AIRSIDE AND OFF-AIRPORT FACTORS AND LANDSIDE CAPACITY

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The California Department of Transportation is developing a multimodal transportation plan that includes airports. The 3 basic air and ground interface components—airside, landside, and off-airport—incorporate different jurisdictional, operational, and financial constraints. An understanding of these is critical if they are to be coordinated into an overall transportation plan. This paper discusses some of the implications of these and how California is working to address related issues.

In July 1973 the California Department of Public Works and other state agencies with transportation responsibilities became the California Department of Transportation. This major reorganization reflected changing attitudes on the part of the people of California toward the state’s dominant form of transportation, the automobile, and a public demand for a balanced transportation system.

The new department is now directing a multiagency planning effort to develop a multimodal California Transportation Plan (CTP) by January 1976. A primary thrust of the CTP will be to unify 6 identified transportation elements into this plan. Airports are the obvious interface between ground and aviation elements in any such transportation plan. This paper discusses some of the system planning factors that must be considered if the aviation element is to be an effective component of a total transportation system. Emphasis is given to the separation of system planning from project planning, for markedly different jurisdictional, technical, and political factors influence each.

Early returns from CTP efforts indicate 4 significant areas that bear on airport access.
1. Greater coordination is needed among the modal elements that make up transportation systems. Airports are a multimodal linkage between air and ground systems.
2. Funding for major addition to existing ground transportation systems is and will be extremely limited. Indications are that this may not now obtain in airside and landside elements at the aviation subsystem, but is a critical constraint in the off-airport element.
3. Ground systems that provide access to airports must also serve a variety of other functions. Many of these facilities are or soon will be inadequate to provide desirable levels of service for all these functions.
4. Better techniques could significantly improve capabilities of existing subsystems at modest capital cost.

For the purpose of this paper, airport planning is concerned with 3 separate components: landside, airside, and off-airport. These defined separations can become significant primarily because they are frequently the dividing lines between jurisdictional, financial, and operational responsibilities. The following specifics are fairly consistent among California airports and are believed compatible with airports in general. They are one of the basic assumptions of this paper.

The landside is that portion of an airport between its boundary and boarding gates. Major elements of the landside are terminal facilities, curbside on the landside of terminal buildings, roadway circulation, and parking facilities. Primary jurisdictional responsibility for these is shared by airport operators and airlines. Construction and maintenance of landside facilities are the responsibilities of the operator. Airlines lease terminal space and employee parking and directly finance installation of facilities required by their specific operations. Constraints on landside capacity are generally congested circulation roadways, curbside congestion as passengers are being dropped off or picked up, inadequate baggage-handling facilities, and lack of parking spaces. These constraints are often imposed through a combination of human and mechanical or technical restrictive factors.

The airside is that portion of an airport between the boarding gates and the airspace. Major elements of the airside are runways, taxiways, and navigational systems. Primary jurisdiction over the airside lies with the Federal Aviation Administration (FAA), which funds, maintains, and operates control towers and navigational systems. Although the airport operator is responsible for construction and maintenance of runways and taxiways, these are also financially supported by FAA. Capacity of the airside is largely determined by the number and length of runways, aircraft mix, availability of airspace, and other largely technical aspects of air travel. Airspace is at a premium in California's 4 major urban areas: Los Angeles, San Francisco, San Diego, and Sacramento.

Off-airport elements are located outside an airport boundary but are related to and impact the airport user. These may include location of the airport relative to central business districts; origins and destinations of air travelers, airport employees, and visitors; mix of traffic on access facilities and their location and type; and surrounding land uses. Primary jurisdictional responsibility for off-airport facilities rests with local and state governments. Their interests are often divergent from those of the airport owners, particularly in the immediate area of an airport. Similar jurisdictional conflicts are apparent in operation of vehicles to and from airports. Individual owners, public carriers, and private enterprise all compete for a share of the access market. In some cases this seems to create monopolies; in others it results in counterproductive duplication of services.

**URBAN TRAVEL PATTERNS**

Service at airports must consider 2 divergent categories of users, one mechanical and one human. Aircraft size, ground-handling characteristics, and other physical constraints are primary determinants in planning airside elements. Human characteristics
and physical capabilities are among the major parameters for effective planning of landside and off-airport elements. This indicates the necessity to understand both general and unique characteristics of airline passengers before specific problems are addressed and includes urban travel patterns that relate to airport access.

Most major airports are served either directly or indirectly by a major transportation facility, usually a freeway. These facilities are also vital to a community because they serve not only airport-related traffic but heavy volumes of other urban trips as well. In most cases, nonairport users far exceed those making airport-related trips. The percentage of airport trips using these highways is particularly influenced by 2 factors: the relation of the airport to concentrated destinations, frequently the central city, and the types of surrounding land uses. Since airport peak travel frequently coincides with work-oriented peak travel, the 2 elements of congestion are often accumulative at the most critical times.

Major arterial highways serve both Los Angeles (International) Airport (LAX) and San Francisco (International) Airport (SFO) and experience peak-period travel congestion but under somewhat different conditions. A review of these and some of the lessons learned as a result of detailed analysis may be typical of and assist in resolution of problems at similar airports.

LAX is served by the San Diego Freeway, which lies several miles to the east. During peak demand periods much of the travel on this freeway is composed of intra-regional commuters traveling in both north and south directions. The freeway is operating at maximum capacity during these periods.

Airport-bound traffic is also carried by the freeway at this same time and must compete with area commute traffic. Most of the airport traffic leaves the freeway as it approaches the vicinity of the airport and continues on either Century Boulevard or Sepulveda Boulevard. Each of these is a city street carrying about 60,000 vehicles per day of which about 45 percent is airport oriented. Terminal access is clearly restricted, and it was thought that relief might be gained through improvement of the connecting roadway, specifically by double-decking Century Boulevard. A study was undertaken with a specific charge to evaluate this design. However, the study established that such a proposal was not appropriate since it did not address the real problem areas. These were that the San Diego Freeway, which was already operating at its practical capacity during critical times, could not supply additional airport-bound traffic to Century Boulevard. Furthermore, the airport landside circulation system was heavily congested and unable to accept the volumes already being fed to it. Under these constraining conditions the connecting link, Century Boulevard, was operating below its practical capacity. In short, the study defined location of the real access problems, which was the first step toward developing responsive solutions. This clearly illustrates the problem-definition, problem-solving sequence that must be followed in addressing perceived problems and the necessity to consider off-airport and landside as a single subsystem, although it is often operated by different responsible agencies.

SFO, on the other hand, is directly served by the Bayshore Freeway, which carries an average daily traffic of about 280,000 vehicles. About 21 percent of this is airport related, 60 percent to or from the south and 40 percent to or from the north (1, p. B-41).

The Bayshore Freeway connects directly to airport landside facilities. This greatly simplifies both planning and implementation of access systems. As a result, needed facilities continue to be provided to meet existing or potential air travel demands and to significantly better levels of service for airport customers.

In contrast to airports at Los Angeles and San Francisco, the airport that serves Sacramento has virtually no incompatible development around it. It is located about 15 miles (24 km) north of the city and is surrounded by agricultural lands. Access is by Interstate 5, a 4-lane freeway, which is seldom congested and, in fact, generally operates well below its capacity.

Despite these currently favorable conditions, airport owners are actively planning for the time when airport service, highway traffic, and land use demands significantly increase. Their interest is to provide for orderly and cooperative comprehensive
planning while options may still be exercised. Despite these purposes and the sparse adjoining development, their planning efforts are meeting considerable vocal opposition. Airport planners are experiencing difficulty in obtaining necessary political acceptance.

This emphasizes the impact of jurisdictional relations on airport planning and development. These relations become particularly critical when nonairport agencies must support and assign priorities to airport-oriented facilities. Resolution of the resulting and often divergent objectives may well be the major step toward needed implementation programs.

Specific user characteristics must also be considered in analyzing capacities of airports and their related features. Considerable study has already been devoted to this area, and some broad generalities can be stated although airport specific data or a usable process for developing such data appears to be lacking.

A commonly stated and rational assumption is that each air passenger represents on the average an additional 1 to 1 1/2 visitors. Major airports also have a significant number of employees; for example, LAX has about 37,000 workers and SFO has about 20,000. These supportive trips aggregate to about two-thirds of all airport-oriented trips. More thorough understanding of their unique characteristics, particularly those that can be manipulated, may provide significant potential for relieving existing or potential congestion.

LANDSIDE FACTORS

Parking is often a critical element of the airport landside. Number of spaces varies widely at each airport and is not always consistent with passenger volumes. A number of factors influence this ratio although there are instances when parking appears to have been almost an afterthought.

Parking facilities must be recognized as significant financial elements at many airports. As examples of this, 1971 gross parking revenues were about $7.4 million at LAX and $4.0 million at SFO. This does not imply that parking revenue is the sole reason for providing this important service, but it may well influence how and for whom parking is provided. The significant issue is that parking and its characteristics must be recognized in planning access systems.

Short-term (under 3 hours) parkers result in repeated use of the same spaces, and they tend to be more receptive to higher time-rate charges. Net result is a higher rate of return on parking investments. On the other hand, long-term parkers appear willing to use less convenient spaces to avoid high charges and thus may be attracted to remote and off-airport sites. This, however, places demands on internal connectors between the lots and the terminal or boarding areas. Failure to accommodate parking needs results in repeated circulation of the same vehicle or violation of curbside parking limitation.

Demand for parking spaces is offset by passengers who are dropped off or picked up at curb locations. This in turn creates its own problems since insufficient curb space and resulting vehicle queuing can cause congestion extending to central terminal roadways.

Internal circulation roadways are particularly critical factors in the overall landside capacity of an airport. The ability of internal roadways to function adequately is affected by many factors, including capacity of the roadway related to the number of vehicles entering the airport from external sources, "side friction" or conflicts with curbside or other nonmoving uses, and terminal configuration.

Each of these is an important component of a circulation system. Excessive friction between any two or more of them will effectively reduce ability of the whole. Therefore, an effective circulation system should be designed that supports the aviation purpose of the airport complex. This concept has been applied to new airports and is being adapted to modernization of some older facilities.

Cargo revenue is a significant element of air carrier aviation and may often provide the margin of profit needed to sustain passenger service. Despite this importance, some basic conflicts between cargo loading and passenger loading make maximum
separation desirable. This has been effectively carried out at some airports through provision of separate access roadways and staging areas for each. Final combination into a multipurpose payload is deferred until the boarding area. It would seem that adaptation of older airports to this maximum separation concept could significantly improve handling of both components and simplify the planning of access systems.

AIRSIDE FACTORS

Airside innovations have a direct impact on the operation of the landside, as the advent of wide-bodied jets has dramatically illustrated. These aircraft deliver a significantly greater number of passengers without increasing the number of aircraft operations. In other words, capacity of the airside may not be taxed by additional numbers of aircraft, but terminal facilities and landside facilities must provide service for a significantly increased number of passengers. A traffic study at LAX revealed the following (2, pp. 24-25):

An estimated 77,360 passengers were recorded arriving or departing LAX during a peak Friday in 1972. Of these 17,460 passengers, or 22.6 percent of the total, arrived or departed aboard wide-bodied aircraft. Of 1,038 operations (landings and takeoffs) that day, 117 or 11.2 percent of the total were wide-bodied aircraft. In other words, 22.6 percent of the passengers arrived or departed aboard 11.2 percent of the aircraft operating that day.

This condition is further complicated by peaking of airline schedules, competition among the airlines, and underuse of some metropolitan airports.

Airline scheduling must be recognized as largely controlled by marketing demands. It is, however, a major contributing factor to airport congestion since specific studies indicate that enplaning and deplaning activities are closely correlated with resultant traffic flow (2, pp. 21-23). This correlation is evident from a sample breakdown of entering and exiting vehicles at LAX. In this example the peak-hour entering traffic flow (3,205 vehicles) occurred at 7 p.m., 1 hour before the peak passenger hours; and the peak departing hour (3,470 vehicles) occurred at 9 p.m., 1 hour after the peak passenger period. Similar analyses have indicated variances in "lead time" for departing aircraft, particularly those with habitually or potentially severely congested access systems. This may be from attempts to avoid this congestion, thereby ensuring passengers of on-time check-in at departure gates. Early arrival does create several secondary benefits to both airport owners and airline operators.

The correlation of air-passenger activity and vehicular traffic illustrates the impact that the airside operation has on the landside of major airports. Since peak airline schedules frequently coincide with peak periods of urban vehicular traffic, this impact is also felt on off-airport roadways.

The effect of market competition among airlines, another element impacting access systems, can be illustrated by considering one of the most heavily traveled intercontinental air routes: between LAX-SFO and New York City. Three airlines have exclusive rights to these routes: United, American, and Trans World Airlines. Each of these airlines flies the same number of flights between these cities, at approximately the same time, in direct competition with each other. According to the Official Airline Guide, each flies approximately 12 round trips daily between LAX and New York and between SFO and New York. This results in a significant excess in seat miles over passenger miles between these termini, heavy demands on the airside capacity of the airports, and apparent unnecessary operating costs to the airlines. This scheduling is partially a response to perceived market demands and partially an expression of national policy regarding service levels. At the same time, other emergency constraints in areas such as fiscal capability or energy conservation may indicate a need to review past decisions.

In the discussion above, the California airports (LAX and SFO) were referred to by name, but no reference was made to the airports that serve New York. This illustrates another problem affecting the airside of California's 2 busiest airports: underuse of
airport facilities at Ontario International (ONT) in the Los Angeles basin and at Metropolitan Oakland International (OAK) in the San Francisco Bay area. All flights between the San Francisco Bay area and New York City arrive and depart from SFO. This includes those with origins or destinations in the East Bay area despite a relatively idle, high-standard airport at Oakland. This condition is duplicated in the Los Angeles-San Bernardino area with regard to nonstop transcontinental flights that leave only from LAX. Although this scheduling is largely responsive to specific market demands and perceptions of its potentialities, the significance of the imbalance it creates must eventually become a factor in system planning for air travel. In 1974 passenger volumes were 23.6 million at LAX and 1.3 million at ONT; they were 16.2 million at SFO and 2.3 million at OAK. Future system planning must carefully consider effective use of all existing facilities that can respond to inevitable service demands.

OFF-AIRPORT FACTORS

Off-airport transportation facilities must serve a number of purposes, few of which are primarily for airport access. Frequently, airport uses are not perceived as high-priority uses of off-airport facilities. The off-airport segment of airport access, however, must be of considerable concern to transportation system planners.

Roadway congestion is already apparent at 15 of the major airports that serve 56 percent of all enplaned passengers (1, p. 28). Inevitable increases in the demand for air travel and the probable preferences for the automobile as a primary transportation vehicle can only worsen ground congestion unless positive steps are taken to mitigate the situation.

Automobiles now carry about 70 percent of the total airline passengers at most major airports; buses or limousines carry a large share of the remaining 30 percent. This extensive reliance on the automobile reflects a number of factors, including an ingrained preference compounded by widely dispersed origins and destinations and by a general lack of incentives for airport owners to seek to influence a shift to other types of vehicles.

Much of the urban planning today proposes increased reliance on public transit for moving large numbers of people, including those going to airports. These proposals have yet to be fully tested in the public market since only Cleveland (Hopkins International) Airport has an operating direct rail transit connector. Such systems will undoubtedly be proposed as population centers develop and as other systems become congested. Some existing rail systems may be modified to accept a share of the airport-oriented market.

Rail transit service may be extended to serve the needs of at least 2 California airports, OAK and SFO. Key to this expectation is the Bay Area Rapid Transit (BART) System. BART passes close to OAK on the east shore of the bay although there is no direct connection to the airport. Air passengers who wish to use BART must rely on shuttle-bus service between the airport and BART's Coliseum Station.

Direct connection to the BART main line could simplify system access. The most desirable connection, from the airport user's standpoint, would be through diversion of the main line to the airport terminal. This concept, however, raises the issue of relative priority of airport passengers in competition with that of daily commuters whom BART is designed to carry. It seems unrealistic to predict that these commuters will be penalized by detouring them through the airport terminal. These and other benefits and disadvantages of BART service to OAK are now under analysis, but no specific proposal has yet been advanced.

On the west side of the bay, BART service now terminates at Daly City, 10 miles (16 km) north of SFO. BART extension to SFO was reported on in 1972 (3, p. 21). This report considered routing financial and patronage estimates and recommended how much such a project might be implemented and funded. A critical recommendation was the start of negotiation to extend BART into San Mateo County, which would require voter approval. Implementation of this recommendation is at best questionable in today's political climate.
Similar rail systems have been proposed in the Los Angeles area. Voters have to date refused to accept them as a part of total system development. These have generally included elements to serve LAX, but the key factor in each referendum seemed to be separate and apart from issues of airport access. Neither proponents nor opponents to transit proposals appeared to relate these to solving airport access problems.

In summary, California experiences would seem to raise serious doubts as to the acceptability of rail transit as a common response to access problems. There do seem to be rather widespread opportunities for application of less exotic and expensive concepts to resolution of immediate airport access problems. This would adapt techniques of traffic engineering and highway operational management to the specific problems of airport access roads and needs of airport-oriented travelers. Early emphasis should be placed on proper adaptation of available knowledge and skills since it can be anticipated that these problems may have unique characteristics.

California has recently completed a demonstration management of freeways in the Los Angeles area. The demonstration was highly successful, and some of the techniques are now being applied as fully operational tools. These can be classified into 4 categories:

1. Traffic-responsive ramp control with electronic surveillance,
2. Early detection and rapid removal of unusual incidents,
3. Service for stranded motorists, and
4. An effective warning and information system for motorists.

Development and implementation of these require coordination of traffic engineering and traffic policing skills of the transportation department and the California Highway Patrol.

The demonstration project was oriented toward operation of a freeway system. Modification of its features to address airport access problems is necessary to reflect more intricate jurisdictional relations and specific characteristics of an airport-oriented transfer. This presents an opportunity to make significant low-cost improvements to maximize efficiency of present access facilities.

This discussion has largely centered on technical planning and other professional skills that might be brought to bear on existing or future physical problem areas. Consideration of these parts of the total picture must recognize importance of the critical policy areas within which facility planners must operate. Policy planning is as critical to success as is any other element in the development of a total transportation system. This is a separate area well worth detailed analysis but far beyond the scope of this effort. It is mentioned, however, to recognize the critical need to combine both facility and policy planning in any effective total planning effort.

CONCLUSION

In conclusion it can be stated that the aviation element must be considered a part of the overall transportation system and not as a separate entity. Landside, airside, and off-airport components of that subsystem not only must be balanced within the aviation element, but also must be coordinated with other modal elements.

Financial, technical, and jurisdictional constraints point up the necessity of adopting short-term and perhaps interim solutions to the most pressing problems. This will require coordination of both system and project planners in early conceptual phases and traffic engineering and traffic policing expertise in implementation phases.

Supporting our best efforts to make most effective use of existing facilities must be careful attention to long-range demands on aviation. Short-range planning must not foreclose acceptance of desirable long-range options. This paper has pointed out some of the areas in which further analysis is needed to achieve these objectives.
REFERENCES