Handling People in Long-Haul Air Transportation

MILTON HEINEMANN*
The Boeing Company, Renton, Wash.

Airport and airline facility planners face a very difficult task. Air passenger transportation could easily triple in the next ten years. This means that passenger handling facilities will have to be greatly expanded and improved within the near future. Unfortunately, no single solution can resolve this growth problem, because of the varying needs of different airlines and airports throughout the world. However, airplane manufacturers can assist facility planners by designing airplanes that not only transport large numbers of passengers but that also contribute to increased efficiency in passenger handling. This paper indicates how The Boeing Company is designing the Model 747 to optimize passenger handling efficiency over a broad range of airport facilities. For the purpose of this paper, a system analysis approach is employed to define the total flow of passenger activities from the origination to the destination point. Passenger activities are isolated and studied to find how airplane design can improve their efficiency. This system analysis approach is used only for rhetorical purposes; it is not the actual design approach used.

Checking In

WHEN today's passenger arrives at the air terminal, he faces the time-consuming chore of having his ticket verified, receiving his seat assignment and gate pass, and tagging his baggage. Then while he waits to board, his baggage is put on carts, pulled across the loading ramp, and lifted into the belly of the airplane. This process is now obsolescent because of increasing number of air travelers.

Today's tedious check-in procedure can be greatly simplified by using an automated system. Through extensive coordination with the airlines, Boeing has designed the size and shape of baggage containers to match the lower lobe of the 747 for maximum volumetric and structural efficiency. The containers (Fig. 1) are wind- and rain-proof, so they could be placed on curbs convenient to passengers arriving at the terminal. If the airlines used a color-coding system for passenger and baggage handling, the baggage containers could be color-coded and numbered to match the passenger's check-in ticket. Passengers could load their baggage directly into containers. A possible sophistication of this system might employ containers with individual compartments much like terminal self-checking baggage lockers. The baggage containers could be automatically moved to the airplane and laterally transferred into it (Fig. 2). The Model 747 can hold 30 of these containers loaded with over 5000 ft³ of baggage.

Boarding

The next problem concerns loading large numbers of people into the 747 quickly and efficiently. Passenger flow can be greatly simplified by dividing the passengers into small manageable groups. Boeing has designed five double-width doors on both sides of the fuselage. These 10 doors give great loading flexibility, help speed loading, and enable groups of passengers to enter the airplane quickly. Figure 3 shows how this division concept can be extended to air terminals. Here, the waiting area has been split into three lounges.

Studies have shown that the waiting area or lounge need not be as large as the total capacity of the airplane. Because the arrival rate of passengers entering a waiting lounge is predictable, the lounge size is dependent upon the flow of pas-

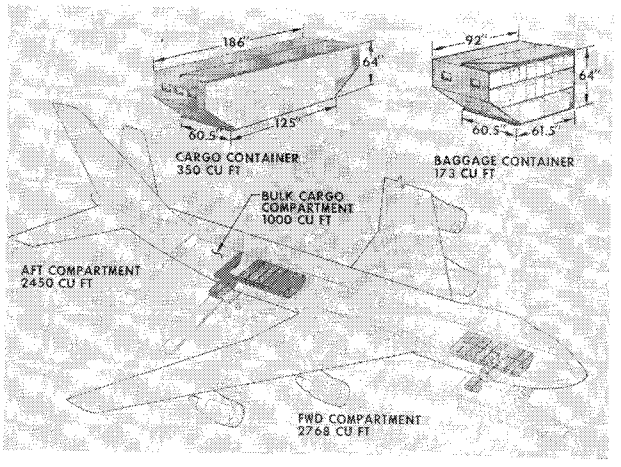

Fig. 2 Baggage container loading.

Fig. 1 Loading baggage.

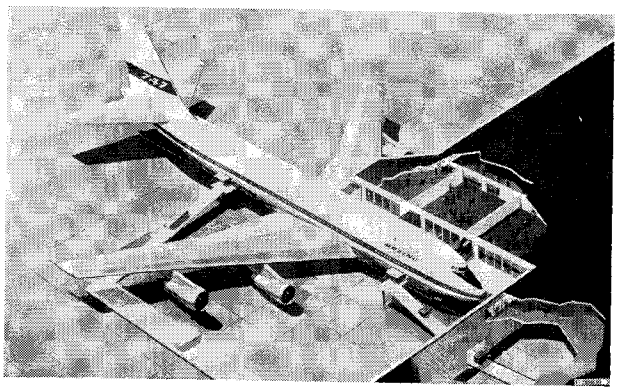

Fig. 3 Waiting area.

Presented as Paper 66–843 at the AIAA Third Annual Meeting, Boston, Mass., November 29–December 2, 1966; submitted December 19, 1966; revision received August 11, 1967. [1.04]

* Chief Project Engineer, 747 Payload Systems.

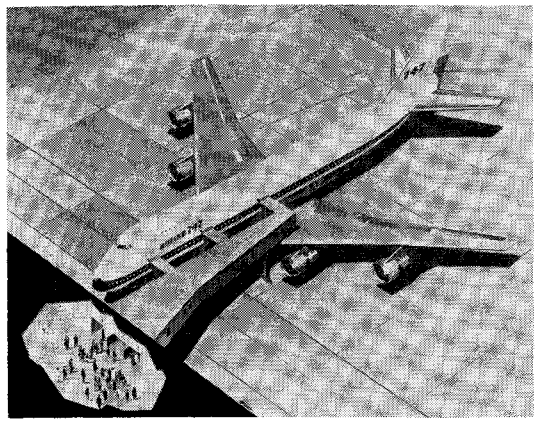

Fig. 4 Cantilevered loading ramp.

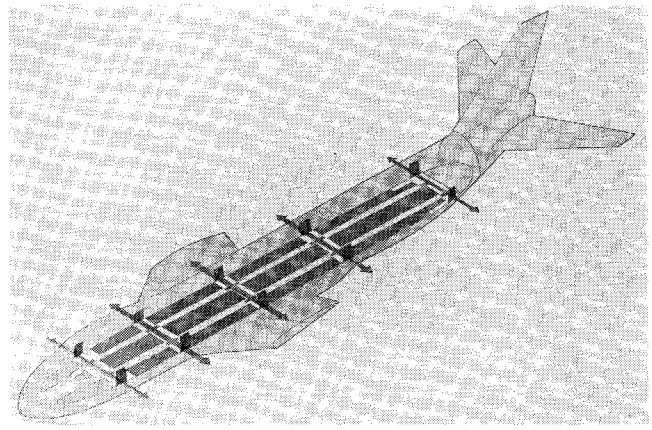

Fig. 7 Doors and aisles.

sengers through the lounge and into the airplane. This flow is dependent, in turn, upon the boarding rate (number of airplane entry doors) and the duration of boarding (how soon boarding is begun before departure). If the airlines use three of the 10 entry doors on the 747, they can easily board a typical load of 360 passengers in 6 min; however, lounge space would be required for almost all of the passengers. But, if

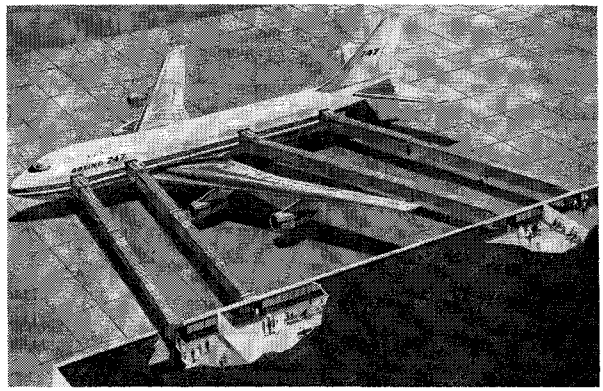

Fig. 5 Passenger bridges.

boarding were begun 30 min before departure, only 40% of the passengers would require lounge space. It is apparent that the sooner boarding is begun, the smaller the lounges need be.

Figure 4 shows a cantilevered loading ramp designed to move passengers from these waiting rooms into the 747. This three-finger ramp leaves the entire right side of the airplane available to service personnel for cleaning, galley servicing, maintenance, and baggage handling. Conventional passenger bridges are shown in Fig. 5. For airports loading passengers remote from the terminal, a track-mounted bridge can be employed to divide both passengers and baggage into small manageable units for ease of loading. Another method for loading passengers on airplanes parked some distance from terminals would employ passenger transporters (Fig. 6).

The 747's 42-in. doors permit two-abreast passenger entry into a 20-ft-wide cabin designed for comfort, accessibility, and efficient passenger movement. Cross aisles, which connect opposite doors to create flow at intermediate sections, divide the interior into five basic zones. These zones make greater seating flexibility available to the airlines (Fig. 7).

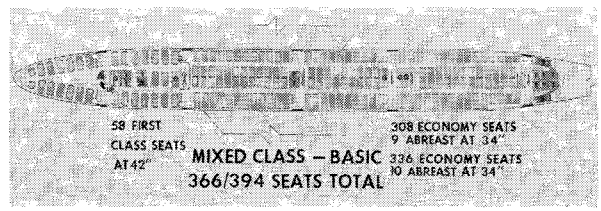

Fig. 8 Interior arrangement.

The interior of the airplane is organized flexibly to permit a wide variety of seating arrangements. In a 9-abreast, mixed-class arrangement (Fig. 8) seats are 10% wider than in present airplanes. Two wide aisles of the 747 permit easier passenger access and egress than do today's airplanes, which have a single aisle for 6-abreast seating. In a 10-abreast arrangement, no aisle in the 747 serves more than five passengers per row.

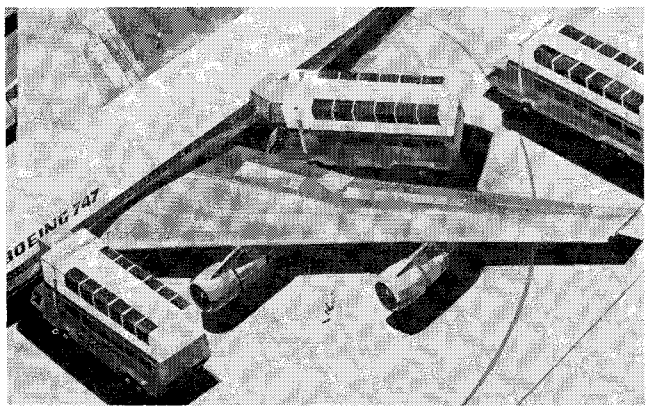

Fig. 6 Transporter.

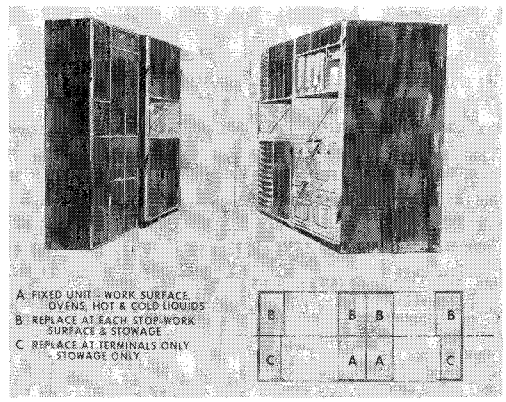

Fig. 9 Modular galley.

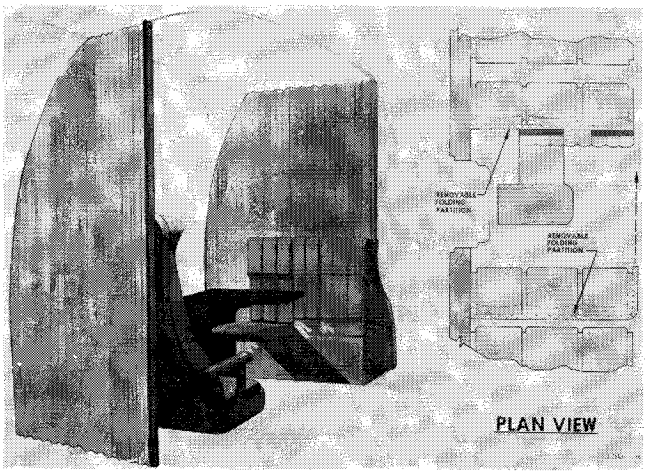

Fig. 10 Customs station.

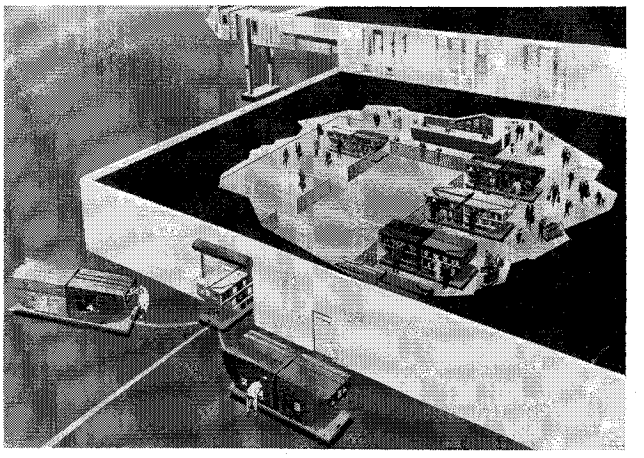

Fig. 12 Baggage pickup containers.

Five service stations (three toilet and two galley areas) are placed along the five cross aisles and represent the hub of passenger flow. Passengers can easily disperse along the longitudinal aisles intersecting the cross aisles without any traffic bottlenecks. Also, food service is greatly improved by locating the galleys in the center of the serving areas.

The wide cross section gives a feeling of spaciousness that does not exist in today's transports. This wide cross section has nearly vertical walls and features full headroom, thus eliminating stooping by passengers entering seats next to windows. This wide cross section was also selected for its ability to carry 8- × 8-ft-cross-section containers side by side on the main deck of freighter versions of the airplane.

Because the cockpit is placed over the main deck, the entire deck can be used for passenger seating. The extra space behind the cockpit can be used as a lounge, a stateroom, or a conference room.

Travel to Destination

During flight, passengers will discover that the airplane has been designed for a full range of entertainment facilities. In additions to taped music and TV, movies can be shown either in a single theater area or in various sections of the airplane. Even the food service has been improved through the use of large modular galleys (Fig. 9). These galleys reduce serving time by permitting automated dispensing. They also reduce airplane turn-around time because entire units can be immediately replaced by fresh units. The A units, composed of work surfaces, ovens, and hot and cold liquid areas, remain fixed in the airplane at all times. The B units are replaced at each stop and the C units are removed only at destination. By taking advantage of the 747's large doors and wide aisles, these units can be removed and taken directly to the sky kitchen in the terminal, where they are cleaned and replenished for later use.

Lavatories require fresh linen, drinking cups, soap, and other amenities. On the 747, the lavatories are organized so that supplies can be kept within a single unit that can be quickly exchanged with a freshly stocked unit by ground personnel.

On international trips, passengers must now clear through customs of the country they are entering. To expedite customs inspection, a station for a government official could be installed either on the main deck (Fig. 10) or behind the flight deck. Thus, time during flight could be used for customs processing.

Deplaning

The 747's wide aisles contribute to easy passenger exit. Once passengers have left the airplane, they will be able to pick up their baggage immediately. The baggage will be automatically transferred to the terminal and placed where it can be easily claimed by passengers. One method of facilitating baggage retrieval employs two large carousels (Fig. 11) where passengers can get their baggage as soon as it comes off the airplane. Another method involves moving the con-

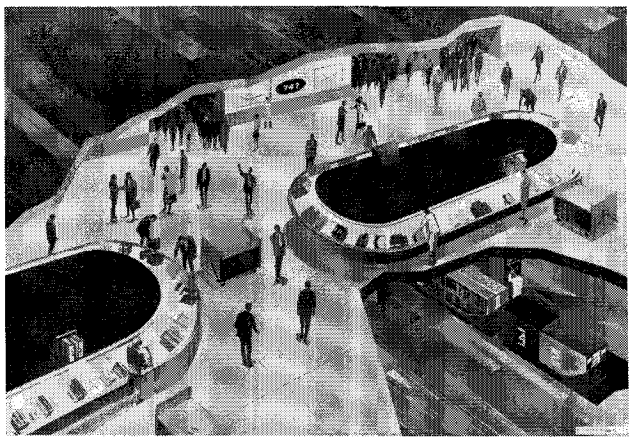

Fig. 11 Baggage pickup carousel.

Fig. 13 Evacuation slide.

tainers into a concourse where passengers can take their baggage from the proper color-coded containers (Fig. 12).

Safety in Handling People

This concludes our analysis of passenger handling under normal conditions. A word about safety is appropriate here. The 747 has been carefully designed for easy and rapid passenger evacuation during emergency situations. In a typical passenger section holding 90 passengers, four double-size doors are available for exit; and no passengers are further than approximately 20 ft from a door. Practical tests have demonstrated the capability of deplaning a full passenger load in 90 sec. This fully meets Federal Aviation Administration requirements for emergency evacuation. Automatically inflatable slides are stowed in each door. A manual backup is provided for actuation by cabin attendants. The width of each slide allows two passengers to deplane simultaneously and permits an uninterrupted flow from all doors until evacuation is complete (Fig. 13).

Conclusion

Ever-increasing numbers of air travelers are crowding terminals. Passenger handling problems are rapidly growing more serious, and require not only the attention of airport and airline operators but also the best efforts of airplane designers and manufacturers. Designers of the 747 analyzed problems relating to passenger flow and found major bottlenecks involving baggage handling, passenger flow into and within the airplane, customs inspection, deplaning, and recovering baggage. As a result, the Model 747 airplane is designed to receive and discharge passengers with unparalleled speed and ease. The Boeing 747 demonstrates how an airplane manufacturer can make a significant contribution to better passenger handling through improved airplane design.

NOV.-DEC. 1967 J. AIRCRAFT VOL. 4, NO. 6

A Logistics-Independent Oxygen System for Military Aircraft

R. A. WYNVEEN*
TRW Equipment Laboratories, Cleveland, Ohio

The requirement to provide a reliable source of breathing oxygen for aviators flying at high altitudes has traditionally been met by providing a sufficient amount of oxygen for each flight prior to takeoff. Storage and maintenance of quantities of high-pressure or cryogenic oxygen on board aircraft pose significant logistics and safety problems. Provision for the production, storage, and transportation of aircraft oxygen at combat air bases poses additional safety hazards and levies a significant cost in training and surveillance. TRW has developed a technique that extracts oxygen from atmospheric air at the time and place it is needed. This technique seems well-suited to aviation application in that the source of oxygen could be cabin air and the storage and transport of quantities of pressurized gas or cryogenic liquid would be avoided. The approach conceived at TRW is simple: only sources of air and electrical power are required to separate pure oxygen from the inert gases and impurities found in the air. The concept is based upon electrochemical technology and utilizes an electrochemical cell design that is lightweight, compact, and includes all the features necessary for operation independent of orientation or gravitational forces.

Introduction

THE requirement to provide a reliable source of breathing oxygen for aviators flying at high altitudes or under adverse conditions has traditionally been met by providing a sufficient amount of oxygen for each flight prior to takeoff. The oxygen is stored on board as either a high-pressure gas or a cryogenic liquid. Of these two methods the cryogenic or LOX system has gained the widest acceptance, because it requires a lower weight and volume per unit quantity of stored oxygen.

Of the many reasons that have been cited for developing a new oxygen system, the major ones are 1) to eliminate the ground support facilities for generating, storing, and transporting the liquid oxygen†; 2) to eliminate between-flight servicing and the costs associated with training personnel to carry out such servicing; and 3) to provide for increased safety and comfort to the pilot and increased safety and versatility for the aircraft.‡

In summary, the reasons for developing a "next generation" oxygen system for aviators can be expressed as follows: to

Presented as Paper 66-787 at the AIAA Military Aircraft Systems Meeting, Dallas, Texas, October 18–19, 1966; submitted February 27, 1967; revision received August 22, 1967. The author wishes to acknowledge the support received for this work from the TRW Equipment Laboratories, W. A. Johnson, General Manager, and the U.S. Air Force. [2.09, 12.01, 12.14]

* Program Manager, Aviator Oxygen System Development.

† It takes more than ten men to operate a LOX generating plant on a 24-hr-a-day basis. Each man requires almost a year of special training at a cost to the Government of over $5000. The modern, transportable LOX generating plant costs over $300,000 with one plant needed per squadron. A critical problem that occurs in a Vietnam-type conflict is that one carefully placed bullet can completely put this ground support equipment out of business. The result is that an entire squadron of aircraft loses its source of aviator's breathing oxygen.

‡ As an illustration of the need for increased aircraft versatility, one can cite the recent challenge Hon. H. Brown gave to industry to help make our present and future-generation aircraft more versatile by working on those characteristics and equipment that will result in "...aircraft (that are) more reliable, economical, and effective."[2]