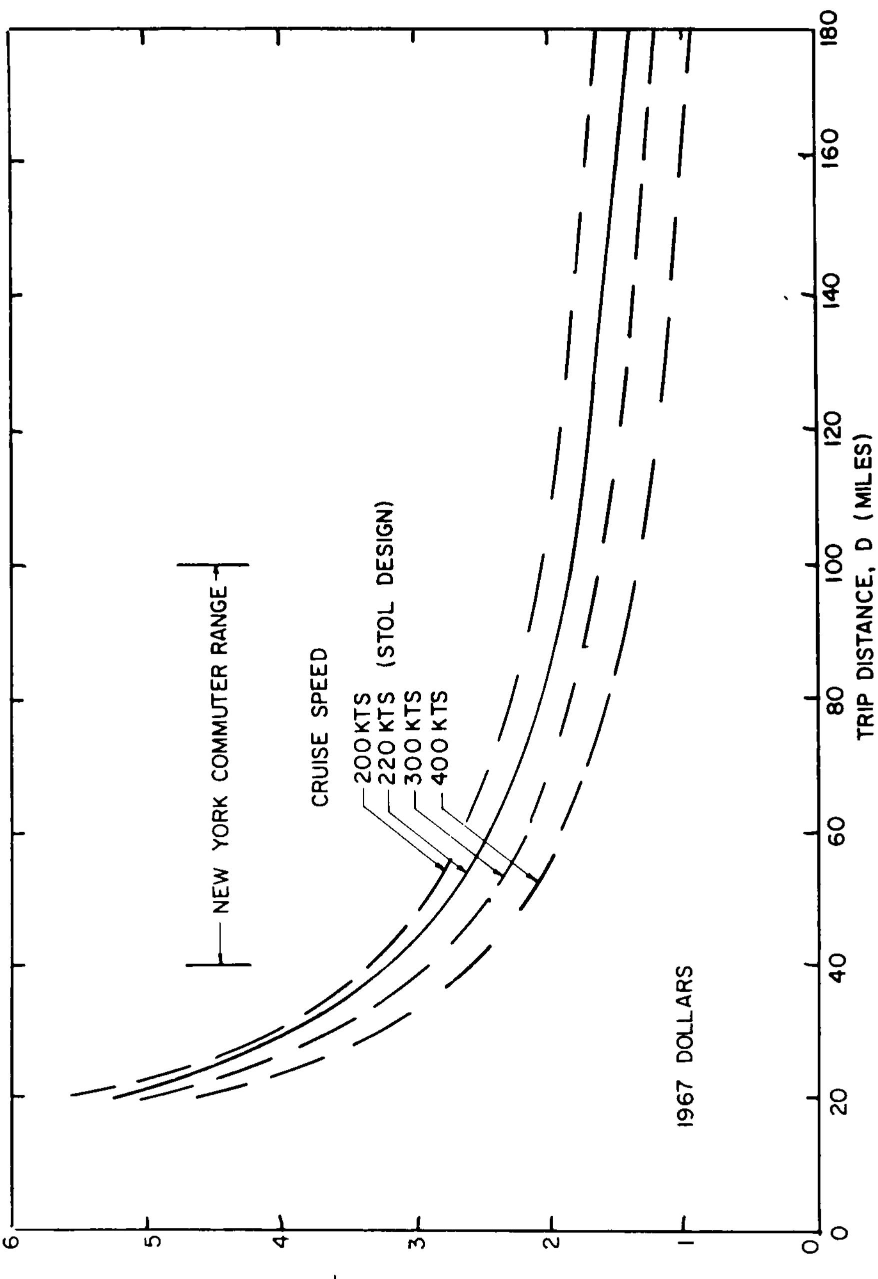

Figure 3. Direct operating costs vs. distance—effect of cruise speed.

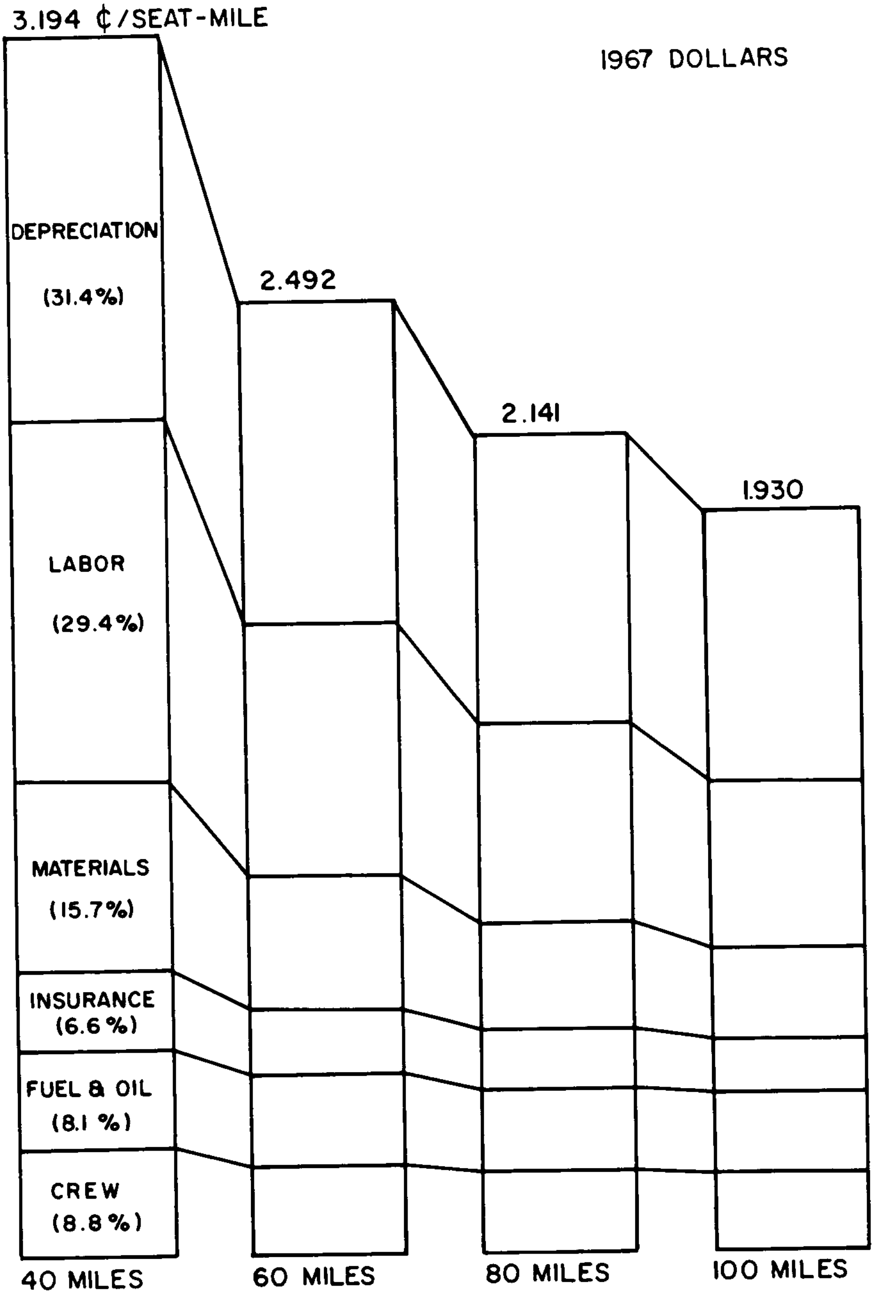

Figure 4. Direct operating costs component breakdown—STOL design.

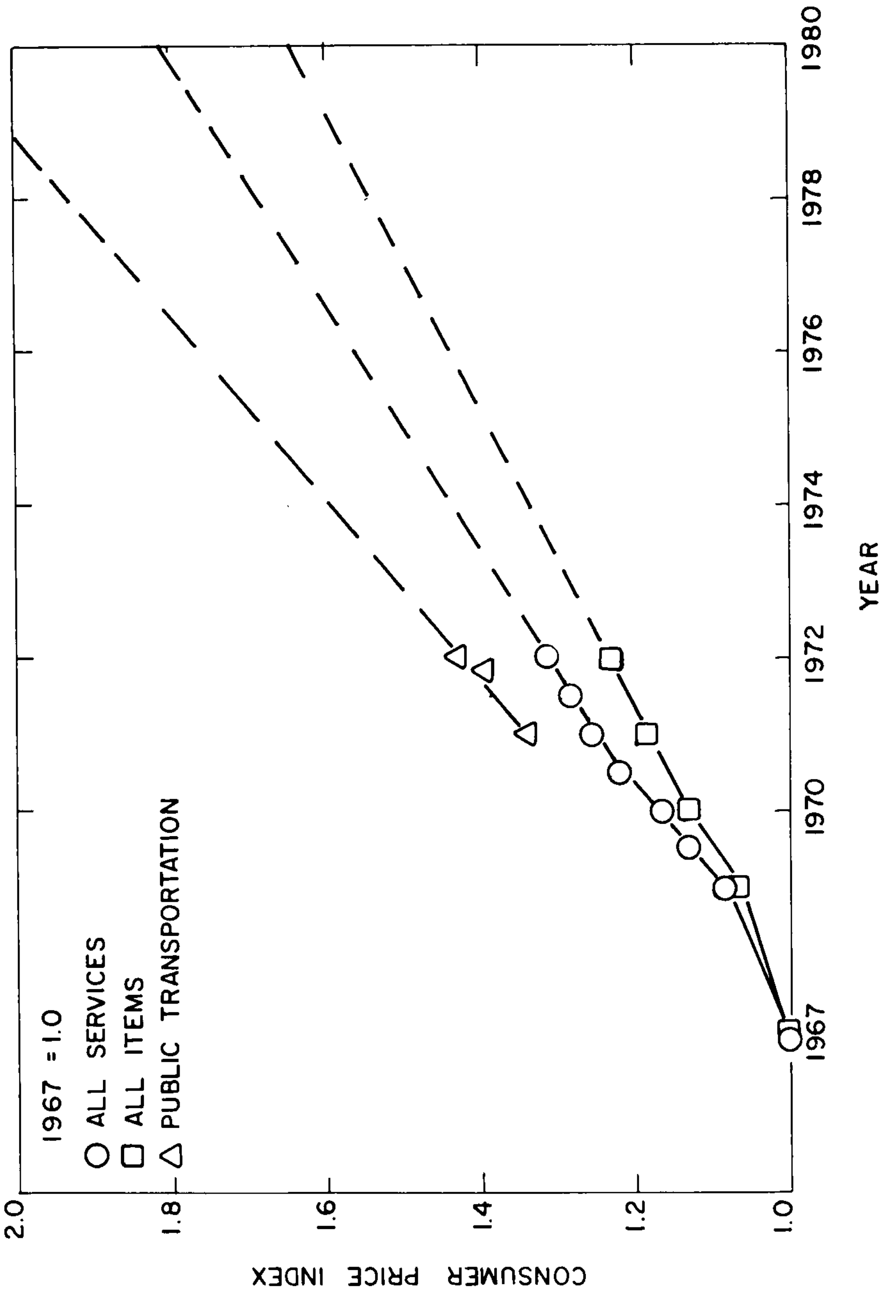

Figure 5. Extrapolation of recent inflationary trends.

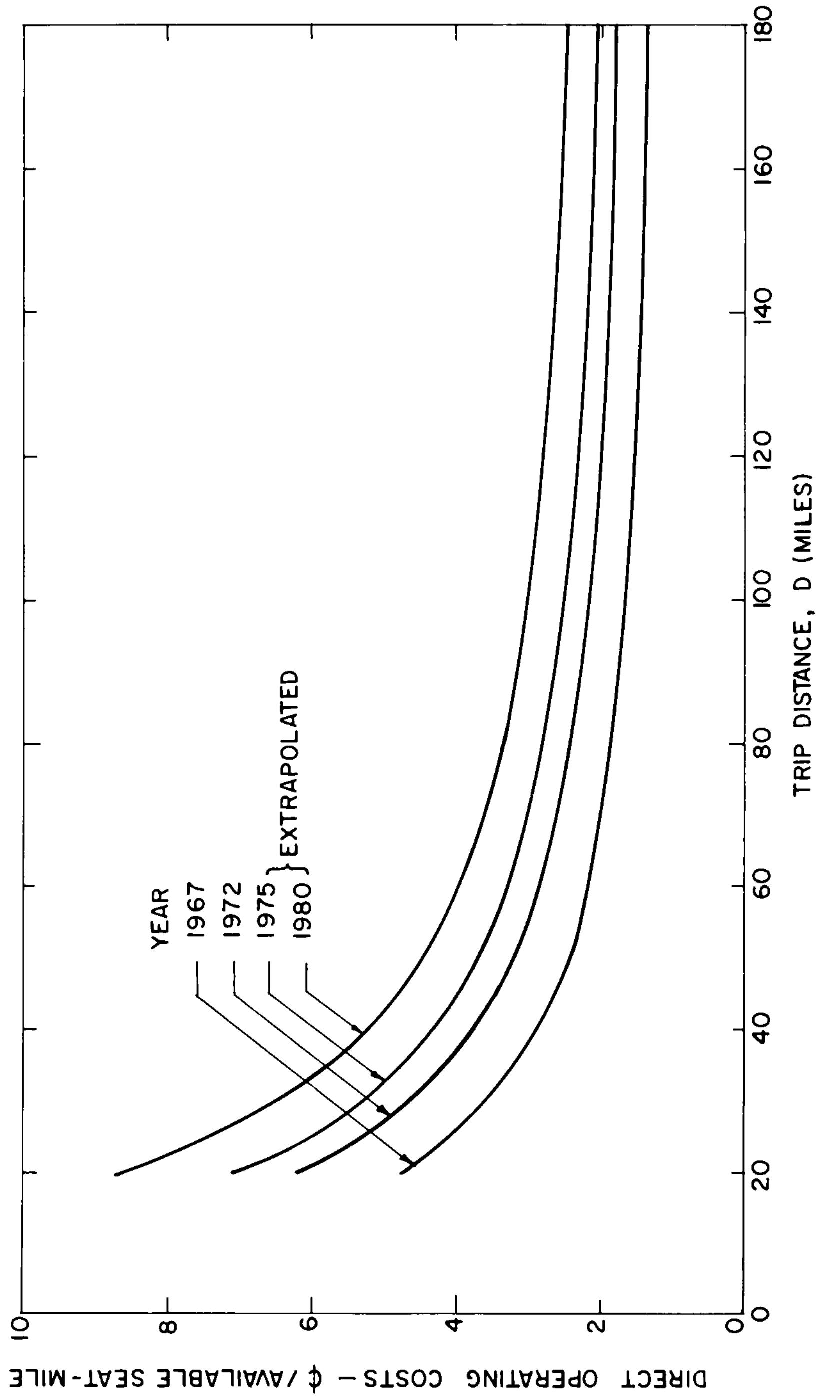

Figure 6. Direct operating cost vs. distance—effect of inflation.

to the 1980 time period as is done here may be conservative to some degree. References 1 and 2 point out that improvements in technology will tend to offset the effects of inflation.

Modal Comparisons

The introduction of a commuter STOL transport system into the Suffolk County-New York City area would divert passengers from existing modes of travel, as well as induce new riders who have not previously commuted to the CBD. At the present time, the commuter's choice of mode is limited to the Long Island Railroad (LIRR) or private automobiles. The viability of the STOL airplane as a transportation mode can only be determined by comparing it to the existing modes of travel.

Comparisons were made on the basis of door-to-door trip times and door-to-door trip costs. A door-to-door trip consists of three components, the access to the particular mode under investigation, the trip proper, and the egress from that mode. These modes could also have been compared on the basis of relative comfort and convenience. However, since these factors are subjective and, therefore, hard to quantify, no effort was made in this direction.

STOL block times were obtained from Figure 2 for a cruise speed of 220 knots. Trip times for the LIRR were taken from timetables; and the average rush hour highway speeds, as given in Reference 10, were used to determine auto block times. This information was used to develop linear expressions for trip block times by all modes in terms of the line of sight trip distance, D. It should be noted that the value of D is restricted to between 30 and 100 miles for these comparisons.

A simple STOL fare structure which makes no allowance for profit was assumed. The STOL fare is equal to the total operating costs, i.e, the sum of the indirect and direct operating cost (expressed in units of dollars per seat for a trip of distance D) divided by the average load factor, LF. The load factor is defined as the ratio of occupied to available seats and is dependent upon the passenger demand and scheduling considerations. The indirect operating costs, IOC, (wages for ground personnel, facility operating costs, etc.) were assumed to equal the DOC values. This assumption has been made by other intercity STOL transport system investigators, see References 11, 12, and 13. However, References 1 and 2 indicate that this assumption is probably conservative for intracity STOL systems using automatic ticketing machines and austere facilities.

Two fare structures, the single trip and the commuter monthly fares, were used to estimate the trip costs for the LIRR. Auto costs were based on single occupant trips using a unit cost of 5¢ per highway-mile, which is the perceived, or out of pocket auto operating costs, and 10.5¢ per highway-mile, which is representative of the actual costs of operating an automobile. Multiple occupant auto costs are very low but these do not really have to be considered since the average occupancy of the auto entering the CBD is 1.4.[10] Highway miles were converted to line of sight trip distances through the use of an expression based upon a typical route from Suffolk County to Manhattan.

The access and egress times and costs for all modes were estimated. Two STOL egress times and costs were used, corresponding to a) the proposed Jersey City STOLport and b) a Hudson River terminal near 34th Street, in order to assess the importance of a CBD STOLport.

Access and egress times for each mode were added to the vehicle block times to arrive at the total door-to-door trip time. The same procedure was used to determine the total trip costs. Table 2 presents the total trip times and costs as functions of the distance, D, and, in the case of the STOL mode, in terms of the average load factor. Also included in this table are the modal access and egress times and costs.

Figure 7 presents a modal comparison of the total trip times as a function of trip line of sight distance D. It is seen that the intercept of the linear curves with the ordinate represent non-productive travel times which depend upon access and egress times, and the non-cruise segments of the terminal-to-terminal travel time. The penalty for these non-productive times is particularly acute in the case of the STOL airplane. The STOL airplane traveling at 250 mph can fly 30 miles in 7.2 minutes (not allowing time for take-off, climb, descent, etc., so that the non-productive trip time in this case is 38.8 minutes for the Hudson River STOLport and 48.8 minutes for the Jersey City STOLport. It certainly appears that every effort should be made to reduce the non-productive trip time. However, even with this handicap, the STOL is still capable of reducing the rail trip time by 45 minutes and the auto trip time by almost an hour at D = 30 miles. Such a time saving would mean that the average commutation time per day, which now varies from 3 to 3½ hours, could be reduced to 1½ hours with the STOL airplane using a Hudson River STOLport. Another 20 minutes of commutation time would be added, if the airplane were restricted from the CBD terminal and had to use a Jersey City STOLport. A city center STOLport is essential for efficient STOL operations, since such a terminal would reduce the number of intermodal transfers from three to two by eliminating the need to take a trans-Hudson train. The subsequent reduction in travel time and cost would attract more passengers and is worth the added expense of the CBD terminal.

The total trip times shown in Figure 7 are easy to interpret for distances beyond 30 miles. The additional time required for any distance in excess of 30 miles is simply equal to the incremental distance divided by the instantaneous (rather than the average) speed of travel which is equal to 26

Table 2. Access/Egress and Total Trip Times and Costs for All Modes

Mode	Access time min	Access cost $	Egress time min	Egress cost $	Trip time door-to-door min	Trip cost door-to-door $
STOL Manhattan STOLport	14	1.15	15	0.35	0.24D + 38.6	$1.50 + \frac{(.023D + 2.10)}{LF}$
STOL Jersey City STOLport	14	1.15	25	0.85	0.24D + 48.6	$2.00 + \frac{(.023D + 2.10)}{LF}$
LIRR Single trip fare	15	0.50	15	0.35	2.43D + 22.5	0.0548D + 1.76
LIRR Commutation fare	15	0.50	15	0.35	2.34D + 22.5	0.0154D + 1.78
Auto 10.5¢/mile	-	-	8	0.90	1.20D + 67.8	0.109D + 1.76
Auto 5¢/mile	-	-	8	0.90	1.20D + 67.8	0.052D + 1.31

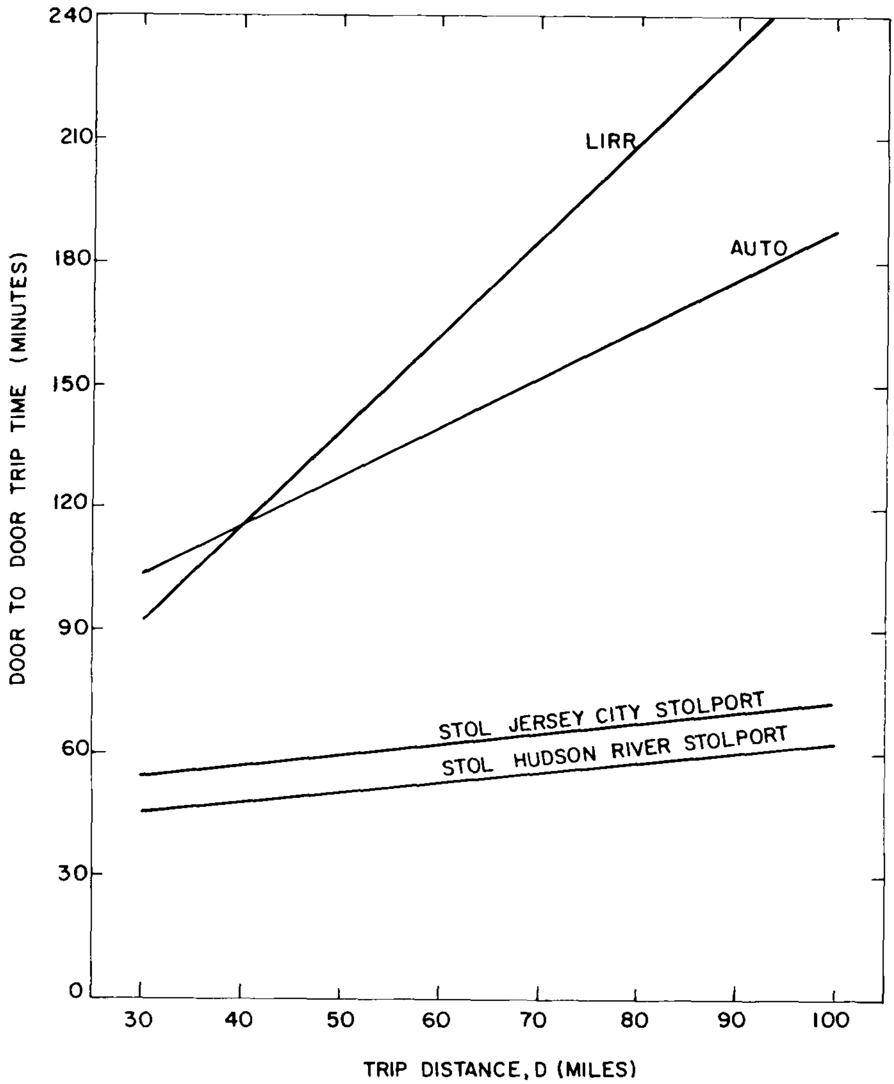

Figure 7. Modal door-to-door trip time comparisons.

mph for the train, 50 mph for the auto, and 250 mph for the airplane. It is clear that for travel distances greater than 50 miles the airplane is unquestionably the fastest mode of travel. The fact that STOL operations are only attractive for these distances indicates that the STOL system would not significantly reduce auto pollution since a large portion of car trips to the CBD originate less than 30 miles away.

The poor travel speed of the railroad is a source of irritation to the rail commuter and promotes auto travel. The auto in turn is a source of much of the air pollution in the metropolitan area. The need for express rail service from Suffolk County to the CBD is very clearly shown and the MTA[14] has plans in progress for such service. Express rail service would reduce total trip times to the order of STOL total trip times, for distances between 30 and 50 miles. For example, the express rail door-to-door trip time from 30 miles would be 60 minutes, as compared to a STOL time of 46 minutes (Hudson River STOLport) and 56 minutes (Jersey City STOLport). However, it is clear that the STOL's non-productive trip times must be reduced if express rail service were established, in order to remain competitive.

The need for a STOL terminal in the city center is even more clearly indicated if the system is to compete with express rail service. However, at the present time, it is not politically feasible to advocate such a terminal due to adverse community reaction. Before the CBD STOLport is constructed, indeed before any STOL terminal can be constructed, the community must be convinced that the terminal will not disrupt their daily lives. It would certainly enhance the acceptability of STOLports if their presence was considered a community asset. For instance, suburban terminals might be surrounded by a buffer zone consisting of parks and recreational areas. In the city center, where the cost of such a buffer zone would be prohibitive, the STOLport should be located in a commercial area if possible, and if not, nearby residents could receive a tax reduction, thus making the STOLport economically attractive to them.

The effect of the STOL system on population distribution is significant in that it would tend to reinforce the existing trend of people moving to the suburbs. Figure 7 shows that, on Long Island, the STOL can transport commuters a distance of 100 miles in about the same time as the LIRR or private automobiles can transport people 30 miles. This would indicate that once the system was initiated, it would begin to generate its own demand at distances where the STOL is most efficient.

Total door-to-door trip costs are presented in Figure 8 as a function of trip distance. The solid curves represent the STOL airplane costs for operations between a point in Suffolk County and the CBD using a Jersey City STOLport, which is the most conservative case. (Costs could be reduced 50¢ if a Hudson River STOLport is used.) Curves are shown for 100% load factor, which represents the ideal situation, and 50% load factors, which is even slightly optimistic. In all probability, a load factor of 40% is more realistic[1,2] and this curve is also shown. The cost of $9 for a 30 mile trip for the 40% load factor STOL is out of reach of most commuters and this clearly indicates that the STOL airplane cannot operate without a heavy subsidy. Such a conclusion was reached in the Detroit[1] and San Francisco[2] studies also.

The auto costs and rail costs are shown in Figure 8 for comparison. Total costs associated with the single trip rail fare and the 100% load factor STOL compare reasonably well; below 70 miles, the rail is less expensive and above this distance the trend reverses. Costs associated with the rail commutation fares are seen to be very low in comparison to either the ideal STOL or even the out of pocket auto costs. However, Long Island Railroad fares are subsidized at a rate of approximately 30% according to the numbers concerning revenues and losses given in Reference 15. The STOL would require an even higher ratio of subsidy to revenue; the 40% load factor STOL would require a 50% subsidy to bring the total trip costs in line with the 100% LF curve, which is still twice the costs associated with rail commutation fares.

The actual auto costs approach the 50% LF STOL curve at a distance of 70 miles and the 40% LF STOL curve at 100 miles. If the STOL were subsidized to achieve the 100% LF curve, it would be both economically superior to and have a shorter total travel time than the automobile. However, if the auto commuter judges his travel costs on the basis of perceived costs, then an even heavier subsidy (one that brings the STOL costs in line with the rail single trip fare costs) would be required to make the STOL competitive. The subsidy required to bring the STOL costs down to the car pool costs shared by four riders operating on a perceived costs basis would be completely unreasonable.

There are improvements in the STOL costs that can be realistically contemplated, and these are: 1) a reduction in the IOC from 100% to 37% of the DOC, as shown in Reference 1, and 2) moving the STOLport from Jersey City to the Hudson River location. The first of these would have the effect of reducing the cost of the ideal STOL trip (100% LF) approximately $1 and the 40% LF STOL trip $2.15 for a 30 mile trip. The second would eliminate the 50¢ fare assumed for the Hudson River crossing. While these savings are significant, the cost trends, as discussed above, are not in any manner reversed. Therefore, the net effect of these cost reductions would be to lower the amount of subsidy required for the STOL system. It can, therefore, be concluded that due to the heavy required subsidies, an intraurban STOL transport system would not be feasible for the Long Island-New York City area.

Summary of Conclusions

A number of conclusions concerning the feasibility of a STOL mass transport system can be drawn from the work presented. It is possible to design an aircraft, using state of the art technology, that conforms with the

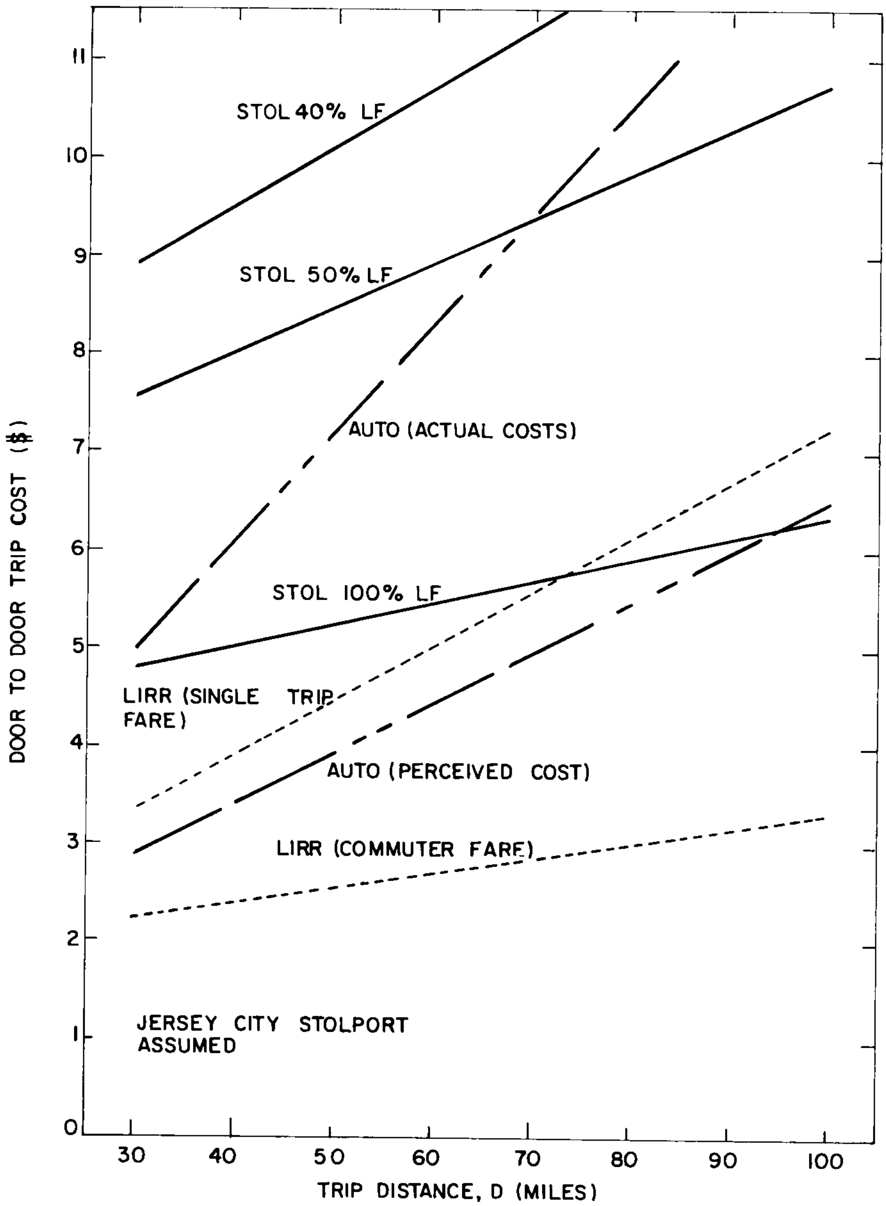

Figure 8. Modal door-to-door trip cost comparisons.

requirements for intraurban flight. Environmentally, such an aircraft would produce little pollution and its noise problem can be solved. However, though the STOL has little adverse environmental impact on its own, no significant improvement in the urban air pollution problem can be expected through the use of STOL aircraft as a substitute for the automobile because most auto trips originate less than 30 miles from the city, and the STOL cannot operate efficiently below this distance.

It was found that large increases in the airplane cruise speed did not produce correspondingly large decreases in the required trip time. This was due to the large portion of time lost in climb, approach maneuvers, routing, access to and egress from terminals, etc. In connection with this problem, it was concluded that a STOL terminal in the city center (Hudson River STOLport) is imperative if the STOL system is to be effective.

Economic comparisons have shown that the STOL system operating in the Long Island-New York City area would require extensive subsidization in order to be viable. The subsidies are needed to offset the effects of the low expected load factors caused by the large number of empty, or nearly empty flights, in the off-peak direction. (These empty flights are caused by the highly directional nature of the traffic flow on Long Island.)

The subsidies required for STOL service on Long Island would be better used to improve the Long Island Railroad. The purchase of high speed rolling stock, coupled with the implementation of express rail service would approximate the STOL travel time at distances between 30 and 50 miles and would reduce the STOL travel time advantage beyond 50 miles. In addition, improved and more efficient LIRR service would attract commuters at distances below 30 miles who now use automobiles. This, in turn, would have a significant effect upon the amount of air and noise pollution generated by the urban transportation system.

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