METHODS TO INCREASE LANDSIDE CAPACITY AT EXISTING AIRPORTS

Leonard G. Klingen, Eastern Air Lines, Inc.

Significant increases in terminal use can be obtained by avoiding sharp peaks during certain hours of the day and by adopting various changes in operating procedure. Among the solutions mentioned are changing aircraft parking from parallel to nose in, using remote aircraft parking, using transporters, combining hold rooms, and automating ticketing and baggage handling. It should be recognized, however, that an airport fulfills a complex series of functions and that we cannot increase the capacity of one system without taking into account its effects on other subsystems farther along the line. Therefore, an accurate knowledge of a station's ability to handle present-day traffic at acceptable levels of service is a prerequisite for any successful expansion program.

In preparing this resource paper, I have drawn fairly extensively from our experience gained in the preparation of the Station Capacity Handbook for Eastern Air Lines. This handbook was prepared in 1974 to provide management with an up-to-date survey of the top 15 stations in the system and the requirements for the next 5 years measured against the current forecast. The anticipated growth during the next 5 years was estimated to require millions of dollars in investment. When such large amounts are at stake, one cannot rely on experience and intuition alone, and ways must be found to quantify requirements. Without these improvements, we have to resort to vague generalizations such as, "We need another gate by 1975" or "Our baggage-handling system is inadequate" or "There are not enough ticket counters at this station."

The questions are, How inadequate is our present system in terms of aircraft delays so that construction of a new gate can be justified? How inefficient is our baggage-handling system? Where are the bottlenecks? How often did the equipment break down?

What percentage of time were standards not met?

In the case of the ticket counters, we are interested in the waiting time of passengers, queue length in front of the counters, and congestion in order to determine the number of counters required. We are interested in the cost effectiveness of our improvements and increasing customer satisfaction with the facilities. There is, therefore, an urgent need to express the demand-capacity relation at an airport in an objective and quantitative manner.

Previous attempts to provide this information have failed because services at an airport do not suddenly become inadequate; rather, a slow deterioration of service sets in. The problem is compounded by the fact that some functional areas become inadequate more rapidly than others. Changes in the method of operation such as the introduction of automatic passenger-processing system, automated baggage handling, and changes in aircraft parking arrangements all complicate the issue.

The present study has overcome these problems by introducing the concept of levels of service. This concept expresses the demand versus capacity relation in levels of service that range from excellent to poor and unacceptable. The range of service is based on predetermined standards that have been accepted throughout the company. For example, the minimum area for a person standing is still 6.25 ft^2 (0.6 m^2). This area increases to 10 ft^2 (0.9 m^2) when allowances are made for some additional room and baggage. When a person walks at an average rate of 4.5 ft/sec (0.4 m/s), he or she requires 20 ft^2 (1.9 m^2) to maintain speed and overtake slow walkers; thus, a density ratio of 10 ft^2/person, which would be minimally acceptable in a baggage claim room where people crowd around a device, is unacceptable for a public circulation area in which a large number of people move about in different directions and at different speeds.

We can and have derived similar measures for cars at the curbside and for aircraft on the ramp requiring gates.

The parameters that govern the airport system we have found change little over time. Taxi-in speeds for category B aircraft range from 15 to 20 mph (24 to 32 km/h) on the open taxiway and from 5 to 10 mph (8 to 16 km/h) on the ramp. Push-out times range from 2½ to 3 minutes for category B aircraft and from 4 to 8 minutes for an L-1011 or a DC-10. Other parameters such as the ratio of bags per passenger at a given station also show a remarkable consistency over time even though there are daily and hourly fluctuations.

It is therefore possible to express the present and future requirements at the airport for elements such as curbside, automobile parking, ticket counter, bag makeup and claim hold rooms, gates, and ramp space in absolute terms and compare those to anticipated traffic flows. In this manner, one can make an objective evaluation of the ability of the station to handle the present and future traffic and determine when the service becomes inadequate. Effects of changes in the schedule and resulting increases or decreases in traffic can also be interpreted by moving up or down the time scale provided for each functional category. The level-of-service standards as applied to Eastern's facilities regarding passenger density ratios are given in Tables 1 and 2.

DATA BANK

The need for accurate data underlies all planning efforts at an airport. Collecting, maintaining, and updating this information is a tedious and laborious task; yet without this knowledge our planning efforts become mere guesswork. We should, therefore, always pay particular attention to the quality and quantity of the data used to justify a new terminal design. At Eastern, airport data are monitored continually. Information regarding aircraft arrivals and departures, gate occupancy times, passenger movements, baggage ratios, and many other statistics are checked by half hourly intervals for the top 40 stations in the system. A sample of the computer report is shown in Figure 1.

From these reports we learn that each airport has its own characteristics. For this reason, development of general standards based on cross-sectional data of stations

Table 1. Passenger circulation areas—level walkways.

Level of Service	Space per Pedestrian (ft^2)	Public Circulation Area	Corridor Intersection	Corridors Near Hold Rooms	Baggage Claim Area
A	20 to 25	Excellent	Excellent	Excellent	—
B	15 to 19	Fair	Fair	Fair	Excellent
C	10 to 14	Poor	Poor	Poor	Good
D	7 to 9	Unacceptable	Unacceptable	Poor	Fair
E	4 to 6	Unacceptable	Unacceptable	Unacceptable	Poor
F	<6	—	—	Unacceptable	Unacceptable

Note: 1 ft^2 = 0.09 m^2.

Table 2. Passenger circulation areas—stairways.

Level of Service	Space per Pedestrian (ft^2)	Public Circulation Area	Corridor Intersection	Corridors Bordered by Hold Rooms	Corridors With No Cross Traffic	Hold Rooms	Ticket Counters	Baggage Claim Area
A	26 to 30	Excellent	Excellent	Excellent	—	—	—	—
B	21 to 25	Good	Good	Good	Excellent	Excellent	Excellent	Excellent
C	16 to 20	Fair	Fair	Fair	Good	Good	Good	Good
D	11 to 15	Poor	Poor	Poor	Fair	Fair	Fair	Fair
E	6 to 10	Unacceptable	Unacceptable	Unacceptable	Poor	Poor	Poor	Poor
F	<6	—	—	—	Unacceptable	Unacceptable	Unacceptable	Unacceptable

Note: 1 ft^2 = 0.09 m^2.

Figure 1. Computer report of information on departures from top 40 stations for August 1974.

TIME OUT	FLT MO	SEAT MO	PAX MO	BAG MO	FLT DAY	SEAT DAY	PAX DAY	BAG DAY	TOT SUN	TOT MON	TOT TUE	TOT WED	TOT THU	TOT FRI	TOT SAT
100	226	25,998	15,786	25,733	7.5	866.5	526.1	857.7	1,877	1,599	2,160	1,307	2,329	2,801	3,693
130	43	4,861	3,199	5,167	1.4	162.0	106.6	172.2	276	191	45	120	221	731	1,615
200	15	1,884	1,116	1,563	.4	62.7	37.1	52.0				74	170	253	619
230	4	869	144	380	.1	28.9	4.8	12.6				36	33		75
300	1	134	27	46	.0	4.4	.9	1.5					27		
400	1	89	47	25	.0	2.9	1.5	.8			47				
430	19	2,546	203	414	.6	84.8	6.7	13.7			31	44	15	120	95
500	5	625	90	139	.1	20.8	2.9	4.6					7	14	69
530	1	254	98	157	.0	8.4	3.2	5.2							98
600	95	8,847	2,758	4,984	3.1	294.8	91.9	166.1	424	473	450	383	335	317	376
630	144	12,953	3,974	6,315	4.7	431.7	132.4	210.4	324	547	438	415	663	660	927
700	74	6,055	1,278	2,132	2.4	201.8	42.5	71.0	90	108	90	88	106	137	659
730	4	356	94	168	.1	11.8	3.1	5.5		16				15	63
800	2	508	76	140	.0	16.9	2.5	4.6						74	2
830	5	655	215	436	.1	21.8	7.1	14.5	145						70
900	1	98	20	38	.0	3.2	.6	1.2							20
930	431	44,714	24,707	40,350	14.3	1490.4	823.5	1344.9	3,259	3,572	3,102	3,064	4,170	4,111	3,429
1,000	133	15,266	9,545	15,113	4.4	508.8	318.1	503.7	1,146	1,758	977	876	1,108	1,346	2,334
1,030	13	1,435	831	1,348	.4	47.8	27.6	44.9	52		29	220		159	371
1,100	497	52,811	32,424	52,392	16.5	1760.3	1080.7	1746.3	4,703	5,083	3,422	3,356	4,823	5,328	5,629
1,130	246	25,081	17,977	27,524	8.1	836.0	599.2	917.4	2,428	2,275	2,427	2,156	2,247	2,729	3,715
1,200	110	11,708	7,596	11,806	3.6	390.2	253.1	393.5	1,133	1,254	1,208	944	1,263	841	933
1,230	292	30,363	19,895	31,723	9.7	1012.0	663.1	1057.4	2,924	3,340	2,197	2,110	2,915	3,586	3,823

throughout the country will only have limited value, and such standards should never be used for any detailed planning of airport facilities.

FUNCTIONAL CATEGORIES

That it is fairly simple to distinguish the various functional areas at a station is proved by the fact that there is general agreement in the literature on this subject. We have followed the same trend here and divided the terminal into the following functional categories:

1. Access and egress roads,
2. Automobile parking,
3. Enplaning and deplaning curb,
4. Ticket counters,
5. Circulation area,
6. Concourses,
7. Hold rooms and gates,
8. Baggage makeup and claim area,
9. Ramp area,
10. Taxiways, and
11. Runways.

In a properly functioning terminal, each of these subsystems should balance with the rest. This, however, seldom happens, and we notice that some areas are overbuilt and others have too little room to function properly. The resulting congestion and delays affect the use of all the subsystems farther along the chain. Therefore, we cannot improve the capacity of the curbside without investigating its effect on the ticket counter and the baggage makeup area. Similarly, introducing more aircraft or substituting wide-bodied aircraft for 727s and DC-9s will strain the entire system.

Many simulation models that have been run in the past attempted to express the entire airport function in one general model. These attempts have met with little success because of the complexity of the entire system. For this reason, we at Eastern have followed a piecemeal approach by running models for each of the functional categories mentioned before. If due regard is paid to the effects of changes in one system on the next and so on, good results can be obtained.

METHODS TO INCREASE CAPACITY

The purpose of increasing capacity of an airport is to enable it to handle a larger volume of traffic. These increases in capacity are achieved by changes in the method of operation or the addition of new facilities or both. We should, however, not lose sight of the fact that one of the most obvious and simple ways to increase traffic at a station is to avoid the sharp peaking of operations during certain hours of the day. At some of the major U.S. airports, some peak operations are well over 30 to 40 percent above the daily average.

The larger these fluctuations are, the more severe is the penalty paid in terms of wasted resources, for expensive facilities remain idle in the off-peak hours. If the airport is saturated or approaching saturation, e.g., Washington (National) and Chicago (O'Hare), "depeaking" will not be applicable, and here the solution is to either provide the new facilities or switch part of the activity to neighboring airports (Dulles, Midway).

The impact of wide-bodied jets has had a mixed effect on airport facilities. Although it has certainly reduced congestion on the runways, the bulk unloading of large numbers of passengers has strained most air terminal subsystems such as corridors, baggage-claim facilities, and curbside and customs facilities.

Apart from these considerations, there are specific courses of action that can be taken at relatively little expense to increase capacity at an airport. A summary of

these methods is given below.

Runways

The general trend with regard to runways has been to decrease the separation between aircraft, but there are FAA-described limits below which it is not advisable to go. High-speed turnoffs and additional taxiways have also provided some relief. A large portion of movements at all the major airports is performed by general aviation aircraft; by limiting these movements, it is possible to increase the capacity of the airport considerably.

Ramp Area

Provision of dual taxiways eliminates most of the congestion due to queuing on the ramp. However, few airports have been equipped in this manner and, once a single taxiway system has been installed, it is there forever. Nothing short of demolishing the concourses would provide the necessary space for a dual taxiway, and this may prove too costly. The feasibility to add additional aircraft parking positions depends on the terminal configuration. The easiest solution is remote parking.

Concourses

At airports where aircraft are parked parallel, a 30 to 50 percent increase in terminal frontage can be obtained by nose-in parking. Due regard should be paid to aircraft wing span and collision clearances, but the resultant increase in parking spaces can be significant. Also apron requirements are minimized by this approach. The disadvantage, however, is that the aircraft must be pushed out, and that requires additional personnel and equipment, which often almost eliminates the cost advantage.

Hold Rooms

One way to increase capacity at terminals is by combining hold rooms into a common area. This has allowed acceptance of wide-bodied jets in areas previously exclusively equipped to handle category B aircraft. After several years of operation, Eastern has not experienced any adverse passenger reaction. In many cases, there has also been a savings in personnel since a doubling of the number of flights does not necessarily mean a doubling of the number of agents. Especially in Miami, the experience has been encouraging. Some separation may be obtained by using different colored seating arrangements. The need for hold rooms does still exist, as Eastern's experience at New York (Kennedy) Airport has indicated. Because concourses at that terminal could not be expanded except at great cost, passengers were held in the large terminal area until the last moment. This practice has led to some confusion among some passengers, and now a minimal amount of seating is provided in the concourses. The practice of making boarding announcements as late as possible has tended to keep passengers away from the hold-room area, thereby reducing personnel and facilities needed.

Corridors

The number of well-wishers filling the corridors and the crowds of passengers moving back and forth have been eliminated by the security check. Inasmuch as we can assume security to be a permanent function at the airport, the problem of saturated corridors can be regarded as solved for the present. Double-decking with one level each of opposing flows of traffic has been successfully applied in many stations.

Baggage Claim

In the early days, the carrousel was a frequently used device. The problem, however, was that it offers the minimum frontage while taking up the maximum area. For a claim unit, maximum exposure on a minimum area is required. The transi-tread or ribbon-shaped device fulfilled this need. By the loops provided, maximum use of the claim area can be obtained without any major construction. Care should be taken that the baggage-off load area is increased accordingly. The increasing trend toward positive claim procedures has complicated passenger flows, and, therefore, made higher demands on the claim area.

Baggage Makeup

The baggage makeup loop in the form of a transi-tread or VIP type of carrousel has tremendously increased throughput capability. Angle parking carts has also optimized the use of the area, but more personnel is required. The baggage makeup function is still largely labor oriented and has until now defied adequate automation. This is confirmed by several failures of automated systems in the industry. Despite this, our experience with automated equipment in Miami has generally been favorable. It has not been possible to obtain adequate figures on labor savings, although it is fairly certain that there have been some. The major problem is the printers that produce the identifying binary circular code (bull's-eye). This has been and still is a costly and time-consuming part of the operation. Our experience is that, in order to cater to peak loads, automated systems must have a much larger capacity since they are less flexible than manual systems. Redundancy is imperative with any automated system.

Transporters

By far the best results in extending the life of a terminal have been achieved by the use of transporters or mobile lounges. Several studies indicate that a transporter operated in a hybrid system is the cheaper alternative to building a gate. This is especially so if push-out operations are required. Of course, there should be room to park the aircraft remotely, and facilities should be provided for their servicing. Generally, about 3 to 4 transporters can be parked in the area occupied by a 727. A common hold room should be provided for the passengers, but 3 transporters can easily service 2 B-727s remotely parked so that almost a doubling of gate capacity can be achieved. Eastern's operation in Atlanta using 3 transporters to service 5 to 6 remotely parked category B aircraft has been successful for the past 3 years. Detailed analyses carried out by Boothe Airside Company, which markets the transporter, and Eastern's experience in Atlanta indicate that there is no appreciable difference in passenger acceptance. There is some increase in published aircraft departure times when transporters are operating with scheduled services departing from gates, but this has not been a problem. At Washington (Dulles) Airport, the published time is when the transporter leaves the gate.

Ticket Counters

Increasing passenger throughput at the ticket counters has been achieved with the automated passenger processing system (APPS). The present average system rate per agent is between 13 to 20 passengers/½ hour. If the ticket procedure is simplified, the by-pass ratio can be increased so that in some stations it may run as high as 20 percent. A procedure that was successfully implemented at one of our stations was to have one ticket agent directing passengers in the queuing area to the various ticket counter positions so that the load is spread evenly. Also the designation of express ticket counters has been helpful. APPS has also enabled us to direct passengers to

the gate area since they can obtain the same service at the gate check-in desk. This has allowed the manager a great amount of flexibility in directing flows. It has also led to labor savings.

Of the 3 major types of ticket counter arrangements that we have investigated, linear counter takes up the least area. Since airlines have to pay for the ticket counter space they occupy, the linear counter concept should be used wherever possible. A flow-through type of arrangement with 10 ticket counters occupies 1,643 ft^2 (153 m^2) including queuing space. It is also more expensive in construction, for each pair of counters would require a separate baggage belt. By contrast, a linear counter occupies only 1,325 ft^2 (123 m^2) including a queuing area of 10 ft (3 m). Baggage throughput is simplified by the use of a long belt running behind the counters. Any circular arrangement of counters requires almost double the area of a linear concept, 2,462 ft^2 (229 m^2). A circular area for counters should, therefore, be avoided (see earlier remarks on the baggage-claim carrousel).

Placement of the ticket counters should be as close as possible to the curbside with no interference from concessions or seating. These functions should be placed at the rear of the ticket counter positions. This arrangement can be studied at Chicago (O'Hare), Newark, Washington (Dulles), and Miami airports.

Curbside

One of the most difficult functional areas to increase at a station is the enplaning or deplaning curbside, for it is intimately connected with the design of the building. The most inexpensive method to increase curbside capacity has been a policing of cars during the peak hours to ensure that their curbside occupancy was reduced to a minimum. For example, a 20 percent reduction in vehicle dwell time could lead to an approximate 30 percent increase in servicing rate. Provision of parking islands will also increase the capacity, but then passengers and skycaps must cross the busy roadway, thus impeding traffic.

Parking and Access and Egress Roads

It has not been possible to obtain any data on methods to increase capacity of automobile parking areas and roadways. At Eastern, we have not yet been much involved with these facilities.