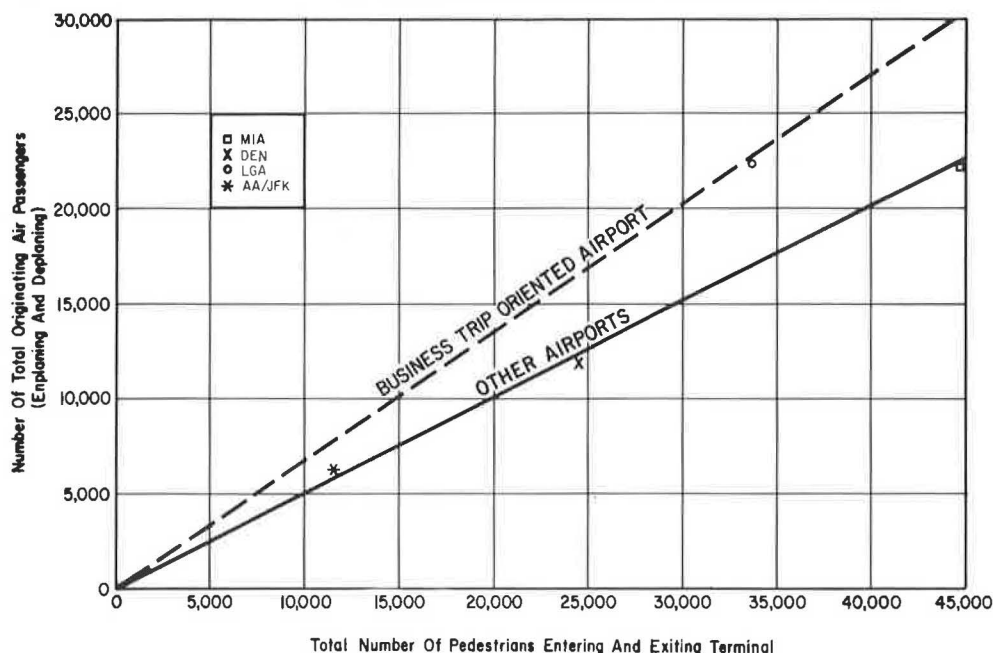


Figure 5. Pedestrians entering and exiting the air terminal versus numbers of originating air passengers.



ment used and the nature of the passenger. For functional planning purposes, however, these values have been presented to indicate the levels of activity that can be expected.

These values have been prepared as an aid to the user in forecasting levels of activity that may be expected at airports. Since each airport has its own peculiarities, only ranges and levels of activity for overall planning purposes are presented and not absolute factors.

ACKNOWLEDGMENT

We would like to thank the Transportation Systems Center, U.S. Department of Transportation, and American Airlines as well as the air carriers, airport operating agencies, and officials who supported and cooperated in the data collection for this research.

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Publication of this paper sponsored by Committee on Airport Landside Operations.

Two Programs to Ease Automobile Congestion at Los Angeles International Airport

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Two programs that have had a positive impact on alleviating automobile congestion at Los Angeles International Airport are discussed. One program consists of reduced-rate off-airport parking lots and free tram service to the terminal buildings. Two lots that provide a combined total of about 11 400 parking spaces are currently in operation. The other program, the FlyAway Bus, is an express bus service that transports people to and from Van Nuys, a large suburban community 32 km (20 miles) north of the airport. The ser-

vice includes low-cost parking for up to 15 days at the suburban bus terminal. The success of both programs is significant not only because of their current impact on airport congestion but also because of their potential for expansion to broader uses in the future and because they prove that the public can be persuaded to trade the privacy and control of the automobile for the efficiency and convenience of public trams and buses.

It has become increasingly obvious over the past 10 years that the item most likely to inhibit the orderly growth and development of Los Angeles International Airport (LAX), as well as some other major airports, is the automobile. Those who are familiar with the Los Angeles metropolitan area know that it is a large, sprawling complex that encompasses more than 2500 km² (1000 mile²) of dense urbanization and houses roughly 7 million persons. Mild weather promotes an active out-of-doors life-style characterized by a pervasive and casual mobility. Although there is no high-density mass transit and only a recently developing municipal bus system, there is a rather comprehensive roadway and freeway system: hence, our love affair with the automobile. In Southern California, when most people want to go somewhere, they take their automobile because it is not only the quickest, most direct, and most convenient way to get there but perhaps the only way.

Unfortunately, this holds true for getting to the airport as well. As LAX grew from 18 million passengers in 1967 to 23.5 in 1973, a squeeze developed in the roadway and parking components of the system. In the early 1970s, the Los Angeles Department of Airports began to look for alternate modes of transporting people to and around the airport and more land-efficient places to sequester automobiles.

To provide relief from vehicle congestion on roadways and in parking lots—the most critical and impending problem—the department initiated two major programs:

1. A program to provide peripheral parking lots attempts to address the problem by inducing airport patrons who are determined to travel to LAX in private automobiles (automobile trips account for more than 80 percent of all trips to and from the airport) to park in lots some distance from the central terminal area and take a free tram to the terminal of their choice.
2. The FlyAway Bus program attempts to motivate airport patrons to leave their automobiles either at home or at a suburban low-cost parking facility and take a limo-bus to LAX.

PERIPHERAL PARKING LOTS

The concept of the peripheral parking lot had already been in operation at LAX for nearly 10 years. Its benefits were somewhat obscure, however, until recently, when increasing passenger volumes began to affect roadway and parking lot service levels. At some point, especially during periods of peak activity, supply and demand began to converge, and the peripheral parking lot became an alternative whose time had come.

The original lot—for "very special parking" (VSP)—initiated service in June 1968 on a 10.4-hm² (26-acre), department-owned site located on airport land 3.2 km (2 miles) southeast of the central terminal area (see Figure 1). For a nominal fee (\$0.25 for 6 h or \$1 for 24 h), patrons used a 1000-space lot and got a free tram ride to the central terminal. The trams ran every 10–15 min. By July 1969, the lot had been doubled in size to 2400 spaces and was showing a small profit. Today, the 17-hm² (43-acre) VSP lot provides almost 6000 parking spaces, an enclosed waiting area with restrooms and vending machines, porter service to handle bags, and bus service to the ticketing buildings—all for a parking fee of \$0.50 for 6 h or \$1.50 for 24 h. Last fiscal year the VSP lot served well over half a million persons.

The second peripheral lot, lot C, is located in the easterly clear zone of the north runways, about 0.8 km (0.5 mile) northeast of the terminal area, on a 64-hm² (160-acre) parcel that was once residential (Figure 1). The land had been determined unsuitable for residential

use because of aircraft noise and subsequently condemned. Since clear-zone uses permit automobile parking—and there was a great need for more parking—the Los Angeles Department of Airports began a complicated 10-year acquisition program that involved more than 50 public hearings and much legal involvement to remove the single-family residences. The next obstacle to be tackled was obtaining clearance from a number of governmental bodies to change this residentially zoned and developed land into a parking lot. The actions were undertaken in stages, and acquisition of certain parts of the land is still in process.

The first phase of lot C was completed, however, and opened for business in October 1975. It provided 2200 parking spaces plus tram service to the terminal area ticketing buildings for a parking fee of \$0.50 for 3 h and up to \$2 for 24 h. The lot was quickly expanded to its present size of 5400 spaces, including a tram terminal, porter service, and a lift-van service for the handicapped. Patronage has grown steadily, and during fiscal year 1976/77 lot C served more than half a million persons.

Expansion of both the VSP lot and lot C is currently programmed. The 5000-space expansion of lot C has larger implications because it includes provisions for the relocation of all U-Drive rental automobiles and ready-up equipment currently based in the central terminal area. This would make approximately 3.2 hm² (8 acres) available for much-needed short-term public parking. LAX currently provides nearly 19 000 automobile parking spaces for the traveling public. For short periods of time during the 1977 Christmas holidays, the remote parking areas operated at capacity.

A major planning study will soon be completed by DeLeuw, Cather, and Company that will provide recommendations for long-range capital improvement projects to maximize vehicle and passenger access to the LAX terminal area. Some of the alternatives being evaluated in the study include an elevated two-lane roadway for high-occupancy vehicles, an elevated semi-automated guideway, and an elevated four-lane roadway that would be open to all types of vehicles. An important benefit of any one of these systems will be reliable service to the peripheral parking areas, which by 1985 may be servicing as many as 8 million passengers annually, or approximately 20 percent of all passengers who use the LAX facility.

FLYAWAY BUS

The FlyAway Bus was designed to transport to LAX persons who are located in the San Fernando Valley, which is centered about 32 km (20 miles) north of LAX (see Figure 2). The purposes of the program were to (a) promote decreased roadway congestion, (b) reduce parking facility requirements, (c) delay passenger capacity saturation, and (d) provide better levels of service.

The Van Nuys area was chosen as an ideal test area for several reasons: It was reasonably far away and was served by only one freeway, I-405, which runs directly to LAX; it contributed a large market share (about 15 percent) of LAX's passenger volume, about 88 percent of which traveled to and from the airport in private automobiles; and right in the middle of it was located a large piece of real estate owned by the Los Angeles Department of Airports—the Van Nuys Airport, a general aviation facility. Van Nuys Airport had a building that, with a modicum of remodeling, was suitable for use as a bus terminal, as well as an adjacent piece of land large enough to accommodate about 1400 automobiles. An economic feasibility study completed in May 1973 concluded that, if given active promotion and support, a

Figure 1. LAX peripheral automobile parking.

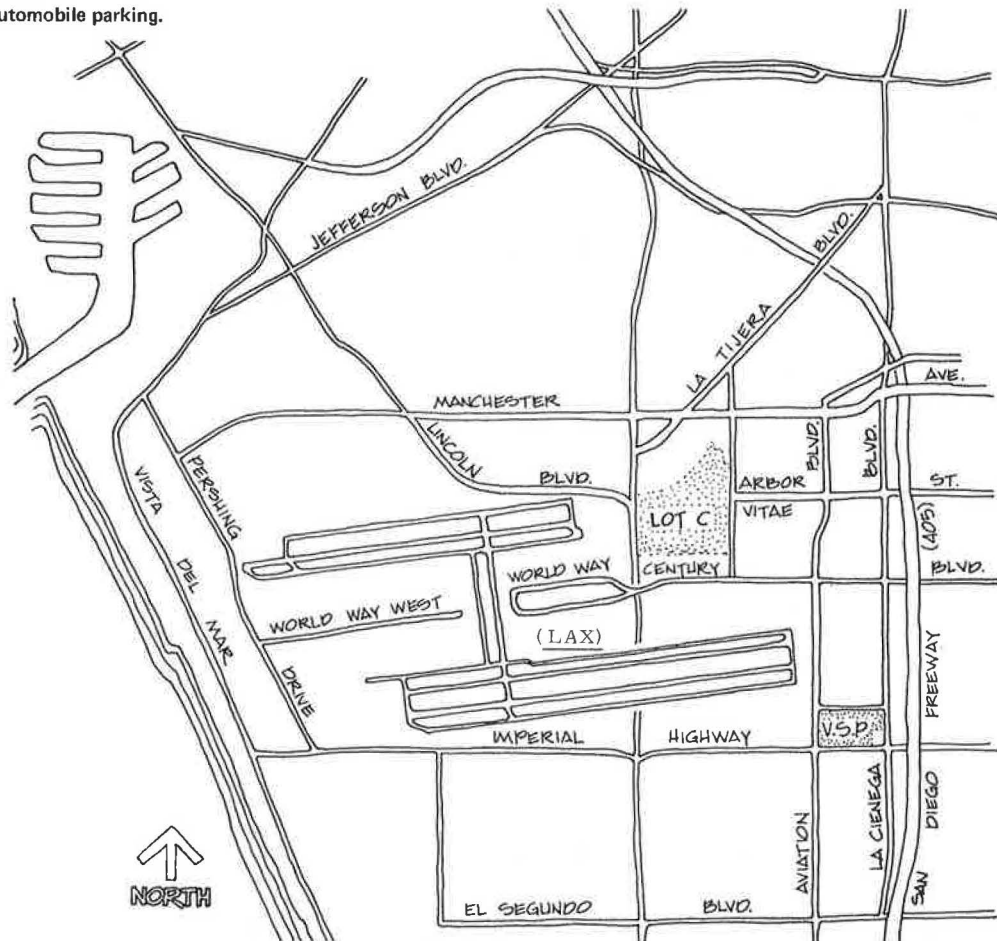
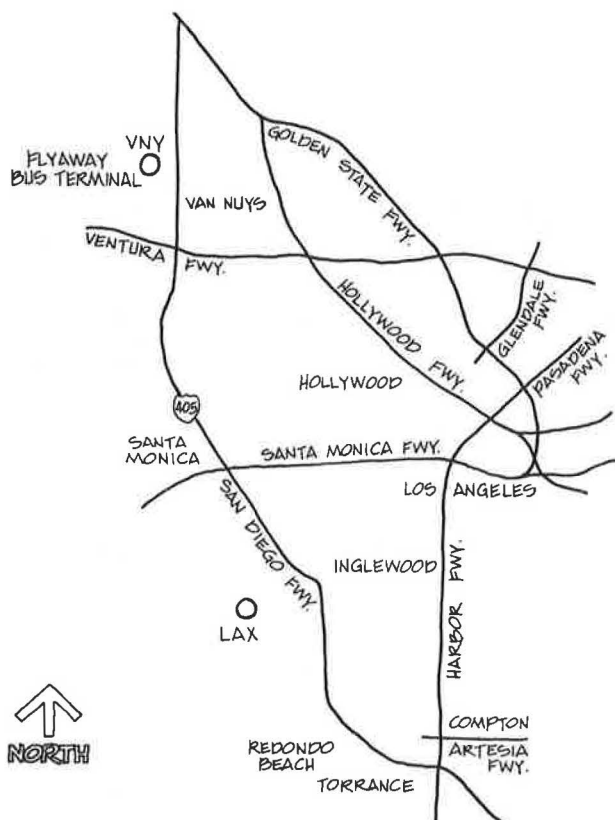


Figure 2. Location of FlyAway Bus terminal in relation to LAX.



limo-bus service from Van Nuys to LAX would capture 270 000 riders/year within six years of operation. It was felt that a successful operation would depend on frequent service, something not previously offered to the traveling public.

Service was inaugurated on July 10, 1975. Six 38-passenger Neoplan buses, purchased for the purpose by the department, made 44 round trips/day. The adult fare was \$5/round trip or \$3 one way, and the children's fare was \$1.50 one way. Once arrived at LAX, the buses circled the central terminal loop, making stops at each ticketing building.

The system got off to a relatively slow start, but within a year it was exceeding predictions, serving more than 27 000 passengers/month. By the end of 1976, the annual passenger volume exceeded 275 000, and by the end of 1977 it was more than 315 000. One unexpected occurrence was the degree of participation among airport employees.

The FlyAway Bus service operates out of a 300-m² (3300-ft²) area in a building nearly twice that size and utilizes a 1400-space parking lot. Passenger fares remain the same as they were when the program began, but parking fees have been increased to \$1 for a maximum of 15 days' parking to discourage long-term parkers. In comparison, parking in the central terminal area at LAX is \$6/day and, in the two peripheral off-airport lots, \$1.50 and \$2/day, which includes a free tram ride to and from the terminals.

In view of the rapid growth of patronage experienced during the short operating life of the FlyAway Bus, we are now looking at several expansion alternatives for the Van Nuys bus terminal. One is to modify and put to use the additional area in the existing building and expand

the existing parking lot by 35 percent to about 1900 spaces. Such improvements should be adequate to handle the 620 000 annual bus passengers expected by 1985, when LAX is expected to be serving 40 million annual passengers. Another alternative is to replace the existing facility with a new one on an available piece of land about 0.8 km (0.5 mile) away, perhaps combining it with terminal facilities and administrative offices. This does not appear to be cost effective at this time.

The most promising aspect of the FlyAway Bus program is its potential for accomplishing the very goals for which it was created—that is, reducing roadway congestion (especially in the central terminal area) and parking facility needs, delaying passenger capacity saturation, and providing better levels of service.

Although the current impact of the FlyAway Bus on the LAX system is relatively small, the implications of the concept are decidedly large. An expansion of the service to cover suitable population centers throughout the service area could and would have considerable impact on ground transportation activity, reducing congestion both on roadways and in parking lots and ultimately constituting a first step in changing the automobile-dependent traveling habits of the local population.

CONCLUSIONS

In calendar year 1977, LAX served more than 28 million annual passengers. This represents a growth of about 9 percent over the previous year. Average daily automobile traffic in the central terminal area grew less than 4 percent over the same time period. This substantiates the success of both the FlyAway Bus program and the expansion of the peripheral parking lots. An expanded and improved FlyAway Bus program and a faster, more convenient transportation system from the peripheral parking lots to the central terminal area should make it possible to efficiently accommodate the forecast demand of 40 million annual passengers at LAX in the mid-1980s. Beyond that point, because of the constraints of off-airport traffic, the Los Angeles Department of Airports must look to other airports—most notably Ontario and Palmdale International—to carry the load.

Publication of this paper sponsored by Committee on Airport Landside Operations.

Behavioral Analysis of Verbal Interaction Between Pilots and Air Traffic Controllers

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The principles of behavior theory are used as the basis for a study of the verbal interaction between air traffic controllers and airplane pilots. The danger created by the diversity of rules and regulations that govern the behavior of pilots and controllers is shown to be a primary reason for such an analysis. Basic concepts of behavior theory are discussed in relation to air traffic control operations. Graphs compiled by using tape recordings of pilot-controller conversations are used to analyze cumulative word rates and speech content. The analysis reveals problems such as a high speech rate among air traffic controllers and aberrant patterns of behavior and response among pilots. Further application of the principles of behavior theory to air traffic control operations is recommended.

Demands are continually made on people to respond to an untold variety of "signals". How they react to those signals determines how they will respond to comparable signals in the future. The lack of a consequence can alter their future reaction to comparable signals even if their first reaction was appropriate.

The formalized study of such phenomena has developed into a body of knowledge referred to as "behavior theory" (1,2). The most important aspect of behavior theory is the three-part reinforcement contingency: In reaction to a discriminative stimulus, a response occurs, which in turn evokes a reinforcing stimulus. It is the reinforcing stimulus that can modify the nature of future responses, for it can either

strengthen or weaken behavior. The absence of a reinforcing stimulus leads to a variety of responses because there is no guidance as to the desirability of any one response.

The work described here was conducted by a behavioral psychologist in consultation with a research team that included an expert in transportation safety and a transportation specialist who is also a pilot. The following information sources and data were considered:

1. The interface between the airplane pilot and the air traffic controller, including the rules and regulations each is required to follow;
2. A significant number of National Transportation Safety Board (NTSB) reports on aircraft accidents and incidents;
3. Background visits to a control tower and an approach control facility; and
4. Tapes of conversations between pilots and air traffic controllers in a number of situations, including an accident and a near accident.

The tapes do not include all conversations of the parties involved, since the pilot could well be involved in cockpit conversations and the air traffic controller in con-