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Airport Access: Case Study of a Remote Terminal Operation

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Interest has developed in recent years in remote airport terminals as a means of reducing landside congestion at metropolitan airports. A prime consideration in assessing the suitability of the remote terminal concept for a particular airport lies in its economic feasibility (i.e., Can it attract sufficient patronage and be operated efficiently enough to be cost effective?). This paper analyzes the costs of operating the FlyAway bus system, an express bus service that links Los Angeles International Airport with a suburban area that contributes about 15 percent of the airport's passengers. Although it does not offer baggage check-in, other services, such as ticketing, are offered on a limited basis and expansion to a full-service remote terminal is a distinct possibility in the future. The objective is to identify actual costs relative to all aspects of the operation to assist planners in determining the costs of such systems for other airports. Included are overviews of physical characteristics, operational problems, passenger market segment, airport and bus patronage growth rates, cost-revenue ratios of bus operation and terminal maintenance, bus fuel price impacts, foregone bus terminal site rental income, break-even patronage, facility replacement costs, and prognosis for future activity. After five years of operation, many of them beset with problems, FlyAway appears to be thriving. A recent passenger survey revealed that much of the system's attractiveness lies in its economical fare, frequent headways, low-cost parking, and dependable service. As passenger volumes rise and roadway capacity continues to be stretched beyond design standards, remote terminals offer the best hope for alleviating airport congestion on the ground. FlyAway demonstrates that, not only do they work, but they work well and cost effectively.

Enthusiasm for new rail systems for express ground transportation service to airports has been dampened by mechanical malfunctions, design inadequacies, and the high capital expenditure associated with building and operating such systems. Therefore, many airport operators are turning to express bus services as an alternative to expensive (in terms of cost and land use) roadway and parking lot expansion. Express buses have a number of decided advantages over other forms of transit:

1. Buses are relatively affordable, they generally cost about \$120 000 for standard models;
2. Buses are dependable and durable, the art of bus design and construction is rather advanced;
3. Buses require minimal start-up time for initiating service because buses generally require no special roadway adaptation or elaborate driver training;
4. Buses may be disposed of readily if a system is unsuccessful in attracting patrons because there is a large market for used buses in the United States; and
5. Buses are adaptable in route selection because

they are free moving and are not bound to fixed guideways.

Given all these positive characteristics and an awareness that the ground access network at Los Angeles International Airport would soon be inadequate if forecasts of passenger demand were accurate, the Los Angeles Department of Airports inaugurated the FlyAway bus service on July 10, 1975. FlyAway was a pilot express bus service designed to provide residents of the San Fernando Valley--a large sprawling suburban community located 20 miles (32.2 km) north of the airport--with a direct bus line to Los Angeles International Airport. The motives for creating this service included the following (1):

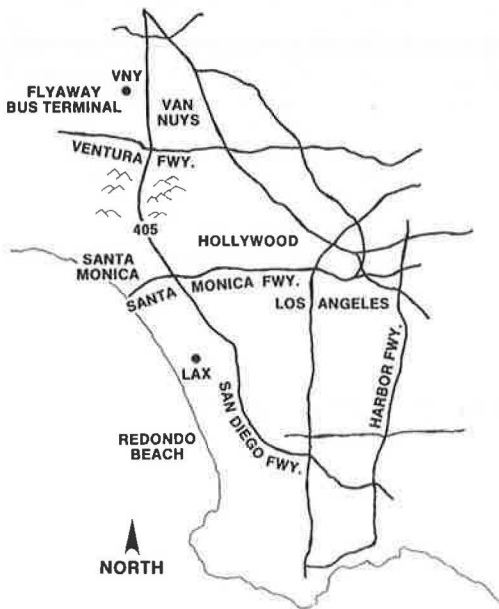
1. Establish a pilot program to study the effectiveness of the remote terminal concept;
2. Alleviate curb-side and parking lot congestion at the airport;
3. Alleviate airport, roadway, and freeway vehicular congestion (2);
4. Conserve energy; and
5. Reduce air pollution.

Most importantly, given the prevailing ground access modal split of 90-10 for private automobile versus bus or limousine transport (3), the airport's central terminal area roadway had a passenger capacity of approximately 28 million passengers annually, which is well below the capacity of the runways and terminal buildings. Consequently, the primary physical constraint to growth at Los Angeles International Airport was ground access capacity.

This problem was due not to faulty design but rather to optimistic planning. The airport had been built under the assumption that a complete freeway network would encircle it and bring traffic from all directions. A set of underground tunnels had also been planned to channel traffic from airport environs directly into roadways and parking lots at the western end of the terminal area loop (4). These improvements were supposed to eliminate bottlenecking at the airport's main entrance, reduce queueing at the curb sides, and relieve congestion on the interior roadway.

Unfortunately, because the extreme high passenger volumes predicted for the late 1960s failed to

Figure 1. Los Angeles International Airport-Van Nuys Airport access route.



materialize on schedule and the flat-growth period of the early 1970s set in, the previously described highway, roadway, and tunnel support system was reduced in concept. Ultimately, slow growth was followed by the 1974-1975 recession, and the support system was tabled indefinitely.

Today, the ground access system that serves Los Angeles International Airport remains virtually the same as when the airport was developed in 1961 (5). It consists of one major freeway that runs north-south (Interstate-405) plus several primary surface streets, including one that feeds from I-405 directly into the airport's central terminal loop. The loop is a U-shaped one-way circulation system; the terminal buildings ring the outer edge and the parking lots and structures are in the middle. The roadway is now capable of handling about 30 million passengers annually at service level D. In 1979, Los Angeles International Airport served nearly 35 million passengers. The FlyAway bus was an experiment to address this imbalance in supply and demand of ground access capacity.

FlyAway, a relative pioneer in the remote terminal arena, has attracted much attention as landside constraints at metropolitan airports point to remote terminals as a tactic for relieving congestion. Though originally conceived as a full-service remote terminal, airline baggage check-in has not yet been implemented and airline ticketing is provided on a limited basis only. Both services may be provided, pending airline support, in the future. This paper describes and discusses the costs of the FlyAway bus service. The purpose of this discussion is to provide background to help airport planners evaluate the economic feasibility of remote terminals.

NEW SYSTEM'S GROWING PAINS

The San Fernando Valley was a prime location for such an airport express bus service. It is located a reasonable distance away (about 20 miles) via a mountain pass that has only two primary access routes to the airport (Sepulveda Boulevard and I-405), it houses a large sprawling bedroom community that contributes about 15 percent to Los Angeles International Airport's total passenger

market, and the department of airports owns a large piece of real estate at a central valley location. This real estate, better known as Van Nuys Airport (a large general aviation facility), meant that the department of airports could initiate its program without buying, leasing, or paying taxes on land (see Figure 1). In addition, an existing building was available at Van Nuys that could be adapted for use as a bus terminal, and it was adjacent to a large parcel that was suitable for a 1400-space parking lot. The site totaled 12.2 acres (4.94 hm^2).

As a result of recommendations contained in a feasibility study completed in 1973 by Wilbur Smith and Associates, the FlyAway bus service was inaugurated in mid-1975. It operated via six department-owned Neoplan buses, made a circuit of 44 scheduled round trips/day, and had 30-min headways in the daytime and 75-min headways between 12:30 and 5:30 a.m. The adult fare was \$5 round trip or \$3 one way, child's fare was \$1.50 each way, and employee passbooks were available to all persons who worked in any capacity at or near the airport. Parking was available at the Van Nuys terminal for \$0.50/lot entry, and no limit was placed on parking duration.

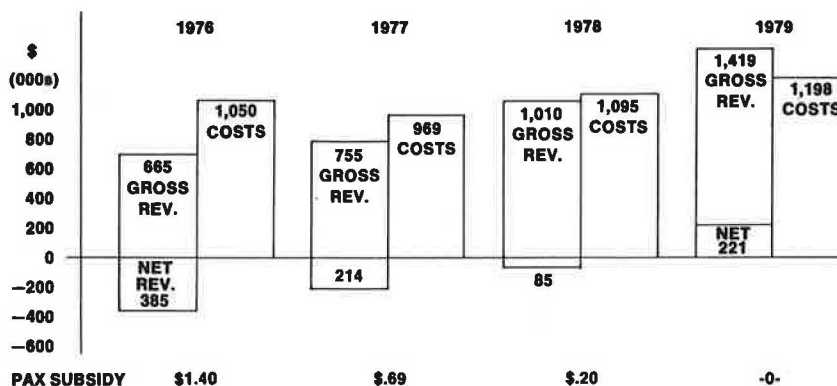
Although the feasibility study had addressed the possibility of the FlyAway being a full-service remote terminal that included airline ticketing and baggage check-in, the additional expense of such a service plus airline opposition to remote baggage check-in made it unsuitable for the pilot program.

By the end of December 1975 the system had carried nearly 90 000 passengers and collected \$225 843 in passenger fares plus \$7239 in parking fees (total = \$233 982). Costs for bus operation were \$464 510, which left an operating deficit of \$231 428. Since the service was new, an initial deficit had been anticipated; however, it was hoped that the service would be in the black within two years.

OPERATIONAL PROBLEMS

Such expectations seemed realistic. From the onset, patronage was much stronger than had been projected in the FlyAway feasibility study, and it continued to grow steadily. In August 1976, the entry fee to the parking lot was raised to \$1, which caused no apparent change in patronage of the parking lot. A break in the growth pattern came in late 1976, when Airport Transit, the company under contract with the department to maintain and operate the buses, folded. This cut off service abruptly and tied up the department's buses in a legal tangle. The Neoplan buses were put into storage pending a decision as to their status, and bus service was suspended for three days until a new company could be hired to resume service by using its own buses. At this point, FlyAway began operating under a series of short-term agreements while legal matters were settled and a new, comprehensive contract negotiated. The Associated Charter Bus Company took over the service on December 23, 1976, and ran it until July 6, 1977, at which time FlyAway was taken over by Grayline Tours. Grayline ran the service until November 7, 1977, when the Associated Charter Bus Company was awarded a one-year contract for bus operation and maintenance issued through the department's standard bid procedure. Associated's contract ran until November 8, 1978. The company planned to phase out bus service operations and did not rebid for the service when its contract expired. Through the bid process and negotiations, the service was then contracted to Grayline for a three-year term plus a two-year option, with a stipulation that seven new buses be purchased. This

Figure 2. Summary of FlyAway Bus system activity.



contract is still current and will remain in effect until November 8, 1981, and may be extended to 1983 if the options are exercised.

COST-REVENUE RELATIONSHIP

The terms of the contract specify one inclusive hourly cost that includes bus operation and purchase, maintenance, and all overhead. These items had previously been billed separately. The hourly costs are \$22.25 for the first year of the contract, \$23 for the second year, and \$24.50 for the third year. The contract stipulates that hourly cost covers the period beginning when a bus arrives at the Van Nuys terminal and ending when the last passenger is dropped off, including any layover (deadhead) time.

The contract also has an escalation clause to cover possible increases in fuel price. The clause stipulates that, for every \$0.03 increase in bus fuel prices, the hourly operations cost will increase by \$0.15. This clause has been an active factor in the bus operation's costs because the price of fuel has fluctuated greatly (see table below).

Date	Fuel Price (\$)	Hourly Rate (\$)
12/78	0.48	22.25
3/79	0.48	22.25
6/79	0.57	22.70
9/79	0.754	23.60
12/79	0.79	24.50
3/80	0.86	24.80
6/80	0.952	25.25
9/80	0.952	25.25
12/80	0.963	25.40

At an average of 34 000 bus service hours/year, the increase in fuel prices added approximately \$55 000 to the cost of the service between November 1978 and June 1980 (\$15 000 for the first year of the current contract period and \$40 000 for the first eight months of the second year).

At the end of the three-year contract period Grayline has the option to continue operating the service for an additional two years. They would apply the Los Angeles-Long Beach consumer price index (CPI) to the hourly base of the previous year to compute each new yearly rate.

Despite periodic and, at times, severe fluctuations in level of service until the end of 1978, when the current contract was enacted, patronage of the FlyAway remained high on an annual basis and reached a peak in 1979. A summary of FlyAway economic activity and passenger subsidy is itemized in Figure 2.

These figures are difficult to compare as a cohesive series because the various bus operators that ran the service charged different hourly fees. For example, for bus operation (excluding bus maintenance and terminal operation) the rates in Table 1 were applied. The apparently large difference in hourly rates is due to differences in hourly pay scales for bus drivers as well as administrative costs. Hourly bus driver wages have varied between about \$5.50 and \$8.50 per hour (nonunion versus union, respectively) for private operators in the southern California area. The cheaper service had a lower service level, frequent personnel problems, and frequent bus breakdowns. There was a noticeable relation between level of service and patronage during 1976 and 1977, when the service changed management frequently. Patronage would fall off when the service became irregular, unreliable, or unfriendly and then would revive slowly when such problems were corrected. In addition, monthly payments of \$15 862.12 to United California Bank for lease and payment of the Neoplan buses were suspended when the buses went into storage in December 1976. These payments were resumed at \$17 137.45 in July 1977 and were paid until November 1978, when the Neoplan buses were retired from FlyAway use. The suspension of payments reduced the system's cost by about \$100 000 in 1977.

A more detailed breakdown of the system's costs is provided in Table 2. When deflated by the CPI for public transportation in the Los Angeles-Long Beach standard metropolitan statistical area (SMSA), the yearly costs convert to \$795 981, \$656 708, \$723 823, and \$728 106 for the years 1976-1979.

Additional personnel and a restructuring of the accounting system account for the large differences in cost for certain items between 1977 and 1979. Terminal staffing as of 1979 included six clerk positions, five security personnel (some were part

Table 1. Operational rates per company.

Year	Company	Service Period	Hourly Rate (\$)
1976	Airport Transit	1/01-11/30	14.58
	No service	12/01-12/02	
	Grayline	12/03-12/22	21.75
1977	Associated	12/23-12/31	14.15
	Associated	1/01-7/06	14.15
1978	Grayline	7/07-11/07	21.75
	Associated	11/08-12/31	14.15
	Associated	1/01-11/07	14.15
1979	Grayline ^a	11/08-12/31	22.25
	Grayline	1/01-11/07	23.00
1980	Grayline	11/08-12/31	24.50
	Grayline	1/01-11/07	24.50

^aStart of three-year contract.

Table 2. FlyAway Bus operational costs.

Item	Operational Cost (\$000s)			
	1976	1977	1978	1979
Security	49.3	53.5	64.5	63.3
Grounds and parking lot	21.4	20.3	30.0	28.3
Terminal maintenance and administration	22.2	48.6	85.1	110.4
Wages and fringes	57.8	65.1	86.0	81.2
Bus operations and maintenance	564.8	550.9	611.7	869.2
Neoplan payments	174.5	137.2	154.3	0
Advertising	157.4	89.1	52.7	36.1
Miscellaneous	2.3	4.5	10.8	9.2
Total	1049.7	969.2	1095.1	1197.7

time), and one supervisor. The high publicity costs in 1976 were generated by an intense campaign to popularize the system. An annual average pay adjustment of +5.6 percent is also reflected in these costs.

As shown in these figures, most items are fixed-cost items. The largest and most essential item was bus operation and maintenance. There is every reason to assume that these items will remain relatively stable over the next few years, with adjustments for inflation and fuel prices. A simplified break-even analysis of the bus system for 1979, the first year it was in the black, produced the relationship shown in Figure 3. Break-even analysis is a method of relating fixed costs, variable costs, and total revenues to show the level of sales that must be attained if the system is to be self-supporting or operate at a profit. The variable costs in the FlyAway analysis included advertising, general administration, and miscellaneous. Also, it was assumed that the proportions or types of tickets sold and the ratio of tickets sold to parking lot use would remain constant.

As is the case with operations that have high overhead, FlyAway's break-even point requires high income; but FlyAway has the potential for a substantial rise in revenue as passenger volumes increase, due to the high degree of operating leverage. This characteristic is even more pronounced in the case of a hypothetical fare increase, as shown in Figure

4. In this instance, a 30 percent price increase was applied, which resulted in much lower passenger volume needed to reach the break-even point and an even higher revenue potential. Since the FlyAway fare prices have remained stable in nominal terms since the service began in 1975, a 30 percent increase is not unreasonable. If deflated by the CPI for transportation in the Los Angeles-Long Beach-Anaheim area over the four-year period, the real bus ticket price is more than 30 percent less than the nominal price.

The prices applicable to the two analyses are as follows:

Item	Price (\$)	
	Figure 3	Figure 4
Adult round trip	5	6.50
Adult one way	3	4
Child	1.50	2
Employee passbook per 20 round trips	35	45

Parking was held constant at \$1 per entry and each stay was limited to 15 days.

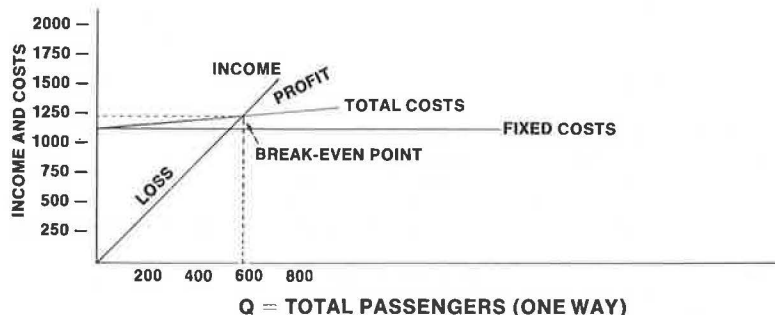
Given that parking in the Los Angeles International Airport central terminal area is \$10/day or \$1.50-\$2/day in Los Angeles International Airport peripheral parking lots and applying a moderate \$0.25/mile cost to driving a car, the 40-mile round-trip ride to Los Angeles International Airport from the valley would cost a minimum of \$10 for driving expense plus an additional amount for parking. At an average parking duration of five days for the FlyAway lot, the least-expensive travel and parking for five days for a private automobile from the valley is \$17.50 (\$10 to drive + \$7.50 to park at \$1.50/day). Clearly, even at the 30 percent higher rate, the FlyAway would still be a bargain.

REPLACEMENT COSTS

An additional element in this cost analysis is a review of facility construction costs and foregone ground rental income at Van Nuys Airport. In December 1977, the use of the Van Nuys site for FlyAway was reviewed and a proposal to relocate the bus terminal was evaluated.

At that time only 3340 ft² (310.62 m²) of the 6530-ft² (607.29-m²) terminal building were

Figure 3. Break-even analysis under 1979 rate structure.



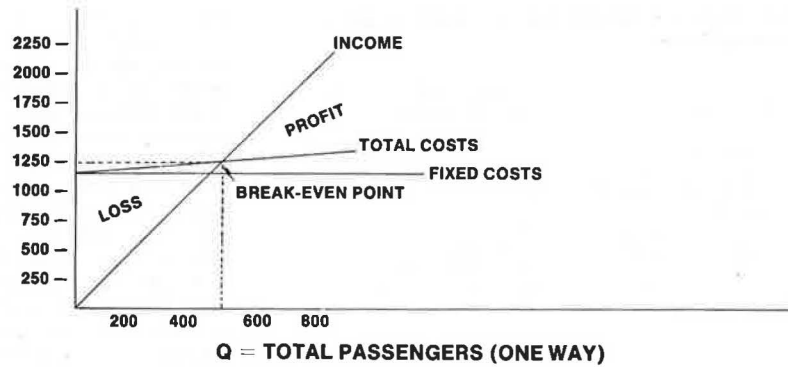
Q	VARIABLE COSTS	FIXED COSTS	TOTAL COSTS	SALES	NET PROFIT
678 000	125 000	1 080 000	1 205 000	1 420 000	215 000
800 000	147 500	1 080 000	1 227 500	1 672 000	444 500

$$\text{Break-even} = \frac{\text{Fixed costs}}{1 - \frac{\text{variable costs}}{\text{sales volume}}} = \frac{FC}{1 - VC/P \cdot Q}$$

variable cost = .1842 Q
average price = \$2.09

$$\text{BE} = \frac{1\ 080\ 000}{.911786} = \$1\ 184\ 488 \text{ in sales} = 566\ 740 \text{ pax}$$

Figure 4. Break-even analysis by using 1979 rate structure adjusted for inflation.



Q	VARIABLE COSTS	FIXED COSTS	TOTAL COSTS	SALES	NET PROFIT
678 000	125 000	1 080 000	1 205 000	1 820 565	615 565
800 000	147 500	1 080 000	1 227 500	2 152 000	924 500

variable cost = .1843 Q
average price = \$2.69

B.E. = $\frac{1\ 080\ 000}{.931}$ = \$1 159 467 in sales = 431 029 pax

Table 3. FlyAway Bus ridership.

Fare Type	One-Way Ridership							
	1976		1977		1978		1979	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Full-fare passenger	215 398	78	240 736	78	326 371	79	508 166	75
Half-fare passenger	11 927	4	13 064	4	17 419	4	27 106	4
Employee passbook	45 880	17	54 246	17	62 364	15	128 735	19
Other	1 899	1	2 669	1	9 605	2	13 551	2
Total	275 104		310 715		415 759		677 554	

being used, and 1400 parking spaces were in use on the 12.2 acre (4.94 hm²) site. It was estimated that construction of a new 3340 ft² terminal that had a 1400-space parking lot would cost about \$1 million in 1979 dollars. This included cost estimates of about \$485/parking space plus \$100/ft² for the building. Replacement with a 6530-ft² building and an 1800-space lot added to more than \$1.5 million.

These costs, when compared with the potential ground rental income of \$7225/acre per year on the industrially zoned site (\$88 145 annually) did not justify relocation of the terminal. Shortly thereafter, the lot was expanded to approximately 1800 spaces and an additional 3.3 acres (1.34 hm²) were added to the parking lot. Even when the lost rental income became \$111 988/year for the 15.5 acre (6.28 hm²) site, this was still lower than the amortized cost over a 30-year period of building a replacement facility (estimated at nearly \$150 000/year).

PATRONAGE

A review of bus passenger ticket activity reveals the breakdown in Table 3. This breakdown shows a constant distribution of types of bus users over time, with a substantial portion of patronage coming from the airport and airline employee sector.

A closer look at the FlyAway market was taken by the department of airports in 1979 via a survey questionnaire handed out and collected on the buses. Questionnaires were collected over a one-week period in April and another week in August, the peak travel month. The April survey, which had 1983 valid responses, was completed just before the gasoline shortage of that year, and the August

survey, which had 666 responses, was intended to hit the peak vacation travel period. Not surprisingly, the responses to the surveys were differentiated by a slightly higher proportion of recreational travelers in the August run. Consequently, the following shifts in passenger market were expressed:

Item	April 1979 (%)	August 1979 (%)
Passenger traveling alone	54.6	45.0
Passenger traveling with spouse	24.0	32.8
Female head of household		
Working outside the home full time	34.2	42.9
Not working	38.3	30.4
Male	62.2	59.9
Female	37.8	40.1
Business trip	46.1	39.9
Vacation or personal trip	47.2	55.6

The remaining market characteristics remained constant. The most relevant ones to this discussion were cross-tabulated and were drawn from the April survey. These include characteristics of modal choice, income, business versus nonbusiness travel, number of trips per year, access travel time, and bus terminal parking characteristics. These data reveal that FlyAway's passengers come from a high-income pool (85 percent earn more than \$30 000/year), are frequent travelers (40 percent take more than 5 business trips/year), are well educated (47 percent are college graduates or postgraduates), are predominantly more than 30 years old (67 percent are in the 30-59 year old group), started out to the bus terminal from their residence or the home of a friend (92 percent), and often drive a considerable

Table 4. Comparison of passenger volumes: FlyAway Bus terminal versus Los Angeles International Airport.

Year	FlyAway Passengers			Los Angeles International Airport Passengers	
	Number	Annual Growth Rate (%)	Market Share (%)	Number	Annual Growth Rate (%)
1976	275 104		10.1	25 983 079	
1977	310 751	12.9	10.4	28 361 836	9.2
1978	415 759	33.8	12	32 901 361	16
1979	677 554	63	18.5	34 923 205	6.1

time to get to the bus terminal (42 percent drove 6-15 min, 37 percent drove 16-30 min, and 10 percent drove 31-45 min). FlyAway's travel time to Los Angeles International Airport from the valley terminal ranges from 30 min under free-flow conditions, to more than an hour during peak periods.

GROWTH RATES OF PASSENGER VOLUMES

When viewed in terms of Los Angeles International Airport passenger volumes, FlyAway has managed to capture a considerable portion of market share. This is illustrated in Table 4.

The market share is calculated by subtracting the 25 percent of Los Angeles International Airport passenger volume that is connecting traffic and then assuming that, of the remainder, 14 percent is currently based in the San Fernando Valley. [The valley's market share has declined from 15 percent in 1975 due to rapid growth in the passenger market located in Orange County (6).]

PLANNED IMPROVEMENTS AT LOS ANGELES INTERNATIONAL AIRPORT

The department of airports currently has a goal of building two major new terminals, three parking structures, and at least one phase of a double deck for the central terminal roadway before the 1984 Olympics. These improvements promise to create serious access problems during the several years of

construction. Systems such as FlyAway offer the only hope for serving growing passenger volumes while roadway capacity is curtailed. In addition, when the second-level roadway is completed, special lanes will be provided for buses on the lower level, thereby more specialized service will be offered for bus passengers. In conjunction with this plan, the regional transportation plan specifies that special lanes for high-occupancy vehicles be provided whenever feasible (7). Such lanes are currently being planned for the freeways that access Los Angeles International Airport. If this system can be coordinated and implemented, remote terminals will clearly become increasingly attractive to passengers, employees, and airport operators.

If the FlyAway experience is at all typical of what a metropolitan remote terminal can do, the good news is that not only can such a system be useful and attract considerable patronage, it may also operate without subsidy.

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Airport Geometric Compatibility of Future Aircraft

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Capacity limitations at many of the major hub airports restrict the ability of carriers to add flights to accommodate increased demand. Increases in seating densities on existing aircraft will reach marginal comfort limits, and therefore, the demand can only be handled by the upgrading of existing airports, building of new airports, or the use of aircraft that have higher seating capacities. The last solution would impose greater operating and physical limitations on the airport system. The ability to physically expand airports and build new ones is subject to environmental and fiscal constraints and land availability and has proven to be almost impossible. Therefore, future growth will require the use of a greater percentage of aircraft that have large seating capacities. This paper analyzes the characteristics of wingspan and existing runway and taxiway separations at 31 hub airports. The effects of these characteristics are evaluated as a function of current airport runway and taxiway systems. The data and conclusions may be used to develop a technical rationale for accurate measurement of necessary separations and to help evaluate the adequacy of current airport standards as more large aircraft are accommodated in the future.

The possible construction of any new U.S. airports within this century is remote; however, air transportation is a rapidly growing industry (Figure 1) that seems to continually exceed planned capacities. The major aircraft manufacturers are receiving strong pressure from two sides:

1. The stressed operating environment, which requires more large aircraft to satisfy the continual increase in demand and relieve capacity problems, and
2. The difficulty in changing existing airports to meet the requirements of the large aircraft, as well as the lack of support by authorities for such changes.

The introduction of the wide-bodied aircraft