# A REVIEW OF EXISTING PRACTICES AND THE TOTAL SYSTEM COST APPROACH TO TRANSPORT AIRCRAFT SELECTION

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## Abstract

This paper provides some insight into difficulties encountered when a total-system-cost approach is used in selecting transport aircraft size. Included are brief descriptions of the partner relationship (manufacturer, airline, airport) that exists in the air transportation industry, the general process which airlines presently follow in selecting and purchasing aircraft, and the effect of the air industry's outlook for the future on airports and airline terminal problems.

## Introduction

As an air traveler and an engineer the author, of course, would like to see the United States air transportation industry operate at maximum efficiency. Selection of proper aircraft size to minimize total system cost is an approach suggested by Schoenfeld, (see pages 2-10 of this circular) and one that the Douglas Aircraft Company and others have proposed investigating. However, most airlines, at this point, would find a total system cost approach difficult to quantify in a practical manner. The problem is too complex and single-point control is lacking as explained later. Further, a proposal to significantly increase aircraft direct operating costs in order to obtain advantages in airport terminal design would be difficult for airlines to accept, especially in today's extremely competitive environment. Airlines, at present, do not seem to place the same degree of importance on airport costs as aircraft costs.

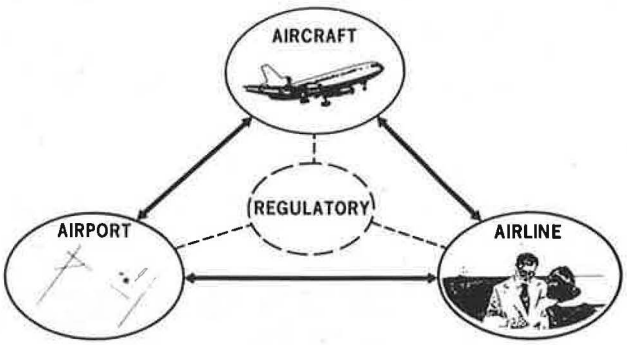
To appreciate the difficulties inherent in the total system cost approach to selecting aircraft size, some insight is needed into both the partner relations of the air transport industry and the process airlines follow in selecting new aircraft. To help provide such insight, this paper describes the industry partnership with its complexities, the manufacturers' attempts to design aircraft to exaxtly match airlines' needs, the aircraft selection process used by airlines, and the major factors that most often influence aircraft purchase decisions. Finally, the writer's thoughts and opinions are offered concerning the future of the industry and possible resulting effects on airport and airline terminal problems.

## The Industry Partners

The three partners involved in the United States air transportation industry are the aircraft manufacturers, the airlines, and the airports (Figure 1). Up to now, these groups have functioned well together. Our country has one of the best air transportation systems in the world and this has required considerable cooperation by the components of this system. Also, they operate under a common regulatory authority -- the Federal Aviation Administration. This partner system, however, lacks the means of achieving the lowest total aircraft system cost because there is no single point of control for establishing how costs and earnings should be shared. To complicate matters, each of these components have different objectives.

The aircraft manufacturers are in business for one reason -- to sell aircraft and make a profit.

Figure 1. Air transport industry.




It is a very competitive business. Many airframe manufacturers have gone out of business through the years. Only a few remain. The managers of these companies are responsible to corporate management and, ultimately, the company stockholders.

Airlines are interested in obtaining equipment and facilities that will allow them to transport passengers at a profit. Since deregulation, they have been operating in an increasingly competitive environment, as evidenced by recent financial failures and the difficulty that some are having in making a profit. The established carriers have to contend with higher labor costs than do the newer airlines which employ less costly non-union crews. It is also a very complex environment within which to operate as developing new markets, operating them, and continuing to make them profitable become more complicated. Interline cooperation has certainly been reduced. The correct approaches to solving these problems are not readily apparent and must be developed by people with good judgment and a good seat-of-the-pants feel for what must be accomplished to stay in business. Airlines must remain solvent to make the whole air transport system function.

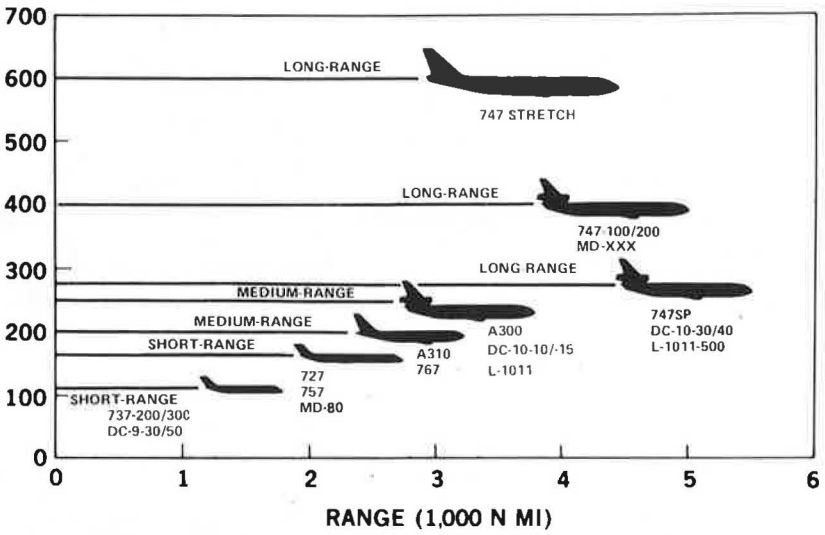
Airports are usually responsible to local government. At times they may be pressured by people within the community to improve airport access or allow increased air services. The airport manager must achieve these objectives in a safe manner while keeping congestion and air and noise pollution to a minimum.

Airports must also recover costs. Their biggest source of revenue is the airlines. They therefore receive a lot of pressure from airlines. Airline management has strong ideas about the terminal facilities they need to operate their aircraft and the flight frequencies they need in order to develop their markets. In addition, airports must also provide adequate airside facilities. Satisfying all these needs sometimes causes airports to compete for carrier business. Airport operators must achieve all these objectives within the political and environmental restrictions placed on them. These restrictions can make it very hard to expand an airport, or build a new one, in the United States today.

## Airframe Manufacturers' Offerings

Airframe manufacturers attempt to provide exactly what each airline wants to buy. The manufacturer continually studies airlines and their operations to be able to offer the right aircraft for each market. Figure 2 illustrates the results of these efforts. Shown are the available or offered jet transports ranging from a 110-passenger aircraft with a relatively short range to an extremely large, four-engine

Figure 2. Passenger aircraft (generic types).




aircraft with a capacity approaching 600 seats. In between are the twin and tri-jet narrow body and tri-jet wide body aircraft having from 150 to 300 seats.

Airlines are constantly conducting studies to determine the size of aircraft that best suits their needs and maximizes their profits. A broad range of different-size aircraft is available from which to choose at present. However, advances in technology and a preference for a particular manufacturer may result in one or more airlines requesting that a manufacturer build a new-design aircraft for a particular application.

## Aircraft Selection Process

The basic aircraft selection criteria used by many airlines are listed here:

- Market approach
  - Fleet plans
  - Traffic forecasts
  - Frequency
  - Flight banking
  - Expansion
- Operating costs
- Return on investment
- Replacement

Some airlines consider additional factors such as ease of ground service; special galley, lavatory, and seating configurations; improved flight deck technology, and reduced crew size, among others. The criteria listed above under Market approach are interrelated. The fleet plan is developed from market strategy and defines the number and mix of aircraft in the airlines. Traffic forecasts and route analyses help establish the fleet plan. Flight frequency is determined from existing needs, but often is increased at specific stations to build passenger traffic. Proper use of banking (the practice of having many hub and spoke aircraft in the hub airport at the same time) is very important in establishing efficient hub and spoke operations. Expanding existing markets or expanding into new ones is a continual goal.

Projected direct operating cost for a specific aircraft is one of the most important factors in deciding which aircraft to buy. Deregulation, high fuel costs, and the existing severe competitive environment have made Direct Operating Costs (DOC) a predominent factor when comparing aircraft for use in specific missions.

All of the issues mentioned above are significant when analyzing the anticipated return-on-investment (ROI) of an aircraft purchase. The bottom line in making a decision to procure new or additional aircraft is whether the anticipated ROI is sufficient to warrant risking the financial investment to obtain it.

Aircraft replacement is also an issue an airline must consider when purchasing aircraft. If an airline's existing aircraft must be replaced, these aircraft have different trade-in values with different manufacturers and under different financial arrangements. An airline also may choose to buy older-technology aircraft and replace them in a relatively short time in order to bridge technology and financial gaps. Political and environmental issues may also force an airline to replace aircraft. For example, quieter aircraft may be required for specific airports.

## Purchase decisions

What are the major factors which most often influence the majority of aircraft purchase decisions? Significant ones are listed below:

Direct operating cost
Seat size (passenger capacity)
Financial arrangement
Noise
Image/prestige
Politics

Every airline carefully reviews a new aircraft's projected DOC before deciding whether to buy it as this is one of the most important factors determining ROI. Major items affecting DOC are fuel burn and crew size, hence the recent emphasis on two-crewman flight decks and the engine manufacturers' efforts to improve turbine engine efficiency. The aircraft must be of the correct seat size (carry an optimum number of passengers). Many airlines are presently interested in an aircraft with approximately a 150-passenger capacity. Deregulation is having a significant effect on the size of aircraft that airlines will require in the future.

Probably the single most important factor in the purchase of an aircraft is the financial arrangements made with the manufacturer. Many factors are involved and many include the negotiated price, loan provisions, trade-in considerations, buy-back agreements, guarantees, and concession services.

Concessions may include spare parts agreements, product support, airport planning assistance, retrofit with higher technology equipment, etc. Douglas has recently been able to work out satisfactory lease/purchase agreement with some airlines instead of outright purchases. The company has found these arrangements to be beneficial to both parties.

Airport and aircraft noise is becoming an increasingly important factor for airlines to consider. Some domestic airports will only allow newer, quieter aircraft, such as Douglas' MD-80, to use their facilities. The John Wayne and Burbank Airports in California are examples.

Often, airline image or a country's prestige or politics will dictate the purchase of certain aircraft irrespective of an air carrier's needs.

## Outlook

What is going to happen in the future? It is not at all clear yet where the air transportation industry is headed. Because of deregulation, the competition between airlines is extremely severe and while larger existing airlines are experiencing financial problems, new small ones seem to be created almost daily. As a result, trip and seat-mile costs are taking on a new significance for some airlines while others purchase old, less fuel-efficient models. There is no doubt that some airlines will not be able to survive. Airport requirements are going to become more important in the future. As aircraft are changed to improve their efficiency, longer wingspans may influence runway, taxiway, apron, and gate clearance requirements. Noise considerations and operating slots may also limit aircraft selection.

## Conclusion

In the near term, airline efforts to increase profits will determine the size of aircraft they pruchase. Only the larger, more sophisticated airlines will be able to include detailed economic airport terminal considerations in their aircraft selection analysis. Airlines will consider other alternatives at length before accepting an increase in direct operating cost to alleviate aircraft terminal problems.

# APRON AND RAMP LIGHTING AT CHICAGO-O'HARE INTERNATIONAL AIRPORT

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## Abstract

The apron and ramp lighting at Chicago-O'Hare International Airport, which served the concourse aprons and service areas for twenty years, has become obsolete due to the traffic of larger aircraft and the need for more complex ground service operations. The low-mounted fluorescent system produces a limited lighting pattern and has become a burden in maintenance service costs. A new lighting system now being installed will overcome these inadequacies and satisfy O'Hare's modern-day visibility requirements for pilots and ground crews. High-mounted 1000 kw. high-pressure sodium cutoff luminaires are supplemented with low-mounted 150 kw. high-pressure sodium units.

## Introduction

The apron and ramp lighting at Chicago's O'Hare Airport, which served the concourse aprons and service areas for twenty years, has outlived its usefulness. Over the years, as larger aircraft, heavier traffic, and greater need for more complex ground service operations developed, the original lighting system has become obsolete due to high operating costs and inadequate performance.

The present system consists of fluorescent luminaires mounted on davit-type poles located on the rooftops of the concourse buildings. Each luminaire contains four 72-inch long, very high output fluorescent lamps, enclosed in a wraparound acrylic lens. The luminaire is inclined at 50° above the horizontal and is approximately 36 feet above the apron.

The illumination levels are very low and fall off rapidly to 0.2 footcandles at a distance of only 100 feet away from the concourse buildings. (See Figure 1) These lighting levels are further reduced during Chicago's severe winter weather due to the effects of low temperatures on fluorescent lumen output.

Another objection has been the direct glare to pilots who approach the terminal gate area with jumbo jets with cockpit eye level at the fixture mounting height. (See Figure 2) There is no directional control of the light output; and the low mounting height, compared with the larger airplanes, causes shadows in the service areas where the visual tasks include baggage handling, refueling, and access to power pit connections.

Extensive fixture maintenance has been necessary due to the dimensional instability of the gasket-mating surfaces with the plastic lenses. Leaks at the ends of the fixtures collect dirt and insects, which results in substantial reduction of luminaire efficiency. Rain and snow enter the fixture, short-circuiting and destroying lamp sockets, ballasts, and other components. Frequent servicing must be performed by a full crew of electricians using special aerial trucks that must occupy the apron areas. This interferes with ground service operations and the aircraft movement.

## Proposed Lighting System

A "Lighting Study of Aprons and Ramps" was commissioned to investigate new technological developments, to increase efficiency of the ground service operations, and to enhance safety.

During the course of the study, numerous other airport lighting arrangements, both in the United States and abroad, were examined, and a literature search was made.

The study suggested

(a) relighting program for replacement of the rooftop fluorescent lighting that uses the latest state of the art in lighting design to provide adequate illumination, and

(b) prototype, or experimental, installation of three sets of poles and luminaries to be evaluated prior to proceeding with the final design of the construction contract documents (this would insure acceptable solutions to all the diverse requirements for the final design).