

**PLANNING FOR AIRPORT CAPACITY
MEETING THE CHALLENGES OF GROWING DEMAND
(AN AIRPORT MANAGEMENT'S PERSPECTIVE)**

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INTRODUCTION

Unprecedented growth in the air transportation industry in recent years has propelled airport capacity issues to the forefront as a matter of increasing concern. As airport traffic grows, and delays become more frequent, a number of Canadian Airports are faced with capacity problems. Such growth has placed a tremendous strain on airport infrastructure.

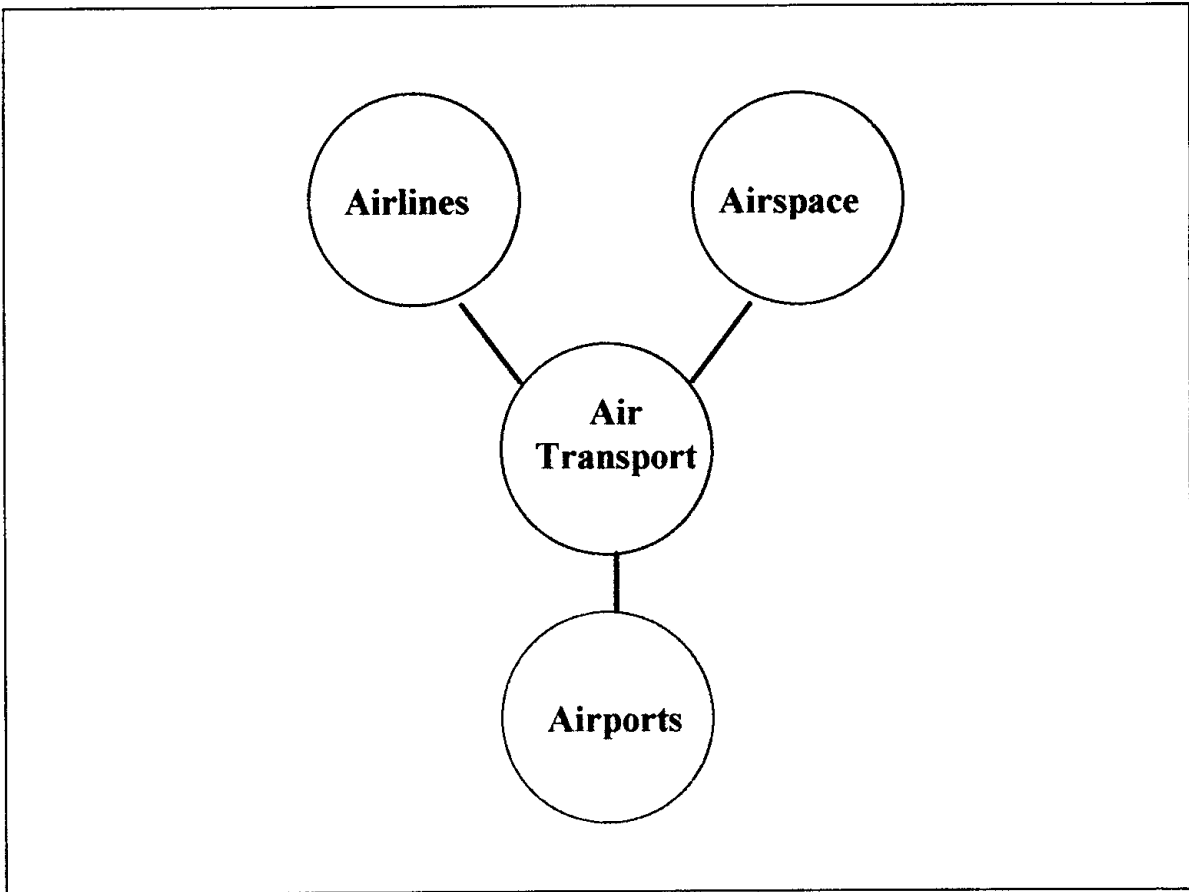
Whether or not infrastructure can meet the demands placed on it is a concern to both airport operators and airline management. Airport capacity issues impact upon every player in the airport community, including airport and airline management, as well as the general public.

The aim of this paper is to explore a number of key capacity issues common to many airports in Canada and around the world, provide an insight into the identification and resolution of airport capacity-related concerns, and to review the dynamics behind the decision-making process inherent in various planned and ongoing efforts to respond to the recent growth in the industry. The role of airline and airport management, as they relate to planning for airport capacity, will be examined and some operational solutions to airport capacity improvements that can be exploited in the short-term, while at the same time respecting the requirement to effectively plan for the long-term, will be put forward.

AIRPORT ELEMENTS AND INTERFACES

There are three major elements in the air transportation system: airlines, airports, and airspace, all which function as partners in this interdependent system. Airports and their associated facilities are an important cog in this system.

Figure 1 - Air Transportation Systems

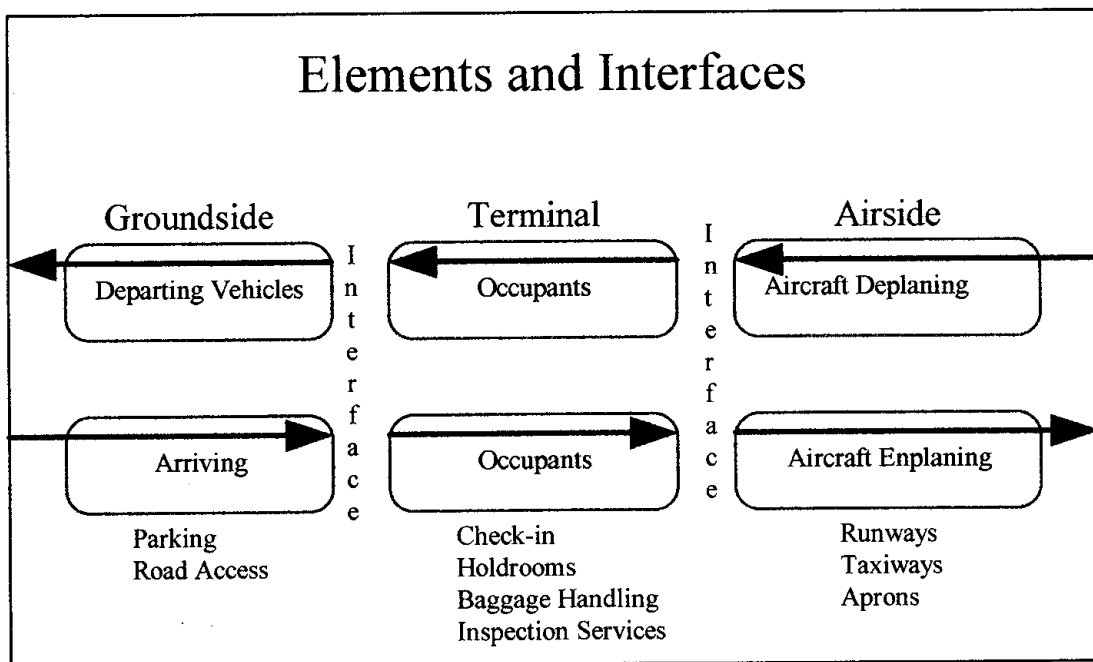


In Canada, there are 26 airports which are classified as part of the National Airport System and, as such, are managed by either the Federal Government, or increasingly by Airport Authorities. Halifax International Airport ranks eighth largest in terms of enplaned and deplaned passenger activity.

The airspace component of the system is managed by NavCanada, a recently privatized not-for-profit corporation. The airline element is dominated by two national carriers: Air Canada and Canadian Airlines International; however, a larger number of regional and charter operators also exist.

An airport facility has many diverse components which, when put together, form the airport system. An airport can be described in terms of three broad sub-systems: groundside, terminal, and airside. The groundside component incorporates those facilities and services necessary to access the terminal facilities; terminal facilities represent the transfer portion of the system; and airside facilities are used for the movement of aircraft. Airport sub-systems and interfaces are shown schematically in Figure 2.

Figure 2 - Airport Sub-Systems and Interfaces



The airport operator is responsible for ensuring that the facilities required for the transfer of passengers and baggage from ground to air, and vice-versa, are available as needed. The capacity of an airport facility is constrained by infrastructure elements at the facility. The extent to which the infrastructure associated with this system can meet the

demands placed on it in the future is a concern to both airport operators and airline management.

FACTORS INFLUENCING AVIATION DEMAND

The demand for air travel has increased tremendously over the past few years. The major factors which have had an impact on airport demand include economic regulatory reform (commonly referred to as deregulation), airline route restructuring, new market entrants, scheduling windows, and night curfews.

Of these, the most significant factor that has accelerated the recent increased demand for air travel in Canada is the program of economic regulatory reform, or deregulation, undertaken by the Federal Government over the past decade. Deregulation of the airline industry has radically changed the market in which airlines and airports operate. Once subject to strict regulation of routes and fares, commercial air carriers are now free to revise routes, adjust fares, and introduce or terminate service to particular airports as market conditions seem to warrant. This new freedom from federal intervention has had pronounced effects on the airline industry. It has spurred intense competition and even price wars among the airlines, led to reconfiguration of the route system, and encouraged the start-up of new carriers.

The path towards regulatory reform was started in 1985, when it became clear that major policy changes were necessary and a new approach to the government's regulatory role was essential. Proposals were put forward to open up the transportation system to competitive market forces, reduce the burden of regulation, and reduce costs to the taxpayer. These "Freedom to Move" proposals formed the basis for the 1987 National Transportation Act.

In the last five years, perhaps the most dramatic illustration of the reform initiative impacting air transportation demand is the Canada - United States “Open Skies” agreement which virtually eliminated barriers to air travel between the two countries. Officials estimate the deal to be worth \$10 billion a year in new cross-border air traffic for both countries. With the “Open Skies” agreement, Canadian airlines benefit from unlimited rights to operate flights to and from any U.S. point with no restrictions on capacity, frequency, or aircraft size. In addition, U.S. airlines are allowed to land at more than one point in Canada, and can increase the number of flights they operate out of Canadian Airports except initially for Toronto, Montreal, or Vancouver. Those cities became more open to U.S. carriers over the three years following the deal. The “Open Skies “ deal was struck on February 25, 1995, with the provision for a three-year implementation period.

With deregulation, and ease of entry and exit, came new services and new airlines. At Halifax International Airport, for example, within the first year of the “Open Skies” agreement, flights left Halifax directly for Detroit, New York City, and four cities in Florida: Fort Lauderdale, Orlando, St. Petersburg, and Tampa. The Florida destinations had been previously available as charters, but became regular flights. Table 1 shows the number of new services to U.S. Airports from Canadian Airports in the 12 months following “Open Skies”.

Table 1- New Transborder Services

City	Number of New Services to U.S. Airports Since "Open Skies"		Total U.S. Airport Links* Summer 1996
	By new operations	By charter conversion	
Vancouver	19	5	22
Calgary	9	4	13
Edmonton International	1	1	5
Toronto	20	11	38
Ottawa	5	2	10
Montreal	9	2	18
Halifax	2	5	8
<i>* Where two or more airlines serve the same non-stop city pair market, it is counted as a single link.</i>			

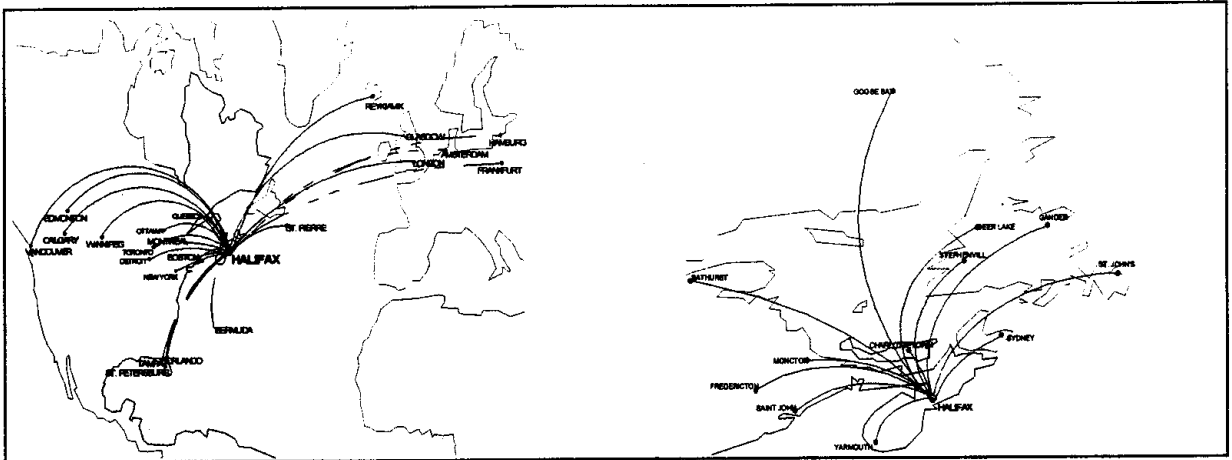
Also with deregulation came the freedom for airlines to set fares, openly compete and aggressively enter new markets. The entire character of the industry changed. Airline networks restructured as a result of economic regulatory reforms. Large airlines abandoned previous linear route systems and implemented a type of network referred to as a hub-and-spoke route system. The term hub-and-spoke is used to describe an airline route structure in which flights radiate from a major (hub) airport, much like spokes from the hub of a wheel, with the major airport serving as a transfer point for passengers changing flights and going on to other, usually longer haul, destinations. The mainline or larger carriers concentrate their services at hubs.

A shift to a hub-and-spoke operation causes the traffic at an airport to explode almost exponentially since it is used then not only as a origin/destination point, but also as a connecting point for transfer. This subsequently represents a genuine change of scale with attendant peaking and capacity problems. Current route structures at Halifax International

Airport are shown in figures 2a and 2b and are representative of a typical hub-and-spoke network.

Figure 3a - International Network

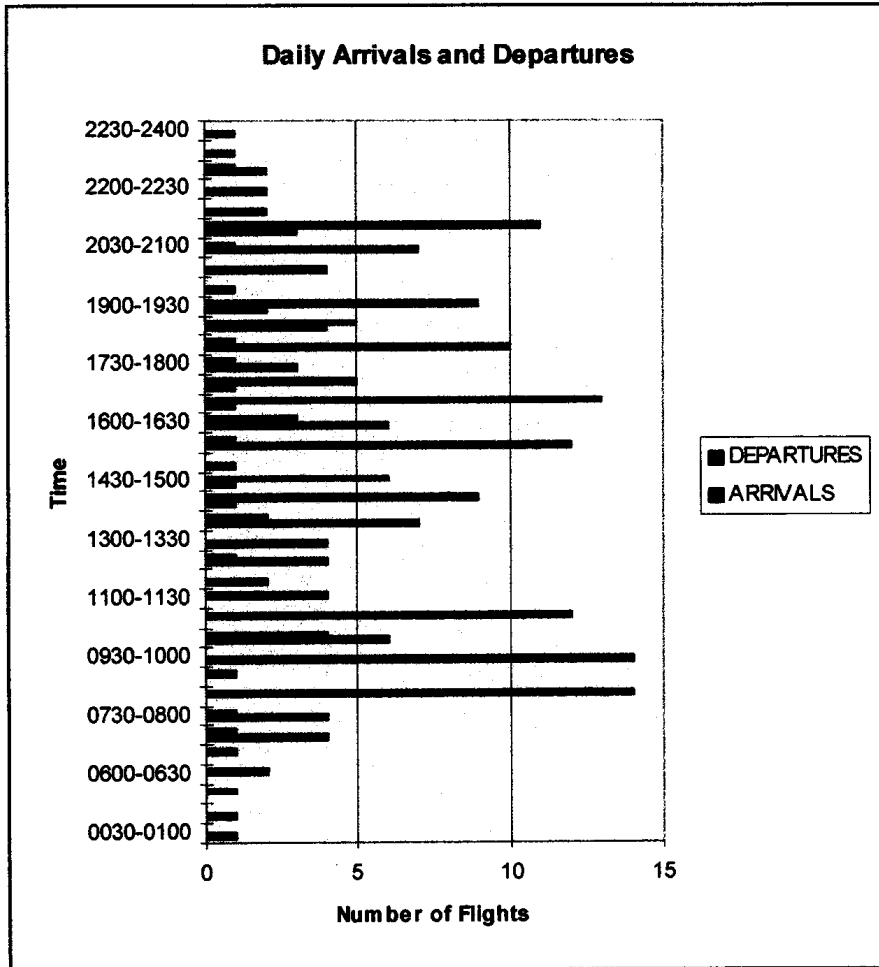
Figure 3b - Regional Network



Strong competition among airlines in recent years has encouraged the use of hubs. At the same time, urbanization and airline use of transfer hubs tends to concentrate traffic at Canada's largest airports. A further factor, particularly in the early years of deregulation, contributing to the development of the hub-and-spoke networks included the strong growth and acceptance of regional or commuter carriers. These smaller airlines supply passengers to and from smaller markets servicing the spokes in the hub-and-spoke system. The growth of regional carriers has resulted in a concentration of flights into very narrow time slots, thus increasing congestion even further. These Regional or Commuter carriers feed into the hubs and are usually affiliated with a mainline carrier. By using regional carriers to feed hubs, both mainline and regional carriers are able to consolidate their markets and maximize their load factors.

The histogram in figure 3 illustrates the impact of airline Hub and Spoke operations at Halifax International Airport and, particularly, the concentration of activity at several peaks throughout the day. The peaking is representative of a typical Canadian hub airport.

Figure 4 - Halifax International Airport - Arrivals and Departures



Another phenomenon associated with deregulation is the way in which service patterns to smaller communities have shifted. Less service is now being provided directly between smaller communities, but more service is being provided between larger communities and smaller communities with greater frequency and smaller aircraft. Consequently, since their

inception, commuter airlines have emerged with a significant role in the air transportation market .

Changes in the type or size of aircraft and new aircraft designs all associated with this shift impact the planning for airport capacity. These changes in aircraft type and frequency are significant factors which augment the strain on airport infrastructure.

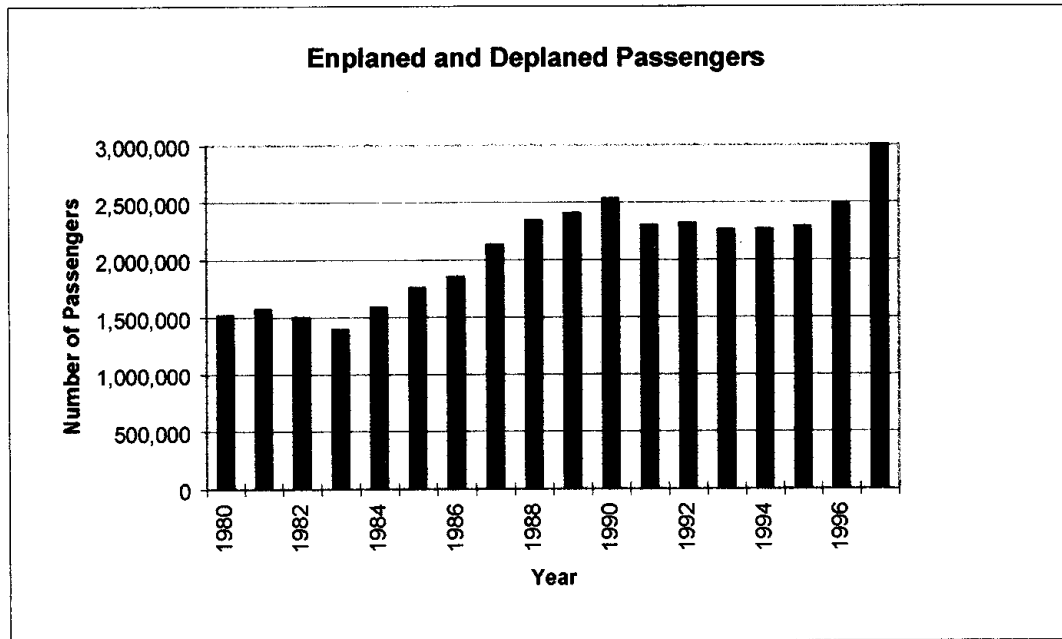
In the context of growing traffic and increasing pressure from communities, night curfews are also becoming a common feature at many airports and can have an impact on plans for future airport capacity. An airport can be impacted not only by curfews in place at that airport, but also by curfews in place at other airports from which common aircraft may be flying.

AIRPORT CAPACITY - IMPLICATIONS FOR AIRPORT INFRASTRUCTURE

Unfortunately, while the demand for air travel has increased tremendously over the past few years, infrastructure has been growing at a much slower rate. As a result, an imbalance between demand and capacity often exists .

At Halifax International Airport, enplaned and deplaned passenger activity air traffic grew by an unprecedented 100 percent over the period from 1980 to 1997. Figure 4 shows this growth in passengers at Halifax International Airport for that period.

Figure 5 - Enplaned and Deplaned Passengers - Halifax International Airport



Growth throughout the industry, similar to that which has occurred at Halifax International Airport, places tremendous strain on airport infrastructures. Airport facilities are often the weak link in the air transportation system, constraining air travel growth. Many airports have no unused capacity for future growth, or, if they exist, the facilities that are available are very limited and cannot accommodate unexpected and unplanned demand increases. Coping with the current demand is often the limit of the capacity of existing airport facilities. The majority of airports impacted by growth face not one, but numerous problems in meeting demand, particularly during peak periods.

For example, a variety of factors influence the capacity of the airfield component of an airport system. The configuration, spacing, and orientation of the runway system; as well as the arrangement, size, and number of gates in the apron area all contribute to the available capacity of the airfield.

Taking the example further, spacing between successive aircraft is a factor which affects runway capacity. This spacing is dependent upon the appropriate air traffic rules which are, to a large extent, functions of weather conditions and aircraft size and mix. Aircraft wake vortices require greater separations when a light aircraft follows a heavy aircraft than when a heavy aircraft follows a light one. The existence and frequency of these vortices, and their impact on airfield capacity, are aspects of operations which must be understood and considered.

The existence and nature of navigational aids, the availability and structure of airspace for establishing arrival and departure routes, and the nature and extent of the air traffic control facilities, are also all factors affecting runway capacity. The number of aircraft arrivals relative to the number of departures, the size and mix of aircraft using the facilities, as well as the number and frequency of touch-and-go operations by general aviation aircraft, influence the capacity of an airfield as well.

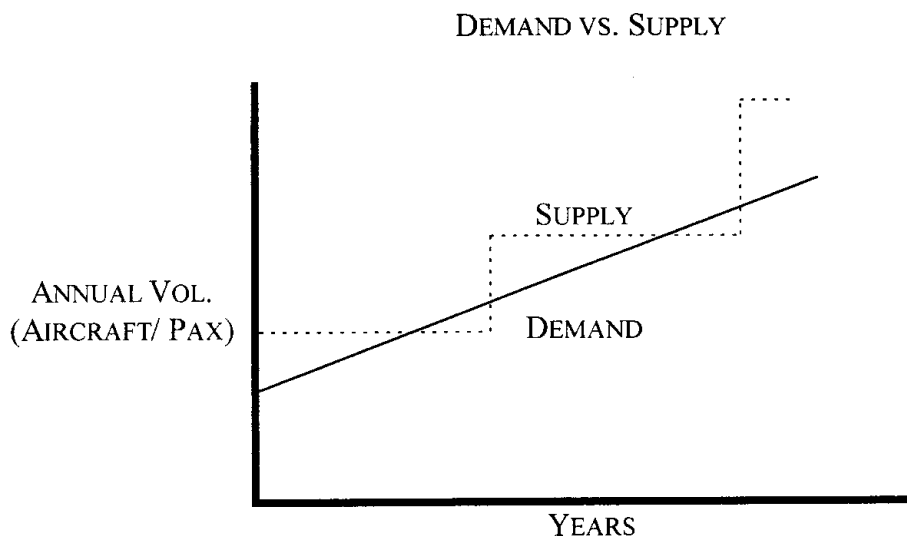
Weather, more particularly visibility and cloud ceiling can also affect the availability of an airfield since air traffic rules in good weather are different from those in poor weather. Some wind conditions may preclude the use of all available runways by all aircraft. Noise abatement procedures may also limit the type and timing of operations on available runways. Within the constraints of wind and noise abatement, the strategy which the controllers choose to operate the runway system is also important and is one of which Airport operators must be aware.

In the final analysis, in terms of impact of demand on airport infrastructure, it must be recognized that the flow of air traffic at airports is not evenly distributed. Rather, it comes in waves, with often very pronounced peaks, and valleys. Aircraft generally arrive and depart in

groups like waves and, when flights arrive, there is a surge of passengers creating the peaks. Consequently, evaluating capacity on the traditional basis of annual volumes may be misleading.

Adequately assessing problems is further compounded because traffic growth occurs in quite small, gradual increments whereas capacity or supply increases occur in quantum leaps associated with, for example, construction of a new terminal, taxiway, or runway. Figure 6 illustrates this situation.

Figure 6 - DEMAND VS. SUPPLY



Both short and long-term solutions exist for airport capacity improvements; however, the cost and appropriateness of each solution require careful evaluation before implementation.

SHORT-TERM MEASURES TO INCREASE CAPACITY

Capacity and delay studies can be an effective tool in determining means to increase capacity and reduce delays at airports. In practice, analyses are conducted to examine the

implications of the changes in the nature of the demand, operating configurations of the airfield, and the impact of facility modifications on the quality of service afforded this demand.

Often, oversimplification of the issues can result in an assessment that the airport doesn't have a capacity problem, rather, it is assumed that the airlines are having a scheduling problem. At some airports, available capacity may have to be allocated among users. In such instances, one of the issues to be considered involves identifying and resolving scheduling problems and negotiating schedule adjustments, where appropriate, to meet demand.

Demand management through voluntary coordination of demand, capacity allocation mechanisms, persuasion, pricing incentives or other restrictions, can also be effective in the short term. Optimizing flows through the terminal building, as well as optimizing runway use and passenger processing, provide effective short-term relief. Satellite processing for ground transportation system components, such as passenger parking, and rental car parking and processing, allow airport authorities to make more effective use of adjacent facilities. Remote processing of passenger check-in services, aircraft parking, airport terminals, or other subsystems can also be considered.

Common or multiple-use facilities also provide a range of measures to increase capacity in the short term. The introduction of Common Use Terminal Equipment (CUTE) offers the possibility of increased utilization of the check-in counter area by airlines that may only need to occupy counters for a portion of the operating day. Appropriate and adequate counters, equipment, furniture and fixtures can all help improve the processing of aircraft and passengers through a facility. Flexible contractual arrangements with airlines can provide some versatility to accommodate increased capacity by facilitating better use of the check-in areas.

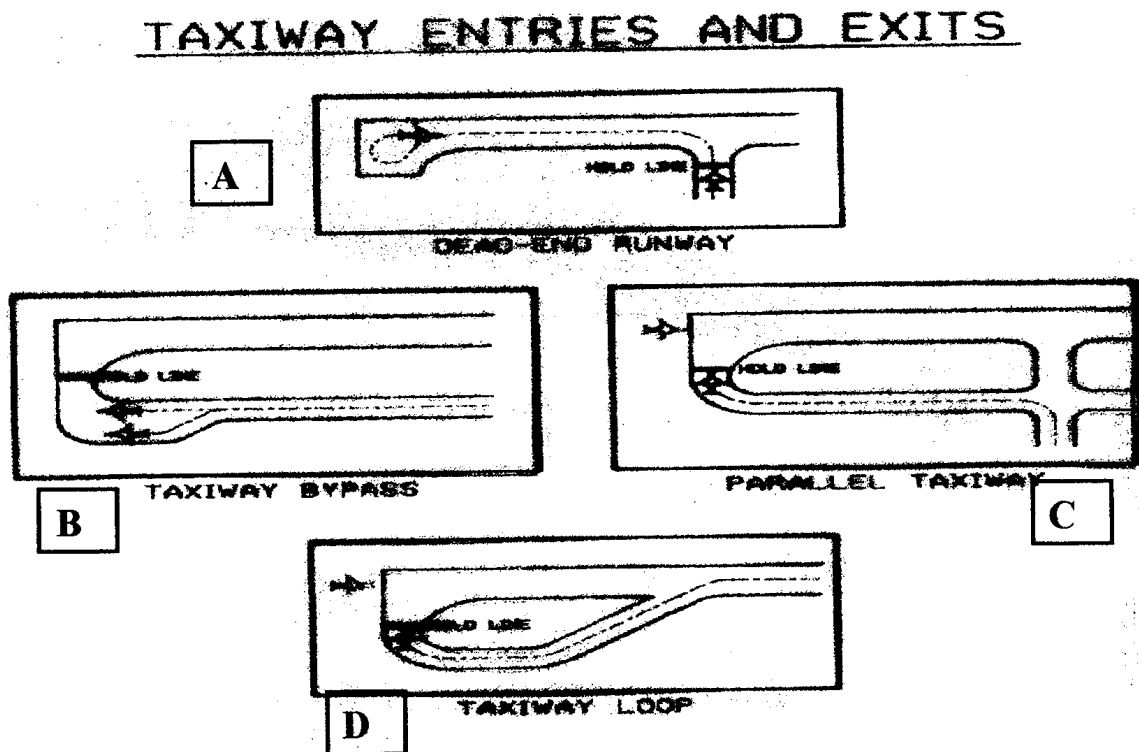
On the airfield, capacity can be increased in the short term through spatial downsizing techniques including reducing aircraft separation, within allowable limits, and by implementing a nose-in parking plan on the apron. Maximizing aircraft parking can be achieved by minimizing wingtip clearances, again within the recommended safety guidelines.

A typical study might include the affect of alternative runway exit locations and geometry on runway system capacity. The impact of airfield restrictions due to noise abatement procedures, limited runway capacity, or inadequate airport navigational aids, on aircraft processing rates would also be an appropriate subject for consideration. The consequences of introducing heavy aircraft into the aircraft mix at an airport, and an examination of alternative mechanisms for servicing the mix, could be the focus of another such review.

An investigation of alternative runway-use configurations and their impact on the airfield's ability to process aircraft, as well as the generation of alternatives for new runway or taxiway construction to facilitate aircraft processing, could be considered. Some gains may be achieved in system capacity or delay reduction by diverting general aviation aircraft to reliever facilities in large air traffic hub areas. This is an increasingly common practice as airports become busier, and a review of this option may be warranted.

Runway occupancy time for arriving and departing aircraft is another factor which influences the capacity of an airfield. Only one aircraft at a time is permitted to use a runway. As a consequence, one way to increase runway capacity is to find a way to reduce the time an aircraft spends on a runway which will, in turn, minimize the need for backtracking. Several different taxiway entrance and exit configurations, with varying degrees of runway occupancy times, are shown in figure 7.

Figure 7 - Taxiway Entries and Exits



Backtracking on a dead-end runway is required in the situation depicted in configuration 7A. Minimizing the need for backtracking can improve runway capacity in this instance. The configuration shown in 7B indicates that using a taxiway bypass eliminates the requirement to use the runway as a taxiway to get into a take-off position. The implementation of a full parallel taxiway, as shown in configuration 7C, means that aircraft never have to use the runway as a taxiway. Further improvements can be achieved by providing a short taxiway loop which will provide departing aircraft with a place to hold clear for arriving aircraft near the take-off threshold. Configuration 7D illustrates such a situation.

There are a wide range of other technical initiatives available to improve capacity at an airport. Runway-use configurations permitting multiple arrival streams or simultaneous take-

offs and landings are very effective in increasing runway capacity. Other possible methods to achieve reductions in runway occupancy time should be reviewed. Furthermore, reductions in aircraft separation requirements are possible and should be considered, where warranted. Automation of Air Traffic Control services can also increase airfield capacity. Additional systems and equipment may also be beneficial such as new technology; e.g., Global Positioning Systems (GPS). The relaxation of noise curfews and other operating restrictions may also be worthy of consideration.

In the end these actions help alleviate in the short term by only small increments. In the longer term there is no substitute for the expansion of capacity. Given the long lead times involved in project development and financial restraints, it is unlikely that short term measures to increase capacity will provide much more than incremental improvements to problems.

LONG-TERM PLANNING

The current issues brought on by deregulation, and the associated factors influencing demand, have necessitated an emphasis on long-range planning in addition to the often short-term measures such as fine tuning of operations and minor facility changes. With the implementation of the freedom-to-move policy, planning has become more difficult as the uncertainty of future service patterns becomes a given for prospective planning purposes. The process of planning to accommodate traffic demand needs to ensure that the capacities of the elements of the airport system are balanced and harmonized.

Airlines often have objectives to expand their market, as well as their market share. Therefore, lack of airport access represents a major frustration for their business. The airline

industry is able to vary schedules and fleets rather quickly whereas airport infrastructure is rather static and takes longer lead times to achieve.

One of the challenges in managing capacity problems from an airport management perspective is dealing with the perception that airport operators are telling airlines how to run their businesses. Airport operators cannot solve capacity problems in isolation from the airlines; working together is essential.

There are a number of things that airline management can do to help minimize capacity shortcomings at an airport. The use of larger aircraft is one of the ways in which airlines can accommodate larger demand and new technology aircraft can also facilitate more efficient use of facilities. Many carriers realize that revenue can be increased through yield increases and less traffic growth. Consequently, consideration must be given to using yield management techniques as a tool to achieve revenue increases. Handling aircraft in more homogeneous groupings can also be an effective tool for planning for airport capacity. An increase in load factors can accommodate more people without overtaxing some airport components as well. From a route planning perspective, airlines can plan to increase services between regional airports without affecting the major hub, which is presumably to be the most severely overtaxed facility. Scheduling flights at off-peak hours is another very effective way of utilizing airport facilities.

Airlines must relate their demand forecasts, not only to the equipment they have, but to the capacity situation at the principal airports they serve. In the selection of new aircraft, airlines must take into account the consequences on airport operations, design, and cost. Airlines make purchasing decisions all the time, usually well in advance of the anticipated delivery date, and should regularly communicate their plans for new aircraft to airport

operators. Airport operators, in turn, can make more informed decisions taking into account the future requirements of the industry. Airlines can't expect all their demands to be met; some reasonableness and flexibility is required. A balance between necessary competition and excessive competition must be reached within the airline industry.

Collection and pooling of evidence of delays, and the quantification of economic penalties resulting from congestion, would assist airlines in making a case for action to be taken to increase capacity. However, requests must be tempered and demonstrate a willingness to compromise. There must also be recognition that someone has to pay for the changes requested; therefore, airlines have to come to terms with being prepared to pay for the facilities that will be needed. In Canada, airports have not recovered their costs, and users have not paid. As a result, the taxpayers have been left to foot the bill. This is no longer acceptable.

Due to the competitive nature of the industry, and time differences inherent in travel throughout a country the size of Canada, scheduled airport arrival and departure times, and the associated gate use, must be carefully coordinated and approved by the airport authority. To effectively and equitably manage the use of airport facilities and maximize available capacity, schedules must be created and a system put in place to maximize the use of facilities. Airline preferential-use provisions and any "grandfathering" allowances in place must also be considered. The management plan will result in scheduling windows, which are periods of time that take into account processing time plus size and type of aircraft. Any new demand has to be accommodated in the scheduling windows.

The role of an airport extends beyond service to commercial air passenger aircraft. There are scheduled cargo flights, charter passenger flights, general aviation - including

corporate business aircraft, courier operations, medical evacuation flights, and private pleasure aircraft. All of these groups have to be recognized in defining the users of an airport. As an airport matures, and as new trends develop in society, the relative importance of each category of user is seen in a different light. When an airport approaches its capacity limits, the difficulty of developing a priority list for access can be considerable, given that often substantial investment in facility development and corporate enterprise has been put in place to serve the non-scheduled traffic.

The construction of new airports, terminals, or runways, is one obvious way to increase capacity and reduce delay. However, often there are a number of barriers to expansion and new construction including cost, political and community opposition, aircraft noise and opposition from incumbent airlines.

As an alternative to new construction, there are a wide range of technological improvements under development which can help airports cope with some of the capacity shortfall. These developments can promote more efficient air traffic movements at and around airports. Airport guidance, surveillance and control systems which can improve capacity are being explored, as well as more capable instrument landing systems, and systems to minimize separation distances for wake turbulence.

Runway and technology improvements that could enable aircraft to take off and land at closer intervals, regardless of weather conditions, will improve an airport's capacity. Larger aircraft requiring shorter runways, or aircraft with reduced takeoff and landing capabilities, or aircraft which can follow steep approach and departure paths, or vertical paths, are possible.

A range of procedural options are available to minimize flying over populated areas during certain periods. The introduction of quieter aircraft is also an effective tool to increase capacity. An effective community relations plan is essential for airports impacted by noise.

Expanding airport runways through new construction is often problematic due to the associated costs associated with mitigating aircraft noise. As an alternative, programs that involve purchasing property haven been successful. Sound insulation programs for affected residential dwellings and school facilities are also in place in some areas. Although such programs can be complex and complicated, well-organized and managed programs can be cost-effective and ensure noise compatibility.

Peak hour rates can be charged when an airport can be expected to be heavily congested. The adoption of peak hour pricing can reduce peak hour activity significantly producing a reduction in the expected amount of delay at the airfield.

Routing traffic to underutilized airports or reliever airports is worthy of consideration if it can be demonstrated that such a measure would be effective. The military has a large number of airfields, and although not common practice in Canada, in other countries, airports can be partially or fully converted to civilian use.

The best, most efficient combination of transportation modes for the movement of people and goods along with the development of strong intermodal links can relieve congestion at gateway airports. Efficient high speed passenger rail service, and superhighways, are ways to get people out of airports and relieve congestion, particularly for shorter trips. In Canada, a rail link to join Pearson International Airport to the downtown core is under consideration at this time.

An airport manager has the responsibility to secure the finances to make the necessary investments in infrastructure to accommodate forecasted demand. At Halifax International Airport, a federally-operated facility, government financial constraints must be considered in any long-term planning scenario. Within the scope of the nation's budget, support for transportation infrastructure is often low on the priority list. Politicians often focus on the length of their term, usually 4-5 years and, as a result, concentrate on the next election. Few governments commit to long-term developments fraught with sensitive implications.

Given the scarcity of resources of federal government financing of capital expansion initiatives and deficit reduction initiatives, innovative financing arrangements must be pursued to ensure the provision of major new infrastructure improvements at federally-operated facilities. At Halifax International Airport, for example, Air Canada and Air Nova recently invested \$ 9.5 million in infrastructure improvements to both exclusive-use and public-use facilities.

Ultimately, the airport operator is responsible for ensuring adequate airport capacity is available to satisfy the demand for air transportation at any given point in the future. Shortage of capacity is one, if not the most significant, problem facing airport operators today. There is no room for complacency, and the airport operator must not only exercise continued vigilance by negotiating and planning for airport capacity, but must also ensure that others are not permitted to become indifferent about capacity issues. Much of the airport business is motivated around short-term results, even short-term survival. Short-term capacity solutions, such as the use of larger aircraft and higher load factors, cannot be allowed to permit a false sense of security to justify ignoring problems and hoping that they will go away. Recognizing

the needs of the airlines and the passengers they serve is an important function of airport management.

To effectively manage for airport capacity, airport management must balance and integrate into a total system approach airline requirements, aircraft design considerations, airspace control procedures, and airport facilities. Cutting down decision time is crucial to ensuring operational effectiveness. Airport managers must be prepared to plan over the long term, and must consult with other agencies to achieve this objective.

COMMUNICATIONS AND CONSULTATION

Anyone who travels by air has experienced firsthand the consequences of inadequate airport capacity. Capacity constraints will stifle our aviation system and stunt the economic development generated by aviation activity unless steps are taken to expand and rebuild our airport infrastructure. The financial viability of carriers, both individually and collectively, and the economic condition of airports and the communities they serve are inextricably linked.

The importance of effective communications and consultation in this context cannot be overstated. Planning for airport capacity requires constant communications with virtually every individual or group impacted by the facility. Airport managers must further strengthen consultation with industry to provide a well-rounded assessment of need in capacity terms, and to ensure agreement by all parties. Increased community involvement in airport-related decision making has become standard practice. That has come about both as a legal requirement and political reality.

There are real benefits to be derived from consultation with others. A partnership approach with the airlines can often facilitate the successful implementation of plans to

improve capacity. In addition, taking an active role in the community with adjacent land use planning and development can also reap many rewards for an airport in the long term.

CONCLUSION

Lack of airport capacity has neither a single cause nor a single solution. All sectors of the air industry have an important role in exchanging ideas and information, and in coordinating efforts in planning for future development of the airport facilities.

There are a number of issues and solutions relating to planning for airport capacity which can be addressed, but only with cooperative efforts. Effective planning and the development of specific strategies are essential to resolve airport capacity issues. Both airport operators and airline management play critical roles in planning for airport capacity and in determining how the airport system will meet the needs of the aviation industry.

There are many difficult choices which must be made in planning for airport capacity, and often there are no easy solutions. A wide range of available measures must be evaluated and appropriate methods selected to address each problem area. In the end, there must be confidence that the chosen strategies will be successful.

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