Workshop 4 Resource Paper

AIRPORT AIRSIDE AND LANDSIDE INTERACTION

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This paper explores and examines some of the principal interactions between 2 elements of the airport—the airside and the landside—and how physical and operational improvements to each element are assessed in the context of the interaction. A brief description of the airside and landside elements is presented, and the most important factors affecting the interaction between the elements are outlined. In addition, recent advancements in the state of the art in determining airside capacity and delays are summarized. The principal influences of the landside on airside activities and development are limited to the apron-gate area component of the airside and are capable of being accommodated without serious conflict with other airport developments. By comparison, the principal influences of the airside on landside activities stem primarily from the fixed-point servicing requirement of airline aircraft, which occurs on the apron-gate area component of the airside. The extent of these influences is largely dependent on the degree of separation of the 3 basic operational areas of the landside: the aircraft-passenger processing area, the passenger collection point, and the access interface area. At most airports, these 3 operational areas are contiguous, and the influence of the airside on the landside, therefore, is substantial. Finally, the requirement, desirability, and practicality of balancing the airside and landside in various ways are addressed.

Between 1960 and 1970, air transportation emerged as an integral part of the national life-style. Today, the aviation industry is advancing toward full maturity and has prospects for a more stable, albeit less dynamic, future. A brief review of the more recent history of the industry, and particularly the maturing influences, provides a useful point of departure for the discussion of the interaction of 2 elements of air transportation: the airport airside and the airport landside.

During the 1960s, air transportation was characterized by spectacular growth in air passenger traffic levels and generally a sometimes unconstrained optimism, largely as a result of nationwide economic expansion and the airlines' conversion to jet aircraft fleets. In the transition into the 1970s, it became generally recognized that the period of dramatic growth was over and that future air passenger traffic would more closely parallel the growth rate of the total national economy. Most recently, the "stagflation" of the world economy, spurred by rising costs and petroleum fuel shortages, has further tempered this outlook and, at the same time, provided extra motivation for self-imposed efficiency within air transportation.

A number of other maturing influences have also impacted air transportation. One of the most dramatic was the rapid introduction of wide-bodied aircraft (i.e., B-747, DC-10, L-1011) into scheduled service. With their sizable passenger and cargo capacities, these large aircraft presented manifold and often conflicting problems to the airports accommodating them. Since the wide bodies could carry larger numbers of passengers per flight, they tended to reduce the level of aircraft operations both on the airfield and in the airspace. Thus, they seemed to defer the point in time when runways would be saturated by air traffic activity. But the wake turbulence problems of the wide bodies and other heavy aircraft caused increased air traffic control separation standards, and as a result runway capacity has actually decreased at airports handling significant volumes of these aircraft. In addition, their sheer size often required special accommodation and treatment on the taxiways and in the apron area.

In the passenger terminal area, previously unknown volumes of passengers and baggage streamed from the wide bodies, often straining terminals to the extent that airport sponsors and airlines fell under tremendous pressure to expand their passenger-handling facilities. The rapid development of wide-bodied aircraft by manufacturers and their equally rapid acceptance and use by the airlines added to the pressure. With few exceptions, airports were forced to scramble to provide for the needs of these aircraft. These and other experiences related to the wide bodies dictate that air transportation must carefully identify and weigh all impacts of any new aircraft requiring a similar commitment of resources in the future.

In the midst of the airports' full reaction to the wide bodies, an emerging awareness of and sensitivity to the environment were evolving on the national scene. The maturing air transportation industry, as a consequence, found it necessary to explicitly incorporate environmental considerations in any plans for future development.

The provisions of the National Environmental Policy Act of 1969 established the framework for study and evaluation of the environmental impacts of any proposed public facilities that could conceivably conflict with the environment. Specific requirements and guidance with regard to airport improvements funded under the Airport and Airway Development Act of 1970 are further spelled out in the FAA Order 5050.2A, Procedures and Policy for Processing Airport Development Actions Affecting the Environment. Among other things, this document requires not only a thorough and an objective evaluation of the environmental impacts of any proposed improvement but also a similar evaluation of all reasonable alternatives to the project that might avoid some or all of the adverse environmental effects. In addition, many states have adopted similar types of environmental assessment requirements.

Another impelling force behind the evolution of air transportation from yesterday's "cap-and-goggle" infancy to today's maturity is the increasing sophistication of the nation's attitudes, concerns, and policies. Because of this expanding outlook, it is becoming more critical than ever to determine and maintain realistic priorities for the development of all elements of air transportation. Such priorities must somehow account for available trade-offs between the elements and must reflect real-world conditions and constraints.

Along these lines, action by the 1973 House Appropriations Committee led to a short-fused Federal Aviation Administration (FAA) study (1) of capacity and delay at 8 major airports in the country and an assessment of FAA research and development programs that might produce more airside capacity at these airports. The study concentrated on the airports serving Atlanta, Chicago (O'Hare), Denver, Los Angeles, Miami, New York (Kennedy), Philadelphia, and San Francisco; these airports consistently have been the scene of more than 60 percent of all aircraft delays reported to FAA.

The results of this study and other related efforts are currently the subject of considerable discussion, particularly with regard to assumptions concerning the disposition of wake turbulence problems, anticipated reductions in aircraft separations, and corresponding changes in air traffic control (ATC) rules and procedures. Nonetheless, the FAA study pointed out that proposed system improvements (e.g., wake vortex avoidance system, aircraft metering and spacing, dual-lane runways, reduced lateral separations, and the like) will tend to offset airfield and ATC saturation at the 8 airports for about 10 years.

Of equal importance in the FAA study, however, is the observation that landside constraints (such as limited terminal facilities and airport access and parking as well as off-airport system considerations) will ultimately restrict any gains in overall airport capacity resulting from airside programs. The FAA study reemphasizes 2 points:

1. Satisfying the aviation needs in these 8 communities can only be accomplished through balanced improvements in all elements of air transportation; and
2. Determining which combination of airside and landside improvements best meets the needs for additional capacity requires a broader and more comprehensive frame of reference than that typically employed within the individual segments of air transportation.

Finally, in ascertaining realistic trade-offs and priorities for air transportation development, financial concerns inevitably are of critical importance. Various organizations have compiled statistics to assist with pending congressional action on an extension or replacement of the Airport and Airway Development Act of 1970. These figures reveal some indication of the mammoth funds at stake in the economic and financial trade-offs just between the airside and the landside elements.

In March 1975, the Airport Operators Council International (AOCI) and the American Association of Airport Executives (AAAE) published a joint survey that indicated that more than $10.6 billion in capital development will be needed to meet the requirements of airline and reliever airports during the next 5 years (Figure 1). Of the $10.6 billion, more than $5.7 billion or 53.4 percent is needed for airside development, including runways and taxiways. More than $3.6 billion or 34.4 percent is required for development of the landside, including passenger terminals, baggage-handling facilities, and access roads. Another $1.2 billion or 12.2 percent is needed for advance land acquisition for airport development beyond 1980 or for noise buffer zones. The survey also showed that large hub airports need more than $3.6 billion in total capital development; the bulk (or 55.7 percent) is required in the landside area.

These and similar statistics support the position of the Ford Administration, the U.S. Department of Transportation, AOCI, AAAE, and the National Association of State Aviation Officials of urging that eligibility under the Airport Development Aid Program (ADAP) be expanded to cover certain portions of terminal facilities. Eligibility under the current ADAP is limited to airfield improvements, certain on-airport access projects, and land acquisition. The statistics also support the need to determine meaningful trade-offs between airport airside and landside so that future development is directed toward those areas with the highest return.

It is against this background of the evolution and maturity of air transportation that this paper will explore and reexamine some of the principal interactions between 2 elements of air transportation—airport airside and airport landside—and the assessment of physical and operational improvements to each element in the context of the interaction. A brief description of airport airside and landside elements is presented, and the most significant variables affecting the interaction between the elements are highlighted. The state of the art in determining airside capacity and delays is summarized, including a brief review of an ongoing study for FAA. Typical influences of the landside on the airside activities and development are discussed; by comparison, the influence of the airside on landside activities and development is summarized. In the concluding portions of the paper, the requirement, desirability, and practicality of balancing the airside and landside in various ways are addressed. Conclusions on the interaction of airside and landside activities are presented.

DEFINITIONS OF AIRSIDE AND LANDSIDE

For purposes of this paper, the airside is defined as a system of 3 components—runways, taxiways, and apron-gate areas—on which aircraft and aircraft support vehicles operate. Air traffic control procedures (including those reflecting the effects of wake vortexes) are major factors that influence operations on the runway component; therefore, the runway component is defined to encompass the approach and departure paths to and from the runways.

By comparison, the landside is defined as those areas and operations within airport boundaries, exclusive of the airside. Although it is recognized that the landside may accommodate a variety of aviation activities such as general aviation, air freight, maintenance and support, and military, this paper deals primarily with the landside as the area on the airport used for the passenger-processing functions. The distinction between airside and landside is shown in Figure 2.

VARIABLES AFFECTING AIRSIDE-LANDSIDE INTERACTIONS

A symbolic diagram of the interaction between the airside and the landside is shown in Figure 3. In effect, physical and operational characteristics of both the landside and the airside are considered to interact within a framework of diverse, complex, and often overriding factors referred to as interaction variables. Several examples of typical interaction variables are presented subsequently.

For a particular airport, it is possible to identify flows and sequences of processes (e.g., baggage-handling subsystem) that exist between the airside and the landside. The fact that the interaction variables differ in importance from airport to airport complicates any attempt to draw broad conclusions and specific, tangible inferences concerning the physical and operational interaction between the airside and the landside. In addition, in many instances the variables are interrelated with one another and may vary over time in response to exogenous conditions and constraints affecting air transportation as a whole.

In addition, the following principal groups of users and providers of airside and landside facilities and services have a significant influence over the structure and extent of the interaction variables.

	Airside		Landside	
Group	User	Provider	User	Provider
Passenger	No	No	Yes	No
Airport sponsor	No	Yes	No	Yes
Airline	Yes	Yes	Yes	Yes
Federal government	No	Yes	No	No

It should be noted that, in a sense, a passenger could be considered as an airside user "captured" by aircraft. The current involvement of the federal government as a landside provider is minimal; a larger role in funding passenger terminal facilities currently is being contemplated.

The 4 principal groups undoubtedly share the common goal of realizing efficient and convenient air transportation. Obviously, each group has other goals that may be conflicting. Reconciling the differing objectives and interests of the groups can be difficult because of the vague, indirect relation between one of the principal users (the airline passenger) and the providers (the airlines, airport sponsor, and the federal government). Also, the ability to reconcile differences relative to any given issue at a particular airport depends largely on the flexibility of the groups to function within existing constraints. In summary, the groups' diverse goals and objectives are

Figure 1. Distribution of funds.

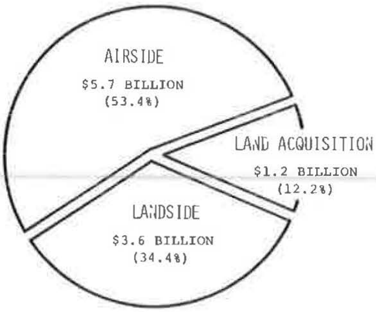


Figure 2. Distinction between airside and landside.

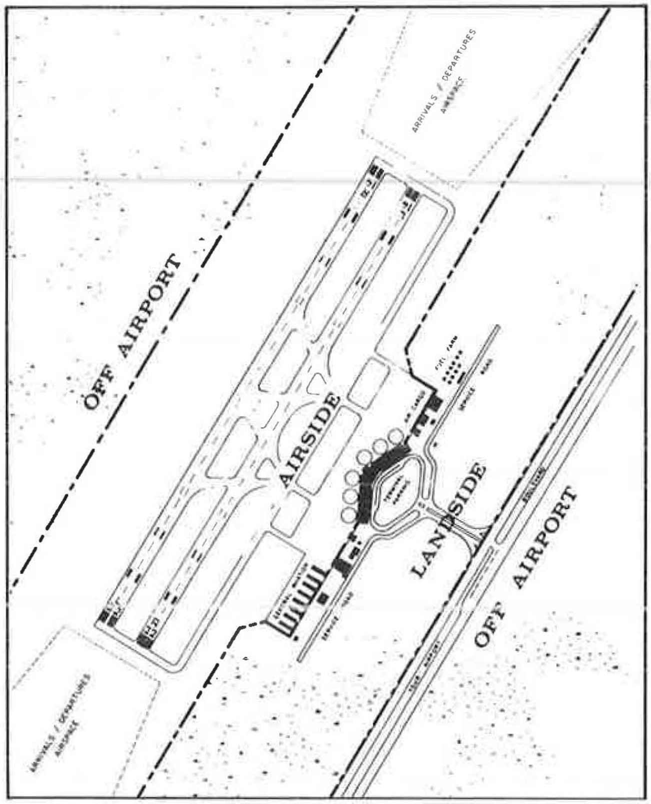
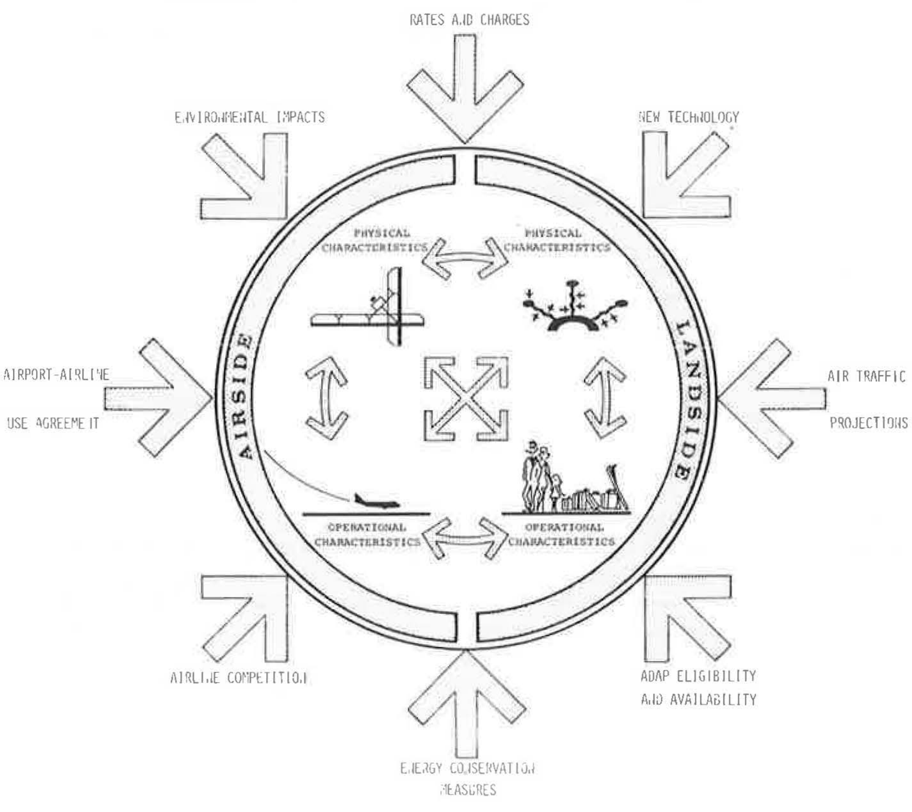


Figure 3. Interaction between airside and landside.



reflected in the interaction variables.

An example of an interaction variable is the schedule of flights by an airline (by origin and destination, by equipment type, by time of day) at a particular airport. Modification of the schedule, by itself, could dramatically affect the interaction between the landside and the airside.

Examination of a hypothetical situation illustrates how landside and airside interaction is affected. An airline may have 3 wide-bodied aircraft arrivals scheduled for a given airport during a peak hour of thc day. Suppose the airline had the flexibility to shift its schedule so that one wide-bodied aircraft arrives in the hour before the peak, one during the peak hour, and the third in the hour after the peak. This new schedule would spread out the flow of passengers and baggage and thus relieve the strain that the landside experiences when all 3 wide-bodied aircraft arrive during the peak hour. The scheduling shift would probably result in a reapportionment of personnel and equipment during a 3-hour period rather than the previous peak-hour concentration. Such a scheduling change could affect operations all the way down to concessioners and taxicab drivers. Clearly, however, a number of external factors (e.g., systemwide equipment constraints, CAB approval on route awards) may alter the airline's desire and ability to implement schedule changes at a particular airport.

In a more realistic case, an entire spectrum of interaction variables affect the interplay of the airside and landside. For example, any decision concerning future improvements to either or both the landside and the airside could be affected by diverse, but common, influences such as

1. Goal of financial self-sufficiency;
2. Terms and conditions of the existing airport-airline use agreement;
3. Availability of funds from ADAP and from other revenue-generating sources on the airport;
4. Operating requirements of the airlines;
5. Expected payoff in satisfying air passenger traffic demands at an appropriate level of service by increasing overall airport capacity or reducing delays;
6. Cost, as reflected in anticipated rates and charges;
7. Level of competition among airlines;
8. Ability of individual improvement projects to survive the environmental review process, and the cost of undertaking the process;
9. Belief in reliability of air traffic forecasts;
10. Desire to preserve future development options; and
11. Anticipated effect of new technology and related uncertainties.

For a particular airport at a particular point in time, assessment of these diverse interaction variables will range from being relatively precise (e.g., terms and conditions of airport-airline use agreement, cost) to being quite subjective (e.g., level of competition among airlines, ability to survive environmental review process). However, unless the interaction variables are identified and accounted for, comprehension of airside and landside interaction will be incomplete.

EVALUATING AIRSIDE CAPACITY AND DELAYS

To provide a basis for discussing the physical and operational interaction between airside and landside, the state of the art in evaluating airside capacity and delay is highlighted below.

In 1960, a basic method for estimating runway capacity was developed for the FAA (2, 3, 4, 5). The 1969 handbook (5) was intended to reflect the progress made, up to that time, in improving the air traffic control system. Since the development of this basic method more than 10 years ago, certain changes have occurred to affect its validity. For example, wide-bodied aircraft have been placed in service and new aircraft separation rules have evolved because of the magnitude of the wake vortexes generated by these aircraft (and other heavy aircraft), as noted previously. In addition, the basic methodology did not permit analysis of the entire airside, but was confined mainly to the runways (even though the titles of the above reports included the words "airport capacity").

Therefore, in June 1972, FAA retained a study team to develop new techniques for determining airside capacity. The objectives of this study include

1. To develop new, validated procedures for determining airfield capacity and aircraft delay to serve as the basis for an airside capacity and delay handbook [the new procedures should permit consideration of present and future air traffic control (ATC) equipment and practices and should include capacity and delay models and supporting computer software], and
2. To prepare an airside capacity and delay handbook for purposes of airport planning.

Handbook User Interviews

During the initial stage of the multifaceted study, the following questions were emphasized:

1. What kind of information concerning airside operations is desired for making decisions regarding planning and implementation of capital improvements or operational changes or both?
2. What are the practical uses of this information?

Therefore, one of the first steps in the study was to conduct a series of interviews with current handbook users. These interviews, conducted in the summer of 1972 with airport sponsors, airlines, FAA, aviation associations, and airport consultants, revealed that

1. Many users cannot visualize existing runway capacity definitions in relation to actual events in the field (various ideas were given for the definition of capacity);
2. Both users of and uses for existing handbooks vary widely as given in Table 1 (5), and thus for new handbooks or basic models to provide adequate information to satisfy the needs of all users and uses would be difficult;
3. The handbooks (and models) should be responsive to a series of factors (weather, navigation aids, future ATC improvements) that affect airside capacity; and
4. Most users want positive FAA planning and design criteria to evolve from this study.

Airfield Performance Measures

Even though there was no consensus on the meanings of "capacity" and delay," the

Table 1. Uses of capacity and delay.

Use	Capacity	Delay
Determine requirements and timing for new facilities (including demand and capacity comparisons)	X	X
Determine whether capacity problem can be expected	X	
Estimate benefits (including inputs for cost effectiveness and economic evaluations)	X	X
Compare alternatives	X	X
Balance capacity of airport components	X	
Establish priorities for airfield improvements	X	X
Estimate impact of factors affecting capacity or delays	X	X
Assist in administrative activities	X	X
Identify locations and levels of congestion		X

interviews and other parallel research revealed that the most frequently required types of information are data on airside capacity and delay to aircraft. Handbook users desire accurate information on capacity and delay of the 3 components of the airside system (i.e., runway, taxiway, and apron-gate components) and of the airside as a whole. Users also indicated an occasional desire or need for other types of specific information on airfield performance, for example, queue lengths, locations of congestion points, and causes of congestion. Therefore, the conclusion was that as much capacity and delay information as practicable should be presented in the new handbook. Other performance measures can be provided from the basic capacity determination procedures (or models) that have been developed for FAA. For a number of reasons, as summarized in the 1973 procedures (6), the following definitions of hourly capacity and delay were adopted for purposes of the FAA study.

Hourly Capacity

The hourly capacity of the airfield (airside) or one of its components is defined as the maximum number of aircraft operations that can take place on the airfield (or component) in an hour. The maximum number of aircraft operations on the airfield or component depends on a number of conditions (e.g., runway use and aircraft mix) each of which must be specified to compute capacity. (Those conditions dependent on landside physical and operational characteristics are discussed in a subsequent portion of this paper.)

Delay to Aircraft

Delay to aircraft is defined as the difference between the actual time it takes an aircraft to operate on an airfield (or component) and the normal time it would take the aircraft to operate without interference from other aircraft on the airfield (or component) under specific operating conditions. Delay is expressed in minutes.

Model Validation and Handbook

Since the handbook user interviews were conducted, extensive technical analyses and data collection have been performed leading to the development of capacity and delay models encompassing the airside and its components. These models have been validated (7) for operations at 3 high-activity airports, including Chicago (O'Hare). In addition, the preliminary format of an airfield capacity and delay handbook (8) has been prepared and coordinated with representatives of various segments of air transportation. The final version of the models and handbook will be delivered to FAA in 1975. During the course of the study for FAA, the study team gained several significant insights on the influence of the landside on airside capacity and delay. These insights are described subsequently.

IDENTIFICATION OF AIRSIDE AND LANDSIDE INTERACTION

Two cases showing the effect of airport improvements on the interaction between the airside and the landside are described below.

The first case concerns those airports that lack sufficient physical, financial, or environmental resources to permit the development of either the landside or the airside in accordance with minimum technical and functional criteria. As an extreme example of the first case, a particular airport may be so limited in available land area resources that the only possible area for major expansion of passenger terminal building facilities is within the runway clear zones. In this example, the evaluation of airside and landside interaction relative to future development possibilities is so obvious (either the landside or the airside uses the clear zone) or so complex (clear zone safety criteria are violated, and both the runways and terminal building share use of the clear zone) that few meaningful, general observations and conclusions can be made.

In the second case of the effect of improvements, sufficient physical, financial, and environmental resources are assumed to be available, and minimum technical and functional criteria are satisfied. Therefore, it is possible to evaluate trade-offs among candidate improvements to the airside and landside.

In addition, it is possible to draw certain general conclusions about the interrelations between the airside and landside for the second case. A distinction is made between the influence of the landside on the airside and the influence of the airside on the landside.

Influence of Landside on Airside

Based primarily on investigations during the ongoing FAA airside capacity study, the following general conclusions apply to most typical airport situations.

For purposes of determining capacity and delay, operations on the runway, taxiway, and apron-gate area components at most airports can be considered as independent of one another [Denver (Stapleton) Airport is a notable exception]. Therefore, each of these components can be analyzed separately. Stated another way, it is sufficiently accurate to assume that the capacity of the runway component is not influenced by operations on either the taxiway component or the apron-gate area component. Therefore, because operations on one airside component generally do not affect the capacity of another component, the capacity of the entire airfield is governed by the capacity of 1 of the 3 components (referred to as the constraint component). Because operations on one component have almost no influence on the delay to aircraft on another component, the total delay to aircraft on the entire airfield can be estimated by adding the delay to aircraft on each individual airside component.

Importance of Terminal Location

Because of the independence of airside components, it can be concluded that the location of the apron-gate component and, therefore, the location of the passenger terminal facilities have little effect on the capacity and delays on the airside.

Landside Influence on Apron-Gate Component

Another conclusion stemming from the independence of airside components is that the principal interaction of the airside with the landside occurs in the apron-gate area component of the airside. Research for the FAA revealed that certain operating conditions need to be specified to determine the capacity and delay of the apron-gate area. The following conditions have a significant effect on the capacities and delays of the apron-gate component:

1. Gate mix (aircraft using the gates by airline and type of equipment),
2. Number and types of gates (which gates serve which airlines and type of aircraft),
3. Gate occupancy time (time an aircraft is considered to effectively occupy a gate), and
4. Demand for the use of the gates (needed for determination of delay only).

This listing shows that capacity and delay of the apron-gate component are primarily a function of airline aircraft physical and operational characteristics. In determining such capacity and delays, the major concern of the airport planner and decision maker should be the numbers and types of gates and the types of aircraft using the gates, not the geometry of the apron (as long as minimum criteria, such as clearances, are satisfied).

Whatever influences the landside exerts on the apron-gate area component would stem primarily from those landside features that affect the use of gates by specific types of aircraft and gate occupancy times. For example, landside features can affect the time required to board or debark passengers or service the aircraft. The size or arrangement of landside facilities (e.g., spacing of holdrooms along a pier finger) or the level of staffing and management of airline personnel may also indirectly influence component capacity and delays.

Summary of Landside Influence

In summary, the governing influence of the landside on the airside is typically limited to the apron-gate component, unless a major expansion program is contemplated that would require competition between the airside and the landside for available land area and financial resources. Based on observations at some 18 high-activity airports during the FAA capacity study as well as those by the authors at a number of other airports, it appears that variations in the interaction variables are likely to have a more significant and volatile influence on landside and airside interactions.

Influence of Airside on Landside

On the other hand, the physical and operational characteristics of the airside can exert a considerable influence on the landside. Possibly the clearest description of the fundamentals of this influence (and probably the first treatment of the subject) is contained in a report (9) prepared for the Hillsborough County Aviation Authority in 1963. According to the report,

> The design of any airport terminal area (complex) must reconcile the requirements of three basic operational areas:
>
> Airside—The area where aircraft loading and servicing takes place, including the passenger processing space dictated by any given design.
>
> Passenger Collection Point—The facility or facilities where passenger processing and service take place prior or subsequent to passenger transfer between airside and landside (conventionally it is the terminal building).
>
> Landside—The area where all ground transportation requirements (roadway systems and parking areas) are accommodated.

In the planning of Tampa (International) Airport, the terms "airside" and "landside" were coined. However, the Tampa study dealt with only the terminal area, and thus these definitions differ somewhat from the definitions previously presented in this paper. To avoid ambiguity, definitions in the Tampa studies will be referred to in this paper as follows: Airside will be the aircraft-passenger processing area, and landside will be the access interface area.

Because airline aircraft must be serviced at a fixed point, the physical layout of the aircraft parking and servicing apron (part of the airside) is inseparably interrelated with passenger-handling procedures and facilities in the aircraft-passenger processing area. In addition, the physical size of aircraft governs passenger and baggage flows; thus, the airside generally influences the landside facilities adjacent to the apron much more than these landside facilities influence the airside.

According to the Tampa studies, the interaction between the 3 operational areas of the terminal complex is largely a function of the degree of physical separation between the aircraft-passenger processing area on the one hand and the passenger collection point and access interface area on the other.

In the typical (conventional) passenger terminal concept, aircraft-passenger processing area requirements have almost always been contiguous to the passenger collection point, connected by some type of finger, tunnel, or concourse (Figure 4). In a conventional concept, the access interface area requirements have likewise been contiguous to the terminal building and have usually been situated on the side opposite the aircraft-passenger processing area. Over the years, the requirements of aircraft-passenger processing area functions have expanded in direct relation to increases in aircraft size and related peak-period passenger volumes. As a result of the close physical interaction of the 3 operational areas, "... it became obvious that the tremendous increases in the size of (conventional) U.S. airport terminals today to their present state of 'terminal sprawl' can be attributed almost completely to the rapid changes in Airside (Aircraft/Passenger Processing Area) requirements" (9).

There are a few notable exceptions to the conventional terminal concept. Tampa (International), Washington (Dulles), and to some extent other airports have significant separation (noncontiguousness) between the aircraft-passenger processing area and the remainder of the landside. In these exceptions, the interaction is substantially reduced.

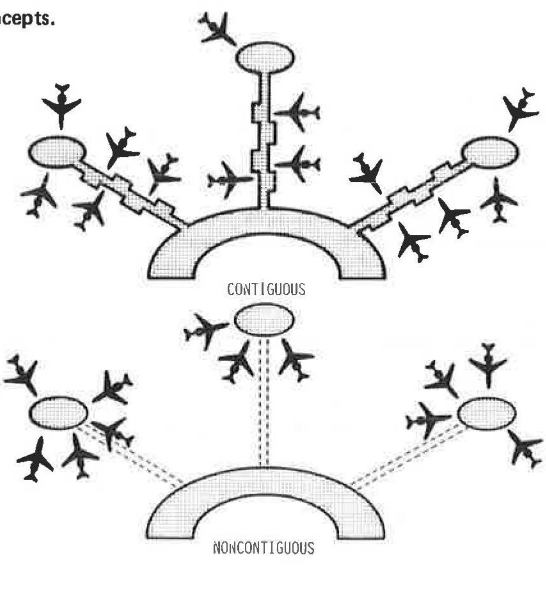
The planners at Tampa foresaw advantages to separation whenever possible, including the opportunity for more independence in planning optimum development in each of the 3 operational areas of the landside (9).

> Basically, Landside (Access Interface Area) and Passenger Collection Point facilities are long-term permanent use facilities. Thus, the investment in such a facility would not be tied to the specialized airport/airline (Aircraft Passenger Processing Area) function.
>
> On the other hand, the airside (Aircraft/Passenger Processing Area) is by definition and mandatory requirement a short-term, impermanent use inexorably tied to the changing aircraft technology with a useful life of approximately 10 to 15 years. The only way to obtain a longer useful life for the airside activities is to stabilize aircraft design and operational procedures, and there is absolutely no reason to believe that aircraft technology will be stabilized.

REQUIREMENT FOR BALANCED AIRSIDE-LANDSIDE PLANNING AND DEVELOPMENT

The term "balance" frequently surfaces as a development goal with regard to interactive elements in a system. For example, the FAA Advisory Circular states (10),

Figure 4. Contiguous and noncontiguous terminal concepts.



"The maximum capacity of an airport may be realized only by obtaining a balance of the needs for runways, passenger and cargo facilities, and airplane storage and servicing areas." Unfortunately, the definition of balance differs depending on the viewpoint of the individual analyst or decision maker and on the context in which the term is used.

In a limited analysis, balance between the airside and the landside might be achieved when the 2 elements have equal capacity or when delays on the elements are at the same level. Even within this limited concept, the analyst would require specific tools to measure or estimate airside and landside capacities and delays as well as ground rules for the comparison of the capacity or delays. Neither a complete set of proper tools nor accepted ground rules for such a comparison truly exist today. Unless ground rules are set, objectivity and comparative validity suffer. The following typical questions might be faced in establishing the ground rules.

1. Should a comparison be made between landside capacity and airside capacity in visual flight rule or in instrument flight rule conditions (usually, airside capacity varies as a function of weather conditions)?
2. Should a comparison of landside delays and airside delays be made on a peak-hour basis (possibly most meaningful to a passenger or air traffic controller)? on a daily basis (possibly most meaningful to airline personnel relative to completing the daily use of the airline's aircraft)? on an annual basis (possibly most meaningful to an economist)?

In the absence today of a complete set of tools and ground rules, planners and decision makers are forced to make subjective judgments in deciding how individual components should be "appropriately" sized and configured to satisfy the demands placed on them and to balance proposed improvements.

If the analyst seeks balance in the broader economic sense, he or she requires an assessment of both the value and cost of improvements, where the assessment of value usually involves the measurement of both costable and noncostable factors. The broader economic approach requires even more extensive tools and ground rules.

If properly employed, the above concepts of balance (or one of numerous variations in between) can shed light on the appropriateness of candidate improvements to the airside and landside. Certainly, these classical approaches are powerful and appealing for analyses when used by those with firsthand experience with the particular problem and the implications of the assumptions underlying the classical approaches.

CONCLUSIONS

1. The evolution and maturity of air transportation dictate that the interactions between the airside and the landside be reexamined to gain further insight and understanding on how best to improve the air transportation system as a whole.
2. For a particular airport, the specific flows and sequences of processes (i.e., functional interrelationships) that exist between the airside and the landside can be identified.
3. Broad conclusions are complicated by the fact that the interplay between the landside and the airside is a function of interaction variables, which vary from airport to airport and with time. These variables largely govern the translation of functional interrelations into their effect on the physical and operational characteristics of the airside and the landside. However, for those airports with sufficient resources to satisfy minimum criteria, certain fundamental conclusions concerning typical airside and landside interactions are apparent.
    a. The influence of the landside on the airside is limited to the apron-gate area component of the airside; this influence usually can be accommodated without serious conflict with other airport developments.
    b. The influence of the airside on the landside stems primarily from the fixed-point servicing requirement of airline aircraft that occurs on the apron-gate area

component of the airside. The extent of the interaction between the apron-gate area component and the landside is largely a function of the degree of separation between the aircraft-passenger processing area on the one hand and the passenger collection point and access interface area on the other. At most airports, these 3 operational areas are contiguous; therefore, the landside and the apron-gate area component of the airside are inseparable and are highly interactive.

c. For the most part, the airside exerts a much larger governing influence on the landside than vice versa.

d. For a large number of typical planning and development decisions on airport improvements, the interactions between the airside and the landside may be slight. In such cases, it is useful to evaluate airside and landside components separately.

4. Today, application of the concept of balance typically reduces to a determination of how the individual components of the airside and landside should be appropriately sized and configured to satisfy demands placed on them.

5. The crux of properly accounting for the interaction between the airside and the landside is in the identification and comprehension of the interaction variables. Professional airport planners and decision makers must make intuitive and subjective judgments to assist in the assessment of the landside and the airside within the milieu of interaction variables. Thus, the degree of success in assessing the trade-offs and priorities for improvements in the landside and the airside depends on the ability to judge these variables.

Continued research and development are, of course, vital in the expanding outlook of air transportation. To determine and to maintain realistic priorities for the development of the airside and the landside are also becoming more critical than ever. Such priorities must somehow reflect the best choice of available alternatives within real-world conditions and constraints.

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