IDENTIFICATION AND MEASUREMENT OF CAPACITY AND LEVELS OF SERVICE OF LANDSIDE ELEMENTS OF THE AIRPORT

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Since the mid-1960s, air travelers have faced increasing inconvenience, frustration, and delays in the landside portion of their air trips. Ever-increasing numbers of passengers and the continuing introduction of higher capacity aircraft have created bottlenecks and congestion throughout the landside environment at peak hours and have placed tremendous strains on terminal facilities. Comfort and convenience of passengers in the airport landside are directly related to the capacity and the levels of service provided. Although airport congestion is fully apparent to operators of major airports and to their users, the concepts of capacity and level of service as they relate to the landside have yet to be fully understood. The concept of level of service is particularly difficult to understand, for it relates to quality, and quality, by definition, is subjective. This paper first discusses briefly the background of air transportation development and its effect on the airport landside environment today and then describes the basic functions and facilities of the landside. It then defines capacity and level of service within the context of the airport landside and examines the problems connected with developing meaningful measures of capacity and of level of service. Existing landside planning criteria that have evolved during the years are reviewed, and possible measures of capacity and level of service for landside facilities are outlined.

In 1968, the U.S. News and World Report reported, "In Los Angeles, a businessman missed his flight to Phoenix when he was caught in airport access traffic and later had to walk a mile from the nearest available parking spot. In Chicago, a businessman complains he lost 24 hours in a week because of delays in the air or on the ground. In New York, a college professor arrived on a 45-minute flight from New Hampshire and then waited 50 minutes for his luggage."

Travelers today continue to face the same inconveniences and express the same complaints as those travelers in 1968. But in the face of increasing traffic volumes, the changing demand resulting from changes in aircraft equipment, and the spiraling costs of airport improvement programs, can the problems involved in providing improved service on the ground be resolved? Or is the level of service being offered at airports today adequate given the volumes of passengers, the cost of providing basic public services, and the appropriate obligations of the 2 major parties (the airport sponsor and the airlines) involved in providing these services?

There is no question that the character of the air transportation market has changed drastically in the last 25 years and, with it, the level of service. In the 1950s, the airport (and specifically the terminal building) was virtually an exclusive fliers club. The passenger (or the flier) paid for a high level of service in order to enjoy the exhilaration of flying on an airline. As the aviation industry moved into the 1960s and as the airline aircraft fleet was upgraded and became increasingly reliable and safe, aviation began to emerge as an integral part of the worldwide common carrier transportation system.

As air transportation became a necessity, rather than a luxury, the role of the airport changed from the exclusive club to an essential transportation facility that serves what is today an indispensable transportation mode. Whereas the airport was once a singular facility used by a select few, today the airport is increasingly like the historic bus or rail terminal and is used by the masses—and the level of service offered has changed accordingly to accommodate a mass market rather than a select market.

The identification and the measurement of level of service are complicated at best, for level of service relates to quality and, by its nature, quality is subjective. The identification and the measurement of level of service are further complicated by 2 other factors.

First, no single agency is responsible (or can be responsible) for the level of service experienced by a passenger on an entire airport trip. From the time the passenger leaves an origin point to the time the passenger boards the aircraft, he or she is exposed to a series of elements within the total trip, each of which may be controlled by one or more agencies or institutions. For example, the access portion of the trip is generally controlled by one public agency, but the terminal access (inside the airport) is controlled by another. Once inside the terminal building facility, the responsibility for level of service passes back and forth from the airlines to the airport sponsor (and even from these 2 entities to concessionaires). Consequently, there is a complexity of facilities that passengers use and a complexity of jurisdictions that operate the various facilities. As passengers pass through the total system, they are in essence passed from one controlling agency to another; therefore, they can experience various levels of service in each element of the system.

Second, level of service is to a great extent a function of facilities and services provided, and the extent and the character of facilities and services provided depend to a great extent on their costs. Because of the revenue financing requirements at major U.S. airports today, the airlines have become "partners" in the provision of all airport services. Consequently, level of service at major U.S. airports is, in fact, negotiated with the airlines.

Within this framework, this paper attempts to define capacity and level of service as they relate to the airport landside, to examine the problems connected with measuring capacity and level of service, to review existing landside planning criteria as a basis for determining its value in any measuring process, and to establish possible measures for capacity and level of service. (In the latter case, those measures that are easy to quantify and those that are difficult to quantify have been identified.)

Because of the complexity of the subject at hand, the authors have attempted to bring together in this paper as many viewpoints as possible to contribute to the understanding of the concepts of capacity and level of service and the need for and limitations in developing measurements of them. Although the paper may raise more questions than it answers, we hope that the viewpoints expressed will stimulate discussion and continuing research on this important subject.

DEFINITION OF LANDSIDE

For purposes of this paper, the landside is defined as those areas of an airport that are used for the functional processing of airline passengers. Those areas used for the movement and parking of aircraft (typically called the airside) are excluded.

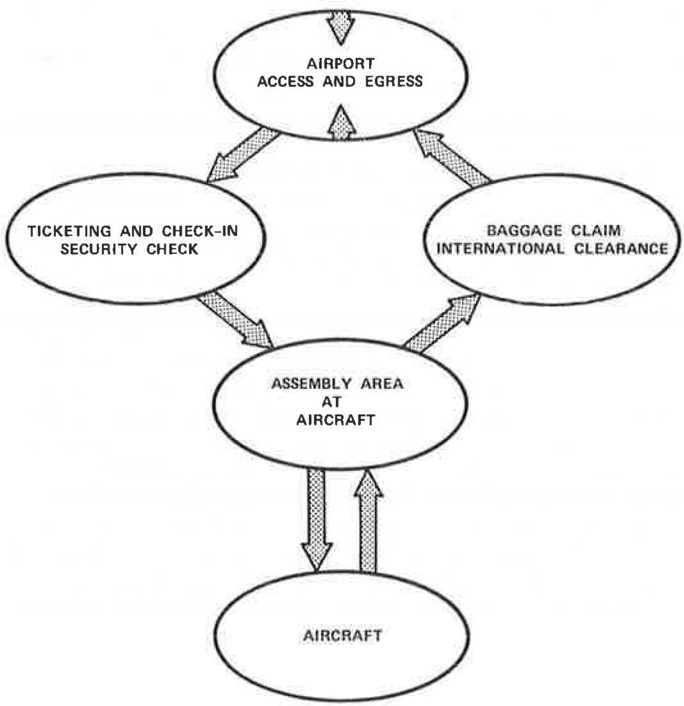
The landside may accommodate a number of other essential aviation-related functions (such as general aviation, airline maintenance hangars, cargo and airmail facilities, crash-fire-rescue facilities, and airport maintenance buildings) and a number of other nonaviation functions (such as hotels and motels, industrial parks, and miscellaneous commercial uses). However, the basic purpose of the landside of an airport is to effect the transfer of the air traveler from ground transportation to air transportation. Since the airport planning process as a whole stems from the passenger forecasts and the best way to provide the facilities to meet those forecasts, we concentrate in this paper on the basic functions and facilities necessary to accommodate the airline passenger. On this basis, the landside would include the following physical elements:

1. Terminal building proper,
2. Access roadways, and
3. Parking for vehicles used for the ground transportation of passengers (private automobiles, taxicabs, limousines, rent-a-cars, buses).

A simple diagram of the basic passenger-handling system is shown in Figure 1. The basic functions of the passenger-handling system can be identified as follows:

1. Primary functions, including airport access and egress, ticketing and check-in, international clearance, assembly at the aircraft, enplaning and deplaning the aircraft, and baggage claim; and

Figure 1. Airport landside passenger-handling system.



2. Secondary functions, including services (restrooms, public telephones), concessions (newsstands, restaurants), and meeting and greeting space.

Each of these primary functions is associated with one or more physical facilities, as given in Table 1.

HISTORICAL PROBLEM IN PLANNING THE AIRPORT LANDSIDE

Much has been written about the function of an airport landside—more commonly called passenger terminal building area or (for larger airports) passenger terminal complex. Most authorities would agree that the primary purpose of the landside is to effect the transfer of passengers and their baggage from surface transportation to air transportation in minimum time and with a minimum amount of confusion and discomfort. Historically, the major problem in planning the airport landside—and particularly the terminal building—has been that the starting point in the planning has been the size and operating requirements of the aircraft.

On the one hand, the airside of the terminal building must accommodate what to date has been a radically changing aircraft technology. On the other hand, the landside of the terminal building must accommodate the access and vehicle parking requirements of the passengers. Thus, the ever-increasing size of the aircraft and its fixed-point servicing requirements coupled with increasing volumes of passengers and their concomitant surface transportation volumes have resulted in the expansion or development of terminal buildings that far exceed the human scale.

Actually, from the passenger viewpoint, "terminal building" is a misnomer. The terminal building is a terminus only from the standpoint of the aircraft and the surface transportation vehicle. For the passenger, the terminal represents only a means to transfer from one mode of transportation to another. Were it not for the complexity of the airline processing requirements (ticketing, check-in, baggage handling, baggage check-in, security), a terminal building could be little more than a sheltered collection and waiting point (like facilities for other mode transfers, e.g., a bus stop).

Another problem in the planning of the landside has been that the aircraft technology has developed rapidly during the last 20 years, and each change in technology has created new and different demands on ground facilities (airports). In the 1960s, the aviation industry witnessed radical changes in aircraft technology and an explosive growth in airline passenger demand. (The growth in passenger demand was at least in part a response to the reliability and speed of the new aircraft technology.) Consequently, airport sponsors and the airlines were under tremendous pressures to provide facilities to meet these demands as quickly and effectively as possible. Because airports are operated in the public environment, which by the nature of the political process responds to change slowly, the lead time on even modest terminal building expansions can run from 3 to 5 years. For the development of a new terminal complex, the lead time can run to 10 years. Consequently, there has been little time to research new solutions to landside planning.

Interestingly, the research that has led to the development of new landside facilities has usually been the smallest part of the overall planning and design process. Because of the sheer magnitude of the mechanical efforts involved in any major terminal project (working drawings and specifications) and the diverse views of the various parties involved (all of which must be reconciled), the implementation of a terminal design after the planning concept has been adopted absorbs by far the greatest amount of time in any landside development project.

DEFINITION OF CAPACITY

In general, capacity is the physical capability of a facility to provide a service. In an airport landside, this service can be flow (e.g., passengers flowing through a ticketing facility) or storage (e.g., passengers using seats in a departure lounge). Therefore, capacity can be measured either as flow in terms of items processed per unit of time or as storage in terms of items stored. Both measures are useful in determining the capacity of an airport landside.

Table 1. Passenger-handling system.

Primary Function	Physical Facilities	Airport Landside
Access and egress to and from airport	Private automobile	Curbside
		Parking space
		Curbside
		Open lot
		Structural parking
		Valet
		Short term
		Long term
	Rental car	Curbside
		Ready and return areas
	Taxicab, limousine, bus	Curbside
		Dispatch facility
		Staging area
	Train	Station
	Private aircraft	Aircraft parking position
	Public air carrier	Aircraft parking position
Ticketing	Home or office (mail)	
	Ticket counter	
	Remote	
	At terminal	Counter
Check-in	At rail station	
	At downtown terminal	
	At airport terminal	Curbside
		Ticket counter
		Walk-through check-in counters
		Aircraft gate
		Parking lot or garage
		Ground transportation center
International clearance	At airport terminal	
	Passport control	Counter
	Immigration	Counter
	Public health	Counter
	Customs	Claim and inspection facility
		Direct from cart
		Linear tray
		Diverter
		Carousel
		Conveyor belt
Assembly area for aircraft	At airport terminal	Queuing area (concourse)
		Departure lounge
		Transporter
		Main waiting room
		VIP rooms
		In-transit lounge
Enplaning and deplaning	At airport terminal	Above apron level loading
		Loading bridges
		Transporter
		Apron level loading
		Open boarding stairs
		Covered boarding stairs
		Escalators
Baggage claim	At airport terminal	Baggage claim area
		Direct from cart
		Linear tray
		Diverter
		Carousel
		Conveyor belt
Circulation	At airport terminal	Concourses
		Moving sidewalks
		Escalators
		Elevators
		Shuttle trains
		Buses
		Carts

Within the airport terminal building, passengers and baggage are processed through a series of facilities (Table 1), each of which has different characteristics. Each of these facilities may be regarded as an impedance to the flow of passengers and baggage to and from the aircraft. To determine the capacity of the landside in terms of passengers and baggage requires an investigation of both the capacity of the individual service facilities within the landside and any special interactions that occur among them. (Interactions are particularly important when demand exceeds capacity and some form of congestion or overflow occurs.)

PROBLEMS IN MEASURING LANDSIDE CAPACITY

As mentioned above, capacity can be measured in terms of either flow or storage. Because of the many facilities and their different capacity measures (some of which are not yet defined or known), to measure capacities of the individual components of the landside and to ensure that these individual components are appropriately sized for the demands placed upon them are more meaningful at present than to measure the capacity of the landside as a whole. Problems in measuring capacity of the landside as a whole are discussed below.

1. A perceived, intuitive interrelation between level of service and capacity affects measurement of capacity. Capacity is defined in this paper as a maximum flow rate or storage that can occur under specific operating conditions. An alternate measure of capacity has been used that might be described as service volume. Service volume generally relates maximum flow or storage to a prescribed level-of-service standard, and the maximum flow rate or ultimate capacity concept separates capacity from level of service. For example, the capacity of a departure lounge might be described as 100 seated passengers. This stated capacity implies a level-of-service standard that all passengers will be allowed to be seated in the departure lounge. In fact, however, standing room might be available for an additional 100 passengers and thus create a higher capacity at a lower level of service. In this case, the seated capacity might be regarded as the service volume of the departure lounge. To distinguish clearly whether ultimate capacity or service volume is being referred to in discussions of measuring landside capacity is therefore important.
2. Capacity of both individual facilities and the landside as a whole depends on passenger demand characteristics, such as trip purpose, each passenger's familiarity with the airport, and number of persons traveling together. Therefore, the mix of different types of passengers relative to different types of facilities must be known in order to determine a single capacity value.
3. Operating variables, such as the number of airline counter personnel available, can differ and will cause changes in the capacity of several of the landside facilities. Some services are provided exclusively by individual airlines, and the proportion of total demand on each airline may not be in balance with the capacity that each airline provides at its facilities.
4. Operating conditions that affect capacity vary with the time of day, the day of the week, and the season of the year. There is no single measure of the capacity of the landside for all different operating conditions, and any single capacity value implies a fixed set of operating conditions.
5. Even for a fixed set of facilities and demand characteristics, capacity is not constant. In fact, service times and areas required vary from time to time and place to place. Therefore, capacity can be regarded as an expected or average maximum flow or storage. On an individual basis, flows and storages may be higher or lower than the expected capacity value.
6. Both flow of passengers and flow of baggage must be considered in determining the capacity of the landside. If an airport in a particular year has a ratio of, say, 1.5 bags/passenger, the capacity of the landside might be determined as being constrained by baggage facilities. If the ratio of bags per passenger drops in the future (because of changes in travel demand or availability of carry-on facilities on aircraft), the

passenger flow processes may then become the capacity constraint. Therefore, the capacity measures must be clearly related to the demand characteristics of the individual units (passengers, bags) being processed.

7. The interactions between the landside and other adjacent elements of the transportation system (e.g., airfield and urban transportation network) also affect measurement of capacity. For example, most passengers allow a buffer in their access time to the airport (because of the uncertainty in travel time in the urban transportation network) to ensure a high probability of catching their flights. Therefore, most passengers normally arrive a reasonably significant amount of time before that required to board their aircraft. The early arrival poses a storage load on the terminal building and other elements of the landside that would not occur to the same extent if travelers were more certain about travel times from origins to the airport. Therefore, in considering the capacity of the landside, the "boundary" effects of other parts of the transportation system must also be considered.

Within the problems and constraints described above, it is still possible to achieve reasonably valid measures of the capacity of different functional components of the landside. These measurements can be performed by mathematical or logical analyses or by observation of field data or (probably better) by a combination of the two. In each case it is important to recognize and note the specific operating conditions that are occurring at the time the capacity is measured.

Table 2 gives possible units of measurement for the capacity of landside facilities. For each of these facilities a change in any of the operating characteristics may cause a change in the capacity of the facility. For example, a change in the processing time for ticketing may cause a change in the capacity of the area in front of the ticket counter. If this individual processing facility is the constraining facility, a change in the capacity for this facility will also change the capacity of the landside as a whole.

DEFINITION OF LEVEL OF SERVICE

To date, there appears to be no accepted definition of level of service in terms of an airport or an airport landside. Level of service is a traffic engineering term and, by definition, is a qualitative measurement of a number of factors. For example, the Highway Research Board defined level of service as follows (1):

> Level of service is a term which, broadly interpreted, denotes any one of an infinite number of differing combinations of operating conditions that may occur on a given lane or roadway when it is accommodating various traffic volumes. Level of service is a qualitative measure of the effect of a

Table 2. Measures of capacity of landside facilities.

Landside Facility	Measure of Capacity
Access facilities (roads, transit)	Flow rate (vehicles/hour) Flow rate (passengers/hour)
Terminal curbside	Flow rate (vehicles/hour) Flow rate (passengers/hour)
Parking facilities (garage, remote lot)	Storage capability (number of vehicle parking spaces)
Ticket counter and check-in	Processing rate (passengers/hour)
Security	Processing rate (passengers/hour)
Federal inspection facilities (customs, immigration)	Processing rate (passengers/hour)
Holdrooms	Storage capability (number of passengers)
Baggage claim	Flow rate (bags/unit time)
Circulation elements (e.g., corridors)	Flow rate (passengers/hour)
Waiting areas	Storage capability (number of passengers)
Passenger services (restrooms, public telephones)	Not applicable
Concessions (newsstands, restaurants)	Not applicable
Information services (signing)	Not applicable

> number of factors, which include speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs. In practice, selected specific levels are defined in terms of particular limiting values of certain of these factors.

Although portions of this definition have general application to the landside environment, and particularly to elements of the access roadway system, by its very nature this definition applies to a vehicle that, though operated by a human being, is operated by that human being with knowledge of vehicular and highway constraints. On the other hand, within an airport terminal complex, the human being becomes a pedestrian who is freer—or feels freer—to move in accordance with his or her own desires. Consequently, behavior patterns are less predictable.

For passengers moving through the airport landside, level of service is a subjective impression of the quality of the transfer between the access mode and the aircraft. This subjective impression is dependent on a series of factors, including (but not necessarily limited to) time necessary to be processed through the landside; reliability or predictability of processing time; reaction to overall landside environment; physical comfort and convenience; reaction to treatment by airline personnel, concessionaires, security officers, and other airport personnel; cost of air fare and airport services; type of passenger and purpose of trip; frequency of air travel; and expectations of level of service. Since level of service is made up of all these factors (and possibly many others) in an infinite number of combinations according to personal preferences, we will discuss each of these factors more fully before discussing measures of level of service.

1. Time necessary to be processed through the landside. The ideal amount of time spent in the landside depends on the viewpoint of the passenger. One traveler may wish to minimize his or her time spent in the landside, and another may consider time spent in the landside (or certain elements thereof) as a pleasurable portion of the trip. All travelers, however, desire speed and ease in the basic processing functions (ticketing, check-in, baggage handling, security check). To the extent that the passenger must wait in lines or spend inordinate time in the hold room, the level of service in his or her view may deteriorate. As a consequence, travel time as a measure of level of service must be weighted both by the individual characteristics of the passenger and by the service characteristics of different landside facilities. The overall level of service experienced by the passenger in different facilities also may be affected by other measures of level of service as described below.

2. Reliability of processing time. In the airport trip, each passenger normally allows buffer time for variations in access trip time and in expected processing times through the landside (parking, ticketing, check-in, security check). If variations in processing time could be reduced, then the passenger buffer time could also be reduced, with a concomitant reduction in total processing time. Therefore, one of the measures of level of service is the variability and unpredictability of processing time that can occur in each of the airport landside functions.

3. Reaction to overall landside environment. For both travelers who are interested in minimizing processing time within the landside and the travelers who find their travel experiences are enhanced by time spent in the landside, perception of the quality of the experience is affected by numerous factors in the landside environment including open space, ceiling heights, design and decor, colors and textures of surfaces, cleanliness, floor coverings, lighting, landscaping, and a host of architectural and design features. Although these features significantly influence level of service as perceived by the passenger, this perception is so subjective—and possibly so subtle—that it defies any single objective measure of level of service.

4. Physical comfort and convenience. Closely related to the psychological reaction to the landside environment are physical aspects of contact with this environment. Space available per person, walking distances, temperature, humidity, cleanliness of the air, comfort of seating facilities, convenience of location in essential services, and many other factors influence the physical comfort and convenience experienced by the traveling passenger. Like reactions to architectural and design features, perception

of comfort and convenience factors is often subjective and defies any single objective measure of level of service.

5. Treatment by airline personnel, concessionaires, security officers, and other airport personnel. The efficiency and friendliness of airport and airline personnel can be crucial to the perceived level of service by the passenger. For example, a single negative experience with an airline agent, a newsstand operator, an immigration officer, or security guard can outweigh all of the other positive factors in the airport landside and induce a net negative impression of poor level of service from the point of view of the passenger.

6. Cost of air fare and airport services. The level of service perceived by the passenger may sometimes be affected by the air fare paid for the trip. A charter passenger paying a relatively low fare may be willing to accept a level of service in the landside lower than that passengers paying regular coach or first-class fares will accept—even though that acceptance does not necessarily mean the charter passenger likes the level of service. In addition, the cost of using various services provided within an airport landside (parking, rent-a-car, restaurants, gift shops, bars) may affect the overall impression of level of service for the landside as a whole as perceived by the passenger.

7. Type of passenger and purpose of trip. The type of passenger and the purpose of the trip may strongly affect the passenger's view of level of service. For example, the level of service from the viewpoint of a commuter passenger may be entirely different from level of service as viewed by the aged or infirm traveler. Similarly, the level of service from the viewpoint of a business traveler may be entirely different from that of a pleasure traveler. And still further, the level of service from the viewpoint of the same individual may change relative to the purpose of the trip. A passenger may react to the landside environment entirely differently when traveling on business and under pressure than when traveling on an extended pleasure trip around the world. A business traveler might consider speed and convenience as the highest measure of level of service. Speed and convenience would involve convenient parking at the originating airport, simplicity and efficiency of check-in, quick access to the gate, and possibly the availability of newspapers, convenience items, and restrooms close to the departure area. At the destination airport, the business traveler might place a high value on convenience of ground transportation (probably taxicab or rent-a-car services) and nearby hotel accommodations. For the business traveler, the price of services may not be a major consideration. On the other hand, although price-conscious pleasure travelers will probably value speed and convenience of service, they may be willing to compromise these comforts in favor of having available the basic necessary services (limousine, buses, telephones, restrooms) at the lowest possible cost. In other words, speed and convenience would normally have a higher value than price for the business traveler, but price would normally have a higher value than speed and convenience for the price-conscious pleasure traveler.

8. Frequency of air travel. The passenger's view of level of service may also be affected by the frequency that he or she travels by air and by familiarity with a given airport landside environment. Frequent air travelers learn what services and operating conditions to expect in the airport landsides they use and can plan their airport trip accordingly, thereby minimizing any uncertainties they might otherwise have. On the other hand, infrequent air travelers or passengers using a given airport landside for the first time may feel uncertain and uncomfortable in any of the large airport landsides because of their unfamiliarity with the facilities and services and a fear that they might miss their flights. The frequent traveler may also learn to maximize his or her perceived level of service within the landside at hand by using special facilities that are provided in most landsides. For example, the frequent traveler may elect to use the theme restaurant (rather than a fast-food facility) or an airline club room (rather than a public cocktail lounge).

9. Expectations of level of service. The perception of level of service by any individual traveler is also greatly affected by the expectation he or she brings to the airport. In today's world, advertising creates levels of expectation against which an individual "measures" the service received. The airlines spend tremendous sums on

advertising that creates high expectations about air travel, and these expectations frequently are not satisfied in the airport landside environment. Hence, level of service is frequently perceived as poor. In essence, markets are created through advertising; and to the extent that these efforts are successful, the level of service as perceived by the passenger may deteriorate accordingly since the service received does not come up to the passenger's expectations. The term "service" means "for the benefit of another," or something done for someone. On the other hand, "process" means "a series of actions definitely conducive to an end." Whereas the advertising media give the impression of the airline doing something for the traveler (service), the actual experience is frequently more likely to be that of something done to the traveler (process).

In summary, level of service in the airport landside is made up of a series of factors that involve the passenger's reaction to the landside environment. Overall, the passenger is primarily interested in speed, comfort, convenience, and cost (not necessarily in that order). The fact remains, however, that the primary objective of any air traveler's trip to the airport is to catch a flight. If there is only one airport that provides the desired flight schedule, the traveler must accept whatever level of service that airport provides.

Interestingly, travelers seldom express a conscious concern about safety; perhaps this apparent lack of concern is a testimonial to the planners, architects, engineers, and designers since it is implicit in their work that transportation modes and facilities be developed to stringent safety specifications with the consequence that the average user takes safety for granted.

PROBLEMS IN MEASURING LEVEL OF SERVICE

Level of service relates to quality of passenger's experience. Since quality is made up of innumerable factors, many of which are subjective, level of service does not lend itself readily to measurement.

Although the Highway Research Board definition specifically recognizes that level of service involves a number of qualitative factors, the best measure of level of service developed to date, from the standpoint of the traffic engineer, is time—probably because time is relatively easy to measure, and comfort and convenience are not.

In measurements of the factors that contribute to level of service, 3 primary entities whose views must be considered are passenger, airlines, and airport sponsor. Each of these entities has a different view of the desirable or optimum level of service, even though each entity is concerned with (among other things) safety of passengers and other landside users; convenience and comfort of the passenger; optimum performance (e.g., delay time) of the landside facilities in relation to overall costs; and general pleasantness of the landside environment, particularly in the terminal building.

Passenger Viewpoint

From the passenger viewpoint, there is no consensus of opinion as to what constitutes level of service. Like beauty, level of service is probably in the eye of the beholder. However, because the primary function of the landside is to accommodate passengers, level of service from the passenger viewpoint should be of major importance in the attempt to develop level-of-service measures.

Block (2) states that the airport is part of the social system (as well as the air transport, economic, and regional development system) "since no achievement or activity has any raison d'etre or value in the end except in relation to mankind." Block goes on to say that an airport must consider carefully human aspirations and the quality of human relations since, without care for these matters, the harmony of life in society is no longer possible.

In a more practical vein, Block further notes that the passenger is "first and foremost the customer of the airport, whose services he uses and pays for either directly, through specific charges or fees, or indirectly through his personal taxes or airplane tickets."

Human values (or human factors) are normally expressed in terms of physical and psychological comforts. As suggested earlier, elements relating to physical comfort may be considered to include distances necessary to walk from ground transportation to the aircraft; stairways and ramps that passengers must go up and down to reach the aircraft; the passenger's baggage load and how far it must be carried; congestion encountered in the various facilities the passenger desires or is required to use in reaching the aircraft; the size and type of seating; and building temperatures and humidity.

Elements relating to psychological comfort may be considered to include waiting times, speed and ease of check-in, ease of locating flight departure room, ready availability of flight information, congestion in the various landside components, and any other factor that contributes to the psychological comfort (or discomfort) of the passenger, some of which may also relate to physical comfort.

The lack of both physical and psychological comfort for the air traveler is evident in many major terminals today. Yet, attitudinal surveys with regard to passenger desires in airport terminals are relatively few. As long ago as 1962, a survey conducted by Printer's Ink suggested that even at that time the air traveling businessman was growing increasingly disenchanted with air transportation. The reasons cited included lost baggage, "inadequate, uniformed and for the most part uninterested counter and telephone personnel," delays not due to weather, bad service at airports, waiting in line to check in, long walks from arrival and departure areas, and waste of time before each flight.

More recent insight may be gained from a 1972 study by Resource Management Corporation, Inc. This study summarized problems that were encountered by the public in using domestic intercity common carriers (air, bus, and rail) and that stemmed from inadequacies in services, procedures, facilities, and equipment. Briefly, these include

1. Inadequacies in terminal facilities, such as unavailability of physical assistance with luggage, loss and damage from baggage-handling systems, insufficient security for traveler belongings, building maintenance, and malfunctioning on-board equipment;
2. Lack of consistency in coordination, standards, and procedures for information systems (incomplete trip data and directions), signing (lack of uniformity), industry abbreviations and terminology, public address systems, passenger handling, local transportation, and food and beverage services; and
3. Inconsistent and inadequate level of service (here the authors do not cite the inconsistencies or inadequacies, but point to the failure of public agencies to prescribe such standards, the lack of coordination between government agencies and private organizations, and the fact that the common carriers determine their own procedures and standards so that quality is largely dependent on the extent and level of competition).

Formal passenger complaints to the U.S. airlines, submitted to and compiled by the Civil Aeronautics Board (3, 4), address primarily aspects of airline operations. In 1974, the CAB handled almost 16,000 complaints from air travelers. The chief causes of the complaints (in descending order) were fares and refunds, flight delays, problems in reservations, oversale of tickets, and baggage loss. By comparison, in 1969, baggage loss was the chief cause of formal complaints to the airlines.

According to surveys taken at European airports (5), passengers desire the following (in order of importance):

1. Quicker baggage reclaim on arrival,
2. Improved and faster security checks,
3. Faster check-in on departure,
4. Shorter walks to the aircraft, and
5. Quicker immigration and customs checks.

These complaints and preferences are directed primarily to aspects of airline operations, and many of them can and are being resolved by continuing technological advances in ticketing techniques, baggage-handling systems, and the like. However, the problems related to other aspects of human comfort are much more subtle and difficult to quantify. Furthermore, as suggested previously, the matter of level of service will vary for each individual passenger, since each person has his or her own view of expected (or tolerable) level of service.

Another aspect of the human values problem is a sociological one. Sommer (6) attempts to pinpoint the problem of human values as they relate to public buildings as follows: "Generally the architect is recruited by one group of people (clients), typically a corporate board or public agency, to design something for another group of people (consumers). The danger in such an arrangement is that the consumer becomes a faceless non-person." Sommer goes on to say that the philosophy behind public buildings is that "it is best for everyone, especially the taxpayers who foot the bill, to design things that cannot be destroyed. The result is that architecture is designed to be strong and resistant to human imprint. To the inhabitants it seems impervious, impersonal, and inorganic."

Sommer ranks airport terminal buildings high in his list of socially destructive buildings. He describes them as "among the hardest buildings in the land, precast concrete testimonials to the school of monumental architecture." He contends that most airports are not designed for people, that they are "warehouses where merchandise is sorted and stacked for shipment."

He states that a common misconception is that people spend little time in airports; actually, he says that, even if people spend only an hour in the airport per trip (an estimate he believes to be low), there is no reason why this time must be wasted time in a cold, sterile, and unfriendly building.

Among other things, Sommer cites the seating arrangements, with rows of chairs placed back-to-back or arranged in classroom style, which he marks as impersonal and institutional and discouraging of social intercourse. (It is interesting to note that a frequently found seating arrangement at many airports today continues to reflect "standards" established in 1959 by the Federal Aviation Administration in "Airport Engineering Sheet, Subject: Airport Terminal Building Waiting Areas.")

Actually, Sommer's observations seem overly harsh in many instances, but they can serve as a continuing reminder to the planner and designer that airports are (or should be) built to serve people and should respond to human values. The real challenge to the aviation industry is how the human values problem can be improved.

The thread that runs through innumerable articles and studies concerning all kinds of transportation planning is that the design of transportation facilities has historically been governed by 3 criteria—capacity, functional geometry, and economics—and that little or no consideration has been given to aesthetics, comfort, or convenience. Although this statement may be true for train stations, subway stations, and the like (at least in the past), it hardly is true of airport landside planning in the last 15 to 20 years. Substantial consideration has been given to providing aesthetics, comfort, and convenience in the airport landsides at Dulles, Tampa, Honolulu, and Dallas-Fort Worth, among others. And yet, how can a valid level-of-service measure be applied to these airports? Johnson (7) states:

> Designing streets, roadways, structures, on-ramps, and off-ramps is a long and tedious job; it requires calculation, drawings, sketches, questions, answers, and application of engineering judgment. In spite of its complexity, it is at least a process that we understand.... Injecting human factors into the design process, however, presents an extraordinarily difficult task. We cannot sit down at the drafting table, pull out handbook and slide rule, and produce the right answer. At this point in our experience with human factors engineering in transportation design, we have very few answers to offer. We have many questions and by no means not all of them have even been formulated....
>
> All of the problems in human factors engineering for transportation design, as for other urban facilities, revolve around the basic problem that has been identified for centuries but never solved. And that is the problem of people. How do we find out what people want? Do individuals and

groups know what they want? To what extent will they resist apathy and spend their time and money in a positive effort toward a community goal?

These questions in turn uncover a subtle but important philosophical problem. To what extent is a transportation planner justified in determining what designs are good for the people and in carrying out plans to implement his designs?

Johnson concludes that perhaps it is hopeless if in human factors engineering we use the traditional engineering approach to solving problems—that is, assign numbers to all variables, plug them into a formula, and come up with the answer.

Answers from such formulas can be no better than the values assigned, and in assigning the values lies the basic difficulties. An attempt to assign a numerical value to each human factor that might be identified would wind up hopelessly tangled. The number of variables is staggering.... Reducing human values to statistical measurement is of itself dehumanizing, and dehumanization is the antithesis of human factors engineering. It would indeed be discouraging to discover that somewhere an engineer is industriously working on a mathematical model that will determine what constitutes a good stage play and what the price of the ticket should be for the benefit received.

If this be the case, then what does the human factors engineer use if he or she cannot rely on mathematical models and handbooks? Johnson says, "Judgment.... We must adopt the goal of being human engineers who use human judgment to design for people.... We must maintain our sensitivity to ever-changing human qualities around us.... We should not allow human factors engineering to become just another discipline accompanied by standard textbooks, charts, tables, guidebooks, computers, and technicians who can plug in the numbers and come up with a design."

Fruin (8), who applied level-of-service concepts to the design of pedestrian spaces, further supports the case for judgment. He notes that, like the standards in the Highway Capacity Manual (which were developed for 6 levels of design based on service volumes and a qualitative evaluation of driver convenience), pedestrian service standards should also be based on the freedom to select normal locomotion speed, the ability to bypass slow-moving pedestrians, and the relative ease of cross and reverse flow of movements at pedestrian traffic concentrations. Fruin further states, however, that, although level of service standards provide the designer with a useful means of determining the environmental quality of pedestrian space, "they are no substitute for judgment." Perhaps an overall reservation about the hazards of strict application of standards may best be noted in the preface to Fruin's work, which states, "The title 'Pedestrian Planning and Design' may be considered by some to be a misnomer, since only the Good Lord can plan or design a pedestrian."

Airline and Airport Sponsor Viewpoint

Although the airlines and the airport sponsors have independent viewpoints (the airlines are privately owned and operated for business profit, and air carrier airports are publicly owned and operated in the public interest), for physical planning purposes, the factors of airline economics and airport financial considerations are so interrelated as to be inseparable.

First, the ultimate size of the terminal complex is determined by the total area of the functions to be provided. The number of aircraft parking positions, as well as the requirement for individual passenger and baggage processing facilities, is influenced (in the United States) by the desire of each individual airline to maintain its own competitive identity—an identity that is greatly complicated by the fact that competition must be undertaken on bases other than price. With services aloft growing ever more similar among airlines, competitive identity must be established (or so the airlines state) almost entirely on the basis of ground services—hence, the desire of the airlines for exclusive gate positions and separate servicing equipment, signing, and baggage facilities and hence an increase in overall terminal size and design complexity.

Second, the airlines must consider the location of operating functions in such a way that the minimum number of airline personnel is required and that multiple use is made of personnel where possible (e.g., in common hold-room areas, where 1 or 2 airline personnel handle check-in and seat assignments for 6 to 10 gates). These requirements also result in certain physical planning considerations that may be opposed to human comfort insofar as the passenger is concerned but that create economies for the airlines.

Third, from the viewpoint of both the airport sponsor and the airlines, the landside should be designed to maximize revenues from concessions. As airports require ever greater amounts of capital for expansion and construction, the importance of developing revenues to support the sale of revenue bonds has become increasingly important—hence, the emphasis on the "forced-feed" principle of terminal design whereby passengers are forced through concession areas on their way to gate positions. (The forced-feed principle was specifically rejected at the new Kansas City International Airport and the new Dallas-Fort Worth Airport in the interest of minimizing passenger walking distances.)

Although the use of the forced-feed principle results in the greatest possible exposure of the passenger to the various concessions, it can at the same time increase passenger walking distances and the overall complexity of the landside operation. On the other hand, the presence of a variety of concessions can create an interesting terminal environment for the traveler with time to spend in the airport, and it can be argued that many passengers today consider the presence of certain concessions as essential to their needs in the terminal operation.

Fourth, airport sponsor and airline objectives require that maintenance and operating costs be held to a minimum to maximize overall operating income. Maintenance and operating costs grow in relation to the size of buildings; consequently, the greater the total area is, the higher the maintenance and operating costs will be.

Actually, level of service from the viewpoints of both the airport sponsor and the airlines is expressed in generally the same terms, although possibly not in the same order of priority. The 3 primary measures are capital costs, operating and maintenance costs, and passenger (or public) service (including safety, convenience, efficiency, and aesthetics).

The importance of political considerations with regard to both the airline and airport sponsor viewpoints must be acknowledged; but, of all factors that will affect landside planning, these are the least predictable.

One of the primary stated goals of most sponsors of major airports is "to maximize net revenues to the airport consistent with public service goals." Although this statement is made in the tradition of operating public facilities in the public interest, the question that must be raised is, How does one measure public service? and even, What is public service?

With regard to public service as it relates to airports, any airport operator will attest to the fact that the travel market has changed substantially during the last 15 years, and the general level of public service (that is, quality) desired may also have changed. For example, where "silver-service" dining room and coffee shop facilities were considered desirable (if not required) at major airports 10 years ago, the trend in the food and beverage market on airports today is toward more fast-food facilities. This emerging market for fast-food facilities, however, may also reflect the need to serve quickly increased numbers of passengers, particularly at peak hours, as well as the operating economies such facilities afford the concessionaire.

NEED TO MEASURE LEVEL OF SERVICE

Within the last several years, several documents have been written about the need to establish universal criteria for evaluating terminal concepts and for measuring level of service.

Baker and Wilmotte (9) note that decision makers are increasingly interested in the benefits to be anticipated from different transport investments. According to them, 3 classes of impacts are of major concern: (a) direct effects, that is, how well the system performs its function; (b) indirect effects, that is, how the environs are influenced by the system; and (c) a combination of both direct and indirect effects, that is, how well the programs of the society are supported by the transport system.

The authors state that, within the field of transportation, a capability needs to be developed for a quantitative response to these questions. The authors go on to say that, if adequately defined, level of service can provide this capability and can provide the measure of how transport performs as a basis for design. Transportation, they say, needs a measurement of both quantity and quality, that is, how much and how well the movement of people and goods is accomplished.

According to the authors, the specific elements that should be used to define the level of service of transportation, as well as their method of measurement and grouping, need to be established by practical experience and consensus. The list and grouping should include purpose; quantity; direct effects, including cost (out-of-pocket), time (and time-related), safety, and comfort (physical and psychological); indirect effects (physical and psychological); and resources consumed. At the present time, there is neither a generally accepted definition nor a unified method of measurement of the quality of service of transportation. The question remains whether a valid unified method of measurement can be developed, particularly in view of the subjectivity of level of service (i.e., quality).

Some planners suggest establishing levels of service and then establishing the percentage of passengers for whom service should be equal to or better than the stated limit. Apparently the goal is that a proper airport system should provide good service to most of the passengers and acceptable service to all of the passengers. Once again, the question must be raised as to what is good and what is acceptable.

There also appears to be a belief that once level of service is defined the planner can proceed to set up standards for evaluation and sizing of spaces based on the definition. Criteria for sizing certain landside components (such as sizing of parking spaces, length of curbside, and sizing of queuing areas) and criteria with regard to functional flows are indeed useful to the planner. However, the development (and use) of uniform standards related to a predetermined level of service could seriously restrict the thinking of airport planners in the future in their attempts to improve the landside environment. Each airport and each airport landside has unique problems—site configuration and constraints, existing terminal design (most terminal development projects at major airports today involve expansion of existing facilities, rather than development of completely new ones), community goals and objectives, character of travel market (which can change over time), character of airline service (which also changes over time), and so on.

Consequently, the aviation industry must approach with an open mind the manner in which it develops measurements for level of service but with a full understanding of what level of service can and should do within the needs of the industry. As Johnson said (7, p. 42): "Answers from such formulas (i.e., formulas based on assigning numbers to all variables) can be no better than the values assigned... and an attempt to assign a numerical value to each human factor that might be identified would wind up hopelessly tangled."

EXISTING LANDSIDE PLANNING CRITERIA

Whatever the shortcomings of some terminals, the various parties involved in terminal planning and design have historically placed a high priority on the needs of the passenger (both physical and psychological) in the development of a terminal design.

In its most recent airport terminal manual (10), the International Air Transport Association (IATA) states in the first paragraph of the chapter on Passengers, "In airport terminal facilities, the passenger expects to find comfortable pleasant surroundings and to be conveniently serviced in an expeditious manner." This chapter of the manual goes on to present detailed information and guidance on layout and design concepts, flow principles and design targets, electronic data processing, government controls, facilities sizing and space criteria, and essential ancillary services.

It is interesting to note that, in the 1956, 1959, and 1962 editions of the manual (11, 12, 13), walking distances were defined in terms of distances from the base of the finger to the aircraft or in terms of distance from the building to the aircraft if covered accommodation is not provided. The fifth edition (effective December 1970) reflects the tremendous growth in size of the terminal operation and sets out design targets for walking distances (without mechanical assistance) in 7 terminal situations as follows (10):

Situation	Distance (ft)
Curbside to baggage check-in	65
Car park (farthest car) to baggage check-in	950
Baggage check-in to farthest gate	1,000
Gate to aircraft	165
Farthest gate to baggage delivery	1,000
Baggage delivery to curbside	65
Baggage delivery to car park (farthest car)	950

In view of overall facilities requirements and the differing requirements of the various entities involved, to retain walking distance goals can be difficult. For example, the initial planning goals for the new terminal facilities at Tampa International Airport set a maximum walking distance target of 200 ft (60.8 m). As the precise design evolved, it became apparent that, within the constraints imposed by the terminal complex site, the stated space requirements, the efficient functional relations, and the limitations of the ride system hardware, realizing that goal would be impossible. Ultimately, the goal was revised to a maximum of 700 ft (212 m) without mechanical assistance.

The minimum walking distance goal has become an overriding one in airport terminal planning since 1960, possibly because walking distances can be measured. However, there are other considerations relative to walking distance that are equally important. If walking distances are shortened to the extent that congestion results in other terminal components, then the value of the reduced walking distances is mitigated.

During the years, a series of criteria have evolved that should be considered in terminal (landside) planning, even though many of them do not lend themselves to quantification.

From the standpoint of passenger comfort and convenience, the primary goal in terminal planning (aside from safety) is that the terminal design permit each passenger to (a) flow through the landside in accordance with his or her own preferences, (b) dispose of non-carry-on luggage at the earliest possible moment in the enplaning function and to claim it at the last possible moment in the deplaning function, and (c) be separated from well-wishers at the last possible point prior to boarding the aircraft in the enplaning function and be joined with greeters at the earliest possible point in the deplaning function. Within this primary planning goal for the passenger, the landside should provide

1. Facilities to accommodate the requirements of the various traffic markets (commuter, long-haul, international, domestic, tourist, business) that use the airport and and that have specialized requirements for effective performance;
2. Within the airport boundaries, an adequately sized and clearly signed terminal access roadway system that provides for the efficient flow of arriving and departing passenger traffic and the separation of public and service vehicle loads;
3. Sufficient curbside for the stopping of vehicles (private cars, limousines, taxis, buses, courtesy cars) at the passenger terminal for the purpose of picking up and dropping off passengers and baggage;
4. Adequate public parking facilities convenient to the passenger terminal with

direct and easily understood access and egress;

5. Weather protection from the point the passengers debark from their ground transportation until they reach their seats in the aircraft;
6. Separation of passenger flows from surface vehicle traffic on airport roadways;
7. Separation of passenger flows from aircraft servicing functions by grade separations, safety devices, and enclosed walkway and loading bridges;
8. Direct, self-evident, and unobstructed passenger flow routes that permit free-flowing circulation through the terminal to and from the aircraft boarding areas;
9. Separation of enplaning and deplaning passenger flows and functions to eliminate cross flows;
10. Minimum changes in level and direction for both passenger and baggage flows;
11. Minimum walking distances between ground transportation and the aircraft boarding points;
12. Minimum walking distances with luggage in both the enplaning and deplaning functions;
13. Adequate and varied seating (in baggage claim, ticketing, and main lobby areas) near to but apart from primary circulation patterns;
14. Protection from exposure to weather, aircraft blasts, noise, fumes, and vehicle activity;
15. Appropriate location and sizing of airline, concession, and administrative facilities;
16. Queuing areas at ticketing, baggage claim, and other service facilities of sufficient size to accommodate peak-period volumes without undue congestion;
17. Provision of adequate facilities for sightseers and visitors that do not interfere with passenger and baggage flows or airport functions; and
18. Well-placed directional signs and orientation graphics.

A careful review of these criteria suggests that each contains an element of subjective judgment and that it may not be possible to quantify them in mathematical terms. Specific standards for certain elements (such as size and configuration of access roadways, length of curbside, number of parking stalls, and size of queuing areas and circulation areas) can be determined relative to forecast passenger volumes; however, the juxtaposition of spaces, the overall terminal environment, and the communications and information systems defy a strict "numbers" approach.

MEASURES OF LEVEL OF SERVICE

Table 3 gives the basic landside components, shows possible units of measurement for those level-of-service factors that are easy to quantify, and indicates those level-of-service factors that are difficult (if not impossible) to quantify. The level-of-service factors that are the easiest to measure are those relating to cost and time.

SUMMARY AND CONCLUSIONS

1. Capacity relates to physical capability and lends itself to measurement. Level of service relates to quality and does not lend itself readily to measurement because, by definition, quality is subjective.
2. Capacity can be measured in terms of either flow or storage. However, the capacity of each facility within the landside depends on many factors, and variations in any one factor may cause a change in the capacity of the landside as a whole. Because of this interaction, to measure capacities of each landside component individually and to ensure that each individual component is appropriately sized are more useful than to measure the capacity of the landside as a whole.
3. Measurements of capacity can be made by mathematical analyses, by observation of field data, or (preferably) by a combination of the two. In each case, the specific operating conditions at the time the capacity is to be measured must be established.

4. It is possible to determine capacity only for a given set of demand characteristics at any given airport. The provision of adequate capacity in a given airport landside depends on the forecasts—and forecasting at best remains a nebulous art. If the forecasts prove to be accurate, then, theoretically, capacity should be sufficient. However, in addition to forecasts of gross passenger demands, the character of the demand represented by the forecasts must be known if appropriate capacity is to be provided. If the characteristics of the passenger demand vary from those on which the forecasts were based, excess (or insufficient) capacity in the airport landside or in certain of its components may result.

5. Level of service is made up of innumerable factors. For the passenger, level of service is a subjective impression of the quality of the transfer between his or her access mode and the aircraft. In general, level of service for the passenger can be said to comprise speed, comfort, convenience, and cost. However, speed, comfort, and convenience are extremely broad terms that defy precise definition—particularly

Table 3. Measures of level of service of landside facilities.

	Level of Service	
Landside Facility	Easy to Quantify	Difficult to Quantify
Access facilities (roads, transit)	Travel time Delay Transit frequency Cost to passenger	Adequacy of signing Level of congestion
Terminal curbside	Availability of space Delay	Level of congestion Curbside check-in
Parking facilities (garage, remote lot)	Availability of space Distance to check-in and baggage claim	Shuttle bus service to and from remote lots
Ticket counter and check-in	Processing time	Complexity of procedure Courtesy of airline personnel Overall environment
Security	Processing time	Actual procedure (search, X-ray) Location in relation to concessions Courtesy of security officers
International clearance (customs, immigration)	Processing time	Complexity of procedure Courtesy of clearance officers Overall environment
Hold rooms	Seat availability	Overall environment Location in relation to concessions Level of congestion
Baggage claim	Waiting time for bags	Hardware involved Level of congestion Availability of skycaps Availability of concessions Availability of seating
Circulation elements (corridors, moving sidewalks)	Walking distances Width of corridors Height of ceiling Travel time Frequency of service (hardware) Cost to passenger	Overall environment Hardware used Signing Public address systems Level of congestion
Waiting areas	Availability	Seating arrangement Comfort of seating
Passenger services (restrooms, telephones)	Availability Cost to passenger	Service provided Level of congestion Cleanliness
Concessions (newsstands, restaurants)	Availability Cost to passenger	Service provided Courtesy of operator Overall environment Level of congestion
Information services (signing)	Availability	Service provided Clarity, legibility, placement

within any context that relates to more than one individual. Actually, level of service will vary for each individual passenger, since each person has his or her own view of expected (or tolerable) level of service. Furthermore, for any passenger, there may not be a "single" level of service in any one trip; there may be many levels of service. For these reasons, level of service defies any single, objective measure.

6. Finding out what people want in the airport landside is a prerequisite to further development of the understanding of level of service. Attitudinal surveys concerning passenger preferences in an airport landside are rare. Those surveys that have been made appear to have been directed primarily to the mode of transportation and processing procedures rather than to the more subjective aspects of the passenger's reaction to the quality of the landside environment. If we are to develop valid measures of level of service, we need to know what people want or value in the airport landside. The survey process seems to be the first step, but the development of appropriate survey questions is crucial to the validity of meaningful survey results. Consequently, the real challenge in developing level-of-service criteria lies in how to go about determining and evaluating people's preferences. Such an effort requires the talents of many disciplines, including specialists in human factors, sociology and psychology, airport planning and operations, traffic engineering, urban design, market research, and possibly others.

7. There are increasing pressures for the development of a quantitative response to the question of how well transportation systems perform. It has been said that, if adequately defined, level of service could provide a measure of such performance. There appears to be a belief that, once level of service is defined, the planner can proceed to set up numerical standards for evaluating level of service based on such a definition. Criteria for sizing certain landside components (such as parking spaces, length of curbside, and queuing areas) and criteria with regard to functional flows are indeed useful to the planner. However, the development and use of uniform standards related to a predetermined level of service could seriously restrict the thinking of airport planners in the future in their attempts to improve the landside environment. Each airport and each airport landside has unique problems—site configuration and constraints, existing terminal design (most terminal development projects at major airports today involve expansion of existing facilities, rather than development of completely new ones), community goals and objectives, character of travel market (which can change over time), character of airline service (which can change over time), and so on.

8. The aviation industry should approach with an open mind the manner in which it develops measurements for level of service and must somehow develop a full understanding of what level of service can and should do within the needs of the industry. As Johnson stated (7), "Answers from formulas (that is, formulas based on assigning numbers to all variables) can be no better than the values assigned... and an attempt to assign a numerical value to each human factor that might be identified would wind up hopelessly tangled." However, the level of service concept can serve a useful purpose even if it cannot be measured in strictly numerical terms. If we can develop a better understanding of level of service and if there can be developed a consensus as to the relative importance of each element of level of service, these judgments can then form a basis for improving level of service.

9. A wide body of knowledge containing guidelines and criteria for landside planning exists today and is continually revised and updated by various agencies and institutions. For example, IATA has been preparing terminal planning criteria since 1952 and tends to set "design goals and objectives" rather than rigid criteria. The IATA manuals defer to local situations and the individuality of individual planning projects. Most of these criteria do not lend themselves to quantification, but rather provide a basis for planners to make design judgments.

10. Factors affecting level of service that can be measured easily are those relating to cost and time. Those factors relating to quality and to the perception of the quality of service by the passenger are difficult (if not altogether impossible) to quantify in numerical terms.

11. Before proceeding with further development of level-of-service measures, the

industry must determine precisely what the goals for such measures are to be, the uses to which the information will be put, and the qualifications that should be placed on their use. In making these determinations, the industry should bear in mind the historic implications of a "standards" approach. For example, although noise contour measurements relative to airport environmental studies are specifically designated as planning guidelines and are fully qualified by statements of their technical limitations, in actual practice the contours have been used frequently not as planning guidelines but as precise evaluative tools. As a consequence, in many instances, noise contours have created misunderstandings and negative reactions that may have outweighed their values as a planning tool.

12. In the planning of the airport landside (as in any other venture), nothing can substitute for good management and for good judgment. With good management, a seemingly impossible set of planning problems can be turned into an asset—and may in fact create a challenge that can lead to innovative solutions. With poor management, the value of a fortuitous set of planning circumstances may not be fully realized and, at worst, could be lost altogether.

REFERENCES

1. Highway Capacity Manual. HRB Special Rept. 87, 1965.
2. J. V. Block. Airports and Environment. Aeroport De Paris, France, 1971.
3. 1969 Consumer Complaints Survey Report. Civil Aeronautics Board.
4. Summary of Consumer Complaints, Calendar Year 1974. Civil Aeronautics Board.
5. G. Steensma. Modern Techniques for Passenger Processing. International Air Transportation Conference, San Francisco, March 24-26, 1975.
6. R. Sommer. Tight Spaces. Hard Architecture and How To Humanize It. Prentice-Hall, Englewood Cliffs, N.J., 1974.
7. D. W. Johnson. Urban Transportation... Highways. Consulting Engineer, March 1969.
8. J. J. Fruin. Pedestrian Planning and Design. Metropolitan Association of Urban Designers and Environmental Planners, Inc., New York, 1971.
9. R. F. Baker and R. M. Wilmotte. Technology and Decisions in Airport Access. Urban Transportation Research Council, ASCE, 1970.
10. Airport Terminals Reference Manual. International Air Transport Association, 5th Ed., Dec. 1970.
11. Airport Buildings and Aprons. International Air Transport Association, July 1956.
12. Airport Buildings and Aprons. International Air Transport Association, 2nd Ed., Aug. 1959.
13. Airport Buildings and Aprons. International Air Transport Association, 3rd Ed., Aug. 1962.