AIRPORTS IN THE 21ST CENTURY
Prospects for the Future

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SUMMARY

This paper explores the long-term prospects for airport development between now and the middle of the 21st Century. It tries to identify both key issues and the range of probable outcomes. It draws on knowledge of the past, analysis of the future prospects, and an appreciation of the limits to extrapolation. It will be revised with the help of numerous experts in the field between now and Spring 2000.

It suggests scenarios that need to be considered. Since specific predictions of future events are "always wrong" due to inevitable changes in circumstances, it is preferable to think about the range of probable developments rather than improbable specifics. Recognition of the possible eventualities enables strategic thinkers to build flexibility into their plans so that they can smoothly accommodate to what actually happens.

The scenarios focus on three main elements:
1. The levels of traffic -- passengers, cargo and aircraft;
2. The infrastructure that will be provided to accommodate these loads; and
3. The way these facilities will be managed.

Traffic: Future levels of traffic are perhaps most questionable. While many Americans rarely if ever fly and the domestic market is far from saturated, there are many reasons to think that the rate of growth of US domestic traffic may continue its long-term decline. As seemingly small differences in assumptions about the rate of growth lead over a generation to enormous differences in totals, we must be very tentative about future levels of traffic. For example, by 2025 the number of enplaned passengers in the United States could be two or even three times the current 600 million a year.

The composition of the total traffic is in any case likely to be significantly different from what it is today. The international components could be larger and more pervasive. This could be propelled by two factors: the growth in the number of foreign visitors as the rest of the world catches up to the United States in terms of air travel, and improvements in aircraft range that

facilitate long-distance travel. In this context, we can anticipate that more international traffic will go directly to inland cities that have not had international service. It is also possible that cargo traffic will expand dramatically as companies reorganize their distribution systems around electronic commerce.

The infrastructure: Two new kinds of airports may become more important. We may witness the further development of brand-new massive airports with sets of very long parallel runways, located well outside traditional city limits. They would be on the model of Atlanta, Dallas/Fort Worth, Denver International, Orlando and Washington/Dulles in the United States, and of Athens, Kuala Lumpur, Paris and the new Seoul airports. They would serve as centerpieces of new economic areas or as transfer hubs. We may also see the further development of specialized airports, serving niches of cargo or passenger traffic. Current examples of this phenomenon in the United States are Louisville as a cargo center and Dallas/Love as a base for Southwest as a low-fare airline.

The airport passenger buildings may also be quite different, as the implications of electronic commerce become understood. Electronic ticketing, seat assignment and check-in will reduce the need for massive departure halls with hundreds of counters and extensive queues. More aggressive marketing may on the other hand increase the amount of space desired for shops beyond security clearance. This effect may however be counterbalanced by pervasive e-commerce: how much will people want to carry merchandise with them, when they are used to having worldwide articles delivered at home?

Organization of Airport Business: The organization of airlines into worldwide groups such as the Star and Oneworld alliances will surely have significant repercussions on airports. Most obviously, the airline groups will insist on being co-located in identifiable sections of an airport. More subtly, they will look for common standards of treatment across their suppliers instead of idiosyncratic local rules at hundreds of places. This pressure supplements the increasing desire to run airports more effectively from the commercial point of view. We can thus expect the development of large companies devoted to running airports, or portions of airports, nationally and internationally.

Over time, we may expect that airports will less and less be run as municipal departments or local authorities, and increasingly as franchises to commercial companies operating under policies set by local political structures. This evolution could, through economies of scale, create substantial efficiencies and improvements in service.

BACKGROUND

The past the prologue. Any exploration of future prospects should rest upon a solid appreciation of what has happened so far.

Airports and aviation as we know them today really developed since around 1950. Air transportation became an important routine activity during World War II, and commercial aviation came into its own following the return to civilian normalcy and the reconstruction of the world economies following the end of this conflict. As regards airports, five features are salient as described below.

Growth in aviation passengers and cargo is an outstanding characteristic of the last 50 years. Long-term, over good and bad years in this period, passenger traffic has increased by an average of about 7% a year in the United States and 8% worldwide. This means that the amount of air travel has been doubling every 10 years or so. This level has been generally continuing worldwide. Recently however, this long-term overall growth has dropped, in the United States to about 4 % a year which implies that traffic now doubles about every 15 to 20 years. See Figure 1.

[Figure 1 about here]

This growth in aviation traffic has been propelled by a remarkable combination of factors. Most obviously, the price of air travel has steadily dropped over the past 50 years. As Figure 2 indicates, the long-term drop prices is mirrored by a steady rise in use per person, as one would expect from basic economics. Meanwhile, the safety and smoothness of the flights has increased dramatically. The number of accidents and deaths per trip has dropped by a factor of 2 to 3 in the United States. See Figure 3. Passengers and cargo now receive far more value for money now than they did in the unpressurized small aircraft flying over primitive air traffic control systems. Meanwhile, the increased globalization greatly brought out by better international communications and aviation, further facilitated long-distance travel. These factors have jointly led to the steady growth in aviation of the last half century.

[Figures 2 and 3 about here]

Aviation companies are becoming global enterprises. Airlines traditionally have had specific national characters although they provided international service. American Airlines, British Airways, and Air France for example were each clearly based in their home countries and presented their nationalities proudly. Now however, airlines are developing international

characteristics and submerging their nationalities. For example, Northwest and KLM work together to present a single image, so that the US customer can feel comfortable with an American style of service, while the Dutch customer can similarly expect a familiar treatment.

The global airline partnerships now being formed express this trend. The Star or Oneworld alliances for example link up national airlines into global networks whose stated aim is to provide coherent services to passengers as if they were using one airline. These are leading to patterns of ownership (as between US and Canadian, and US and Latin American airlines). They are also being matched by the emergence of transnational European airlines formed through mergers across borders, for example between KLM and Alitalia, and between Swissair, Sabena (Belgium) and TAP (Portugal).

Airports are similarly losing their local character and becoming international. We are seeing the development of global "airport chains" similar to "hotel chains". International companies are increasingly taking over the operations of portions of these properties, and delivering their own brand of services. As in the hotel business, the management arrangements are sometimes based on long-term contracts (as when BAA from England operates Indianapolis airport), and sometimes on ownership (as when SEA from Milan owns the Argentine airports). These international companies may be based at particular airports (such as Amsterdam, London or Milan), on operating companies (Ogden or Westfield Holdings), or on specially constituted investment companies (such as TBI from England, which has bought up the US based Airports Group International and is contracting with Orlando/Sanford airport).

Airport Capacity Increases have been a constant feature of aviation. Major new airports and runways have come into being regularly and undoubtedly will continue to do so. The last twenty-five years have witnessed several remarkable projects such as the construction of Dallas/Fort Worth, Denver International, Orlando and Washington/Dulles. Several major airports are now constructing or are planning major new runways, for example Miami International, Orlando International, and San Francisco International. Additionally, a number of existing facilities that were previously underutilized have grown considerably as airline routes have expanded. Cincinnati, Detroit and Washington/Dulles have become major hubs while Miami/Fort Lauderdale and Providence have become significant destinations. See Table 1.

[Table 1 about here]

What is truly remarkable, however, is the increased traffic now routinely carried by a given runway, compared to twenty or more years ago. Many airports now serve 50 to 100% more

operations a year than their "Practical Annual Capacity", as estimated by planners in the 1970s. Actual operations now routinely can be as much as 90% above what planners imagined were upper limits (see Table 2).

[Table 2 about here]

These improvements in runway capacity are due principally to extended daily use. Additional improvements came from technical changes, better operating practices and increased skill of the air traffic controllers. Specifically:

- Airport operations now routinely extend from 6 a.m. to past midnight, a sharp contrast to the situation of a generation ago when aviation planners seriously debated whether travelers would ever use such inconvenient times. As deregulation demonstrated, travelers do fly at odd hours when the price is right.
- Bigger aircraft, operating with higher load factors associated with flexible pricing practices that airlines use to fill more seats, increases the volume of traffic.
- Improved spacing and sequencing of aircraft into airports has reduced the variability in landing times, and increased the number of operations it is possible to accommodate.
- Air traffic controllers in the United States now have learned to use existing runways more efficiently, for example when they control landings on intersecting runways.

Environmental Issues will increasingly define the design and implementation of airport systems. They have already been important factors limiting and defining the operation and expansion of airports. The debates about new runways for Boston, San Francisco and Seattle illustrate this phenomenon. Yet these controversies have perhaps been mild. They have been situated in the context in which overall noise levels have generally been steadily decreasing. In recent year the increases in the factors increasing noise (the number and size of the aircraft) were counterbalanced by the introduction of quieter aircraft (stage 2 and stage 3). While the number of enplanements tripled between 1975 and 1998, the population exposed to high noise levels around airports fell by a factor of 10 from 7 to about 0.6 million in the same period. **[need exact reference]** In the future however there are few prospects for quieter aircraft, so that aircraft noise and pollution is bound to increase exponentially. This will make airport planning even more difficult.

Environmental issues will soon begin to affect airline routes and traffic. As constraints affect individual airports, airlines will shift traffic significantly to airports with available capacity or fewer constraints. Within metropolitan areas, airlines will favor uncongested airports. Thus around Miami significant traffic has been directed to Fort Lauderdale in preference to Miami International.

Likewise around Boston, Providence airport has grown by about 4 million passengers a year over the last few years, while traffic at the main airport, Boston/Logan, has been steady (see Table 3).

[Table 3 about here]

Most significantly, airlines faced with environmental constraints in their hubs will develop new ones elsewhere. Thus Northwest when limited at its traditional hub of Minneapolis/St. Paul developed a major hub at Detroit. Similarly, the Dutch airline KLM reacted to environmental pressures in the Netherlands by initiating a merger with Alitalia and planning to establish an alternative hub in Milan, Italy.

Development of Multiple, Competing Airports. Airports compete with each other for the same traffic. Compared to 50 years ago, this is an entirely novel phenomenon. It used to be that traffic destined for a city, San Francisco for example, would go to that city's airport and nowhere else. Now however the notion of San Francisco as a city has expanded over a large metropolitan area so that its residents and visitors may naturally use airports that are hours apart, such as San Jose and Oakland. The same development has happened to Boston, Chicago, Dallas/Fort Worth, Houston, Los Angeles, Miami, New York, and Washington and other cities with multiple airport systems.

The amount of traffic at the airports in the metropolitan multiple airport systems depends on a complex competitive struggle. Airports try to attract airlines to encourage passengers, and to attract passengers to help attract airlines. The airlines meanwhile are looking for their best deals, and routinely play off airports against each other. The results are typically counter-intuitive to those who have not studied the situation. (For full descriptions see de Neufville, 199**? references**).

On a national scale airports compete with each other as intermediate hubs for traffic coming from and going to somewhere else. Thus Dallas/Fort Worth, the major hub for American Airlines, competes directly for transcontinental traffic with Houston Intercontinental (Continental Airlines), St. Louis (TWA) and Chicago/O'Hare (United Airlines). The amount of traffic at each depends both on the local efforts to accommodate the traffic -- as by building new facilities -- and on the global competition of the airline groups.

It is thus no longer possible to predict the traffic at a particular airport as a function of measurable facts such as the attractiveness, the population and the economic activity of its city or region. The traffic at an airport results from complex competitive behaviors of airlines and other airports. As these are constantly changing, so are the levels of traffic as airport. Airport traffic has thus

become volatile (Barber, 1986; Barber and de Neufville, 1991). Furthermore, airlines themselves can and do move major bases of operations, as American Airlines did around 1980, and as Delta did in moving hub operations from Dallas/Fort Worth to Cincinnati in the late 1990s (see Figure 4).

[Figure 4 about here]

PROSPECTS FOR LONG-TERM FORECASTS

"The forecast is always wrong" is a good rule of thumb. The fact is, as repeatedly documented by numerous sources, that what actually happens typically is quite different from what was anticipated (see for example:). This is because all kinds of events disrupt the trends that led to the forecasts. For example:

- The Asian economic crash of 1997 severely depressed traffic throughout Asia; and
- Economic deregulation of the airlines led to significant shifts of airline traffic, such as American Airlines' move to Dallas/Fort Worth, which disrupted traffic at both Chicago/O'Hare and Dallas/Fort Worth.

Predictions are most obviously wrong on the numbers, on the levels of traffic that can immediately be compared to forecasts. This is easy to see by comparing records of previous forecasts with actual results. It is easy for 10-year forecasts to be off by +/- 30% as Figure 5 illustrates. Longer-term predictions will naturally be even more inaccurate. Forecasts are also quite wrong about the technologies that will be used, and the infrastructure needed to support them.

[Figure 5 about here]

Future types of aircraft are easily misjudged. New Large Aircraft (NLA) of 500 passengers or more have been repeatedly forecast since the 1980s and before. Yet none are yet in sight and thus will not be flying until after 2005 at least. Likewise, experts used to believe that supersonic aircraft would be common. For example:

> "Our study developed forecasts of the market for the US supersonic transport aircraft… In a case we consider to have reasonable values by all key assumptions, a 1990 market for 687 SST aircraft is indicated." (Charles River Associates, 1969, p.4)

Actually, only about a half a dozen SST's have flown commercially, the extravagantly subsidized Concorde aircraft operated by British Airways and Air France.

Designs of aviation infrastructure have often been quite unsuited to the future. A typical difficulty with physical designs is that professionals lay out what has worked in the past and fail to anticipate how airports will need to change in the future. Many of the prize-winning architectural designs for airports have, for example, turned out be operational problems within a decade or less of their opening. The circular terminal buildings at Kansas City, for example, made transfer between flights nearly impossible, and contributed strongly to the decision of TWA to transfer its base of operations from that city to Saint Louis.

The designs submitted to the 1930 National Airports Competition illustrate how difficult it can be for experts to anticipate the physical designs that will last. These plans each anticipated short runways radiating in 8 directions, served by a building similar to a railroad terminus (American Institute of Architects, 1990). They agreed with best practice of the day, as defined by Hubbard, McClintock and Williams (1930):

> "Ideally, of course, a landing field should contain a circle, or perhaps some other figure such as a triangle, capable of containing, in the eight primary compass directions, the longest required runways…" (page 14)
>
> "…at present, in view of the tendency toward larger planes, the runways should properly be planned with an ultimate length of from 3500 to 5000 feet." (page 8)

These prescripts, viewed from the distance of 50 years, look quaint and unrealistic in the context of airports with only one set of parallel runways 13,000 feet or more in length.

Given the track record of long-term forecasts, it is most useful to develop scenarios of a plausible range of futures that might exist. It would be foolish to make, let alone to rely upon specific predictions about what might happen 25 or 50 years from now. An appreciation of the range of possibilities can lead us to think about how what we do now might perform in the range of circumstances that might prevail. It will also help us identify the kinds of flexibilities we should build into our plans, so that we can adjust to actuality as it unfolds.

FUTURE TRAFFIC

Future levels of traffic are perhaps most questionable. As small differences in assumptions cumulate to enormous differences in consequences 25 years or more from now, we must be very tentative about future levels of traffic. For example, slight deviations from the current long-term growth rate of 4% a year in enplaned passengers lead to substantially different forecasts. The discrepancy between a 5% and a 3% annual rate of growth compounded over 25 years is

(348 - 212) = 136% of the starting amount. Just as a 10-year forecast may be off by +/- 30%, as Figure 5 illustrates, a 25-year forecast may easily be off by much more, for example by the about +/- 70% indicated. Any assessment of long-range forecasts should be placed in a broad range of possibilities.

Traffic is almost certainly going to grow substantially. Many Americans rarely if ever fly and the domestic market is far from saturated. Plausible increases in population and of national wealth, even if only a few percent per year, will lead to more traffic. Increased globalization will lead to more reasons for long-distance travel for business and personal reasons, in general only realistically feasible by air. Even a historically modest 3% a year growth rate doubles traffic in 25 years.

Conversely, we cannot count on steady growth. The historical growth in air traffic has been propelled by steady reductions in cost due to a series of major changes:

- economic deregulation of the airlines;
- the consequent competitive restraint on wages;
- historically low fuel prices (when adjusted for inflation);
- the introduction of yield management systems that raise overall revenues; and
- larger, more efficient aircraft, driven by 2 engines (instead of 3 or 4) with fewer pilots.

These trends may slow down or stop. Some may reverse. Fuel prices for example might rise considerably, as they did 20 years ago. So there is ample reason to think that the rate of growth of US domestic traffic may continue its long-term decline.

The possibility of forecasting the long-term future is moreover clouded by major developments with unpredictable consequences. What for example will be the net effect of affordable video-conferencing? Will it substitute for travel by permitting virtual face-to-face contacts? Or will it permit more globalization and thereby increase overall passenger-miles traveled? What will be the next effect of changing work patterns? Will casual Fridays turn into 3-day weekends and encourage more travel? Will an increasingly wealthy and healthy elder population be inclined to travel more? With all these kinds of uncertainties, we must be very modest about the possibility of precise forecasts of future traffic.

Overall, it would be reasonable to assume that by 2025 the level of traffic could be two or even three times higher than today. For example, the number of enplaned passengers in the United States in 2025 could be in the range of 1500 million a year, plus or minus 500 million, compared to the current 600 million a year. We should thus prepare for substantial growth (by planning and

land acquisition), but not necessarily commit to building the facilities for the largest possible levels.

The composition of the total traffic is in any case likely to differ significantly from what it is today. In the past 50 years air travel has shifted from being a luxury good for the elite, to a necessary business need, to mass transportation. In the years ahead we may anticipate a different change, a trickle-down from the United States to the rest of the world.

The international components of American traffic may become larger and more pervasive. This could be propelled by two factors:

- the growth in the number of foreign visitors as the rest of the world catches up to the United States in terms of air travel; and
- improvements in aircraft range that facilitate long-distance travel.

In this context, we can anticipate that more international traffic will go directly to inland cities that have not had much or any international service. Many airports may have to adjust to this globalization by installing customs (FIS) facilities and adopting international standards of communication and service.

Cargo traffic may expand dramatically as companies reorganize their distribution systems around electronic commerce. Already, in a development that is not widely perceived, the integrated package carriers such as UPS and Fedex are among the largest airlines in the world in terms of aircraft operated. Their financial strength is staggering compared to the passenger carriers. Fedex is valued at twice the market capitalization as American and United, and UPS with its massive ground operations at over 10 times! (See Table 4) As suppliers substitute web sites for brick and mortar stores, and direct shipments to customers for warehouses and in-store inventories, the growth of the integrated cargo carriers may be very rapid. It is entirely possible that this traffic may be a driving force for future airport developments.

[Table 4 about here]

FUTURE AIRPORT DESIGNS

We may be at a cusp when significant changes may become widespread in airport design. Long-term developments may be gaining enough salience so that future planners might look back on the coming years as a period of major change in airport design. This may affect both the airside

of the airport, as concerns the length, orientation and spacing of the runways; and the landside, as concerns the configuration and functions of the airport passenger buildings.

Much of these changes will be driven by the ever increasing economic significance of air transportation, that makes everyone concerned more anxious to take care of airport facilities and run them as businesses. As of 1998, about a quarter to a third of American imports and exports, as well as about 6% of domestic production, by value are shipped by air [**ck reference on this]**. Furthermore, every major airport expansion is accompanied by estimates of the economics benefits, as required either by the US Federal Aviation Administration or by private lenders subscribing to airport bonds. These financial imperatives will certainly have a major effect on future airport systems planning and design.

Airside: In thinking about the airside, it is important to recognize that aircraft are designed for the airports they serve. It used to be said that aircraft were designed around the short runways at New York/LaGuardia airport. If a new aircraft could not serve this airport, it could not be used on the then busiest route from New York to Chicago, could not be sold to the major US airlines, and would be a commercial failure. Of course, as longer runways were built, then aircraft no longer had to fit the New York/LaGuardia constraint. The moral of the story is that up to a point the lengths of available runways are an important consideration in the design of aircraft, after that the features of the aircraft define how long runways should be built.

In this context we need recognize the emergence of a family of airports with very long parallel runways, approximately 4000m or 13,400ft long, located well outside traditional city limits. These include Atlanta, Dallas/Fort Worth, Denver International, Orlando and Washington/Dulles in the United States, and of Athens, Kuala Lumpur, Paris and the new Seoul airports. These new airports contrast both with the traditional city airports surrounded by development and thus unable to lengthen their runways and forced to impose a variety of operational constraints on aircraft operations. Boston/Logan, New York/LaGuardia, and Washington/National are examples of the close-in older airports. Chicago/O'Hare, Los Angeles/International, Miami/International, New York/Kennedy and San Francisco/International are the older airports and traditional gateways for foreign travel. The new airports and potential new gateways are in a different league (see Table 5).

[Table 5 about here]

These airports are also generally located far from population centers and in this sense are environmentally friendly in contrast to the older international gateways, such as Los

Angeles/international, New York/Kennedy or San Francisco/International. The airports in this class can therefore be expected to have extended operating hours if necessary, and to permit airlines to operate transcontinental flights outside of the traditional windows imposed by curfews at either end of the flight.

These new airports, with long runways unconstrained in their operations, will enable the use of heavily loaded aircraft able to travel very long ranges. Should these aircraft be brought into use, this could radically transform the patterns of international air travel. International gateways would no longer have to be on the shoreline, but might be located anywhere within the continental United States. We might then witness the further development of brand-new massive airports with sets of very long parallel runways. They would serve as centerpieces of new economic areas or as transfer hubs.

The design of most of these new airports has anticipated the possibility of New Large Aircraft (NLA) that would require greater separation between runways, taxiways and buildings than is now standard. Only a few of the major US airports, specifically Denver International, Honolulu and Orlando/International, are now ready to handle the NLA. [**need reference here]** The required lateral clearances are possible at some other airports, but unlikely at many of the traditional gateways such as Los Angeles/International and New York/Kennedy. This fact is yet another reason to anticipate the possibility that the pattern of international, intercontinental gateways may change substantially in the years ahead.

In parallel we may also see the further development of specialized airports, serving niches of cargo or passenger traffic. As the level of traffic increases, and the number of airports in metropolitan regions increase, it is no longer necessary for a major airport to fit all kinds of traffic. On the contrary, cargo and cheap fare airlines typically prefer not to be at the major airports in an area. This is because their operations are in some ways incompatible with the nature of a major metropolitan airport. Both cargo and cheap fare airlines prefer relatively uncongested airports, which lead to fewer delays and lower operating costs. Cargo airlines moreover like night operations, which are generally unappreciated and sometimes regulated by airport abutters.

Current examples of the cargo airports in the United States include Louisville, Los Angeles/Ontario and Memphis. Integrated cargo carriers such as Fedex or UPS have also established hubs internationally, as at Toronto/Hamilton, Liege (Belgium) and Manila. A network of cargo center airports could well emerge in the next generation.

Airports serving Southwest, the predominant low-fare carrier in the United States, illustrate the kind of cheap fare airport that may become more prevalent in the future. These start with Dallas/Love Field as the original base for Southwest and proceed to specialized airports in metropolitan regions, such as Providence in the Boston region, and Fort Lauderdale in the Miami region. A complementary cluster of airports serving international cheap fare or charter airlines may also emerge, either independently or as subsidiaries of these airlines. Already in the United States two airports are candidates for this function: Orlando/Sanford and New York/Stewart. Such specialized airports may proliferate over the next twenty-five years.

Landside: Airport passenger buildings should also be quite different over the next generation. Two major changes are underway that may rearrange the types of facilities and the allocation of spaces in passenger buildings. Electronic ticketing will eliminate or at least disperse much of the work done in departure halls, and make them obsolete. On the other hand more aggressive use of airports as shopping malls may enlarge and reconfigure the design of spaces beyond security.

So far, the implications of electronic ticketing have not been incorporated into the design of airport buildings. Yet much of the work now being done in departure halls is being made obsolete by electronic ticketing, seat assignment and check-in that can be done both beforehand and elsewhere throughout the building by machines similar to ATMs. Massive departure halls with hundreds of counters and extensive queues are becoming obsolete. Even though several such facilities are now being built in North America, they may soon be stricken from the list of facilities needed at airports.

The future of baggage handling may also be quite different from what it is today. It quite possibly will become less of a function for airlines and airports, for which this is a considerable expense. People increasingly prefer to handle their own luggage using wheeled suitcases. They thus by-pass the delays associated with check-in and reclaim facilities. (This phenomenon has already upset designers assumptions: one of the many difficulties of the new Hong Kong/Chep Lap Kok airport is that it carpeted vast areas of the terminal, making it very difficult for travelers to pull their suitcases!). As integrated cargo services expand their services, it is possible that they might handle suitcases, delivering them directly between home and hotels in distant cities. This kind of service has existed for a long time in Japan, and could conceivably be expanded. The consequent revolution in assumptions about the design of airport passenger buildings would be enormous.

The increased attention paid to effective use of airports as shopping malls will certainly change the traditional concepts of space requirements in airport passenger buildings. It would seem

likely that more aggressive marketing would increase the amount of space desired for shops beyond security clearance. At the very least, experienced designers of commercial spaces will become key partners in the design and insist specific features. The overall implications for airports are unclear however. The current push for more commercial space may however be counterbalanced by objections to the way it obstructs easy movement of passengers and to the development of e-commerce. How much will people want to buy at an airport and carry merchandise when they are already overloaded, when they can shop internationally from home and have their purchases delivered?

Access to airports will certainly change toward more collective forms of transport. This will be motivated both by economies of scale in handling passengers and by environmental pressures to reduce the level of pollutants associated with airports. Rail rapid transit, express bus systems and networks of airport limousine services arranged integrally with flights will almost certainly expand from their current level of use. To the extent that they do, these services will free up tracts of land associated with parking areas and roadway lanes, and reconfigure much of the conventional layout of airports.

Complementarily, various forms of tracked collective service will be used to move passengers between the several landside elements of the airport. The people movers, monorails, horizontal elevators and moving sidewalks now being retrofitted into existing airports will certainly be standard part of designer's repertory in the design of future facilities. They will permit the dispersal of terminal and other serving passengers (such as car rental facilities and garages) across the airport away from the central terminal area to less crowded and otherwise more convenient areas. Midfield passenger buildings and remote check-in facilities would be a normal feature of this phenomenon.

FUTURE ORGANIZATION OF THE INDUSTRY

The organization of the airlines into worldwide groups will surely have significant repercussions on airports. These groups may become mega-carriers under a unified management, or may more simply be partnerships that organize among themselves to provide coherent service based on common schedule, baggage handling and other services. Either way, this evolution will affect the physical configuration and operation of airports. It may also lead to profound changes both in who are the airport managers and how they will run the airports. These more subtle organizational changes may lead to significant improvements in the cost and quality of airport services.

Most obviously, the international airlines associated with a group will insist on being collocated in identifiable sections of an airport. They will want to facilitate transfers between themselves, most particularly between the domestic partners and the international services. They will also attempt to wall themselves off from the rest of the airport, to minimize loss of passengers to airlines outside their group. They will thus want to have their own customs (FIS) services and other operations. The new American Airlines buildings under development at New York/Kennedy or the Continental/SAS facility at New York/Newark provide prototypes of this phenomenon.

The development of international carrier groups will render obsolete the concept of "international" and "domestic" terminals. Most of the significant international airlines are already part of airline groups and will not want to be processed in distinct building separate from the domestic facilities used by their partners. Airlines providing both international and domestic service with the same type of aircraft, will moreover not wish either to transfer their aircraft from one building to another, or to have distinct operations and crew centers. They will insist on being able to use a common facility so that they can maximize their efficiency. This reality is a major challenge to new international terminal buildings, which are doubly incompatible with passenger buildings that must cater both to domestic/international passengers and to transfers within a group of airlines. It is entirely possible that the prospective new international terminal buildings at New York/Kennedy and San Francisco/International will have to be reconfigured soon after they open -- if not before.

More subtly, groups of airlines will change the nature of airport management. They will, following the lead of the most progressive major companies, attempt to simplify their relationships with suppliers in order to simplify their accounting systems, reduce duplication, minimize consequent errors and overall to reduce costs. They will look for common standards of treatment across their suppliers instead of idiosyncratic local rules at hundreds of places. Being world-class operators themselves, they will put pressure on airports to provide comparable levels of service. This prospective pressure from airline groups will supplement the increasing public desire to run airports more effectively from the commercial point of view.

These pressures can be expected to lead to the development of large companies devoted to running airports, or portions of airports, nationally and internationally. Examples of this already abound:

- Major airport groups already contract to run airport operations overall, BAA for example is under contract with Indianapolis (as well as with Naples, Italy; Melbourne, Australia and other places);

- Specialist developers have taken over the operations of specific portions of airports, for example Westfield Holdings of Australia operates the shops in one of the passenger buildings at Boston/Logan, as well as at many other airports in the United States; and
- Leading companies take over the entire management of special types of services, as Standard Parking has for parking services at Chicago/O'Hare.

Large-scale, specialized companies will be able both to reduce costs and increase performance. They can afford to put into operation sophisticated accounting and operating systems since they can spread the costs over many operations. They can experiment with and develop new services (such as valet parking at airports). They can afford to train personnel efficiently and recruit ambitious managers who wish to succeed in a large international company. In short, large airport companies can take advantage of economies of scale, as local airports cannot.

Over time, we may thus expect that airports will increasingly be operated as franchises to large international companies. While the airports will operate under policies set by local political structures, they will less and less be run as municipal departments or local authorities. As this occurs it will surely change the relationship between the government and the airport operators.

The development of chains of airports, similar to hotel chains, is a logical extension of this trend. Large companies operating airports will have a brand image they will use to encourage other airports to use their services. Hotel chains operate much the same way -- they frequently contract with local owners to operate hotels for a long time, local owners of the properties are happy to know that a world-class management team is operating their facility. Over time, these chains may even come to be closely associated with airline groups.

CONCLUSION

We may expect substantial changes in the years ahead in terms of the level of traffic, its distribution across the country and business sectors, the physical configuration of airports and their management and way of doing business. No one can claim to predict these accurately, as the final outcomes will depend on many unknowable contingencies.

Planning for the future should thus stress flexibility. The task of airport planners will be to enable the possible futures without making unnecessary, premature commitments to particular structures. A modular, flexible approach to airport systems planning and design is key.

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Table 1: Rapid Growth of new hubs and secondary airports

Airport	Enplanements, Millions, in year			Growth %
	1980	1990	1997	
Cincinnati	1.4	4.5	9.3	565
Detroit	5.0	10.5	15.4	208
Washington/Dulles	1.1	4.9	6.5	490
Miami/Ft. Lauderdale	2.9	4.4	6.1	110
Boston/Providence	0.5	1.2	2.0	300

Source: FAA/DOT ACAIS Database, FAA Statistical Handbook of Aviation

Table 2: Example of US airports that operate well above their 'Practical Annual Capacity' (PANCAP) without the benefit of additional runways that would change that figure.

Airport	PANCAP	Annual Operations, thousands			Excess over PANCAP, %		
	1980 [1]	1980 [1]	1990 [2]	1997 [2]	1980	1990	1997
San Diego	118	156	#N/A	224	32	#N/A	90
St. Louis	280	337	392	517	20	40	85
Los Angeles/International	448	534	680	781	19	52	74
New York/Newark	280	204	379	462	0	35	65
Boston/Logan	303	341	425	483	13	40	59
Philadelphia	295	335	407	467	14	38	58
New York/La Guardia	247	320	354	355	30	43	44
Chicago/O'Hare	616	735	811	884	19	32	44
Seattle	280	216	355	385	0	27	38
Minneapolis	360	285	322	491	0	0	36
New York/Kennedy	272	312	302	353	15	11	30

[1] Source: US Federal Aviation Administration, Office of Aviation Policy and Plans (1981), Airfield and Airspace Capacity/Delay Policy Analysis, FAA-APO-81-14, NTIS, Springfield, VA.

[2] Source: ICAO Digest of Statistics: Airport Traffic 1990, 1997

Table 3: Independent Growth of Secondary Airports -- Boston Example

Airport	Enplanements, Millions, in year			Growth
	1996	1997	1998	%
Boston/Logan	12.2	12.5	13.2	8
Providence	1.2	2.0	2.5**ck**	**ck**

Sources: FAA/DOT ACAIS Database, ACI www.airports.org

Table 4: Relative Financial Strength of Major US Airlines

Airline Company	Symbol	Market Capitalization Billions of Dollars
United Parcel Service	UPS	88.0
Fedex	FDX	13.5
American	AMR	8.8
Delta	DAL	7.0
United	UAL	3.6
Continental	CAL	2.8
US Air	U	2.0
Alaska	ALK	1.0
TWA	TWA	0.2

Source: yahoo.com.financial, Nov. 11, 1999

Table 5: Length of Longest Runway of various US and International Airports

Airport	Category	Length, ft
Washington/National	Close-in Traditional Airports	6,869
New York/LaGuardia		7,000
Boston/Logan		10,081
Washington/Dulles	Traditional International Gateways	11,501
San Francisco/International		11,870
Los Angeles/International		12,091
Chicago/O'Hare		13,000
Miami/International		13,000
Atlanta	New or Reconfigured Airports Featuring Parallel Runways	11,889
Denver International		12,000
Houston/Intercontinental		12,001
Orlando/International		12,004
Seoul/Inchon (new)		12,303
Munich		13,123
Athens/Spata (new)		13,123
Kuala Lumpur/Sepang (new)		13,123
Dallas/Fort Worth		13,400
Paris/Charles de Gaulle		13,829

Sources:

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Paris/de Gaulle www.landings.com

Athens/Spata Engineering News-Record, 8/16/99

Seoul/Inchon Chamber of Commerce and Industry
http://icci.asiansources.com/INCHON/INFRAS.HTM

Figure 1: Rapid Steady Growth in Airline Traffic Worldwide over the past 50 years.

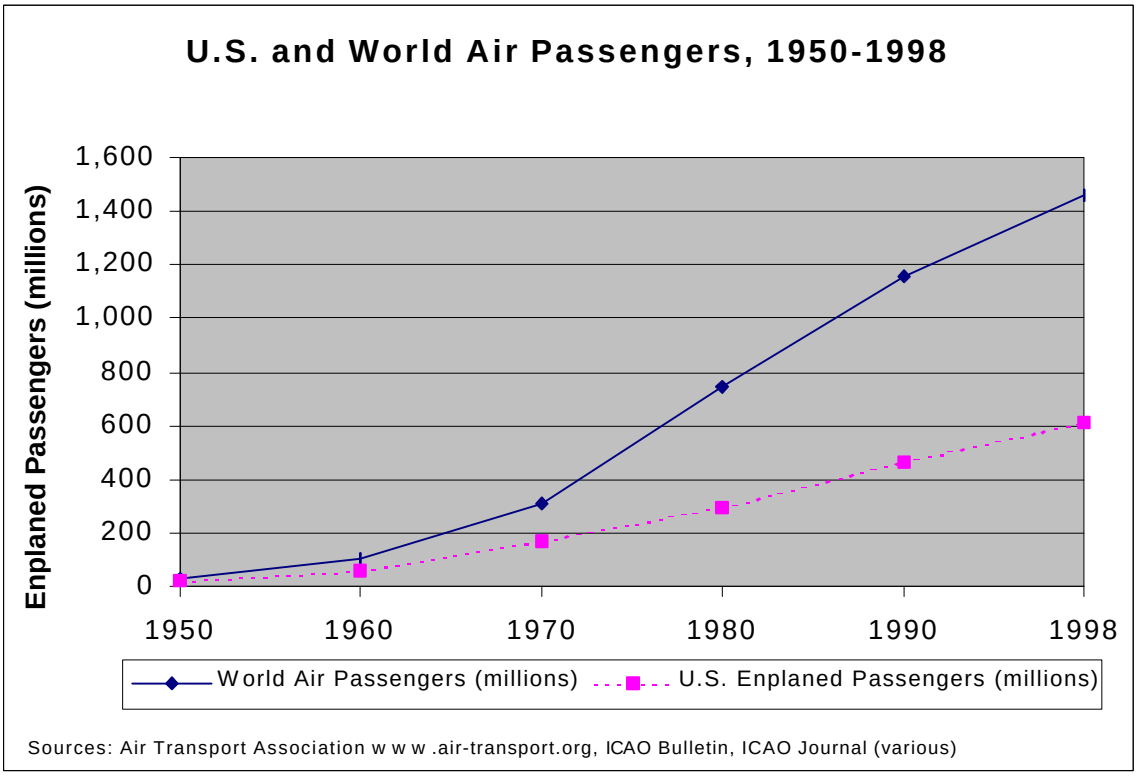
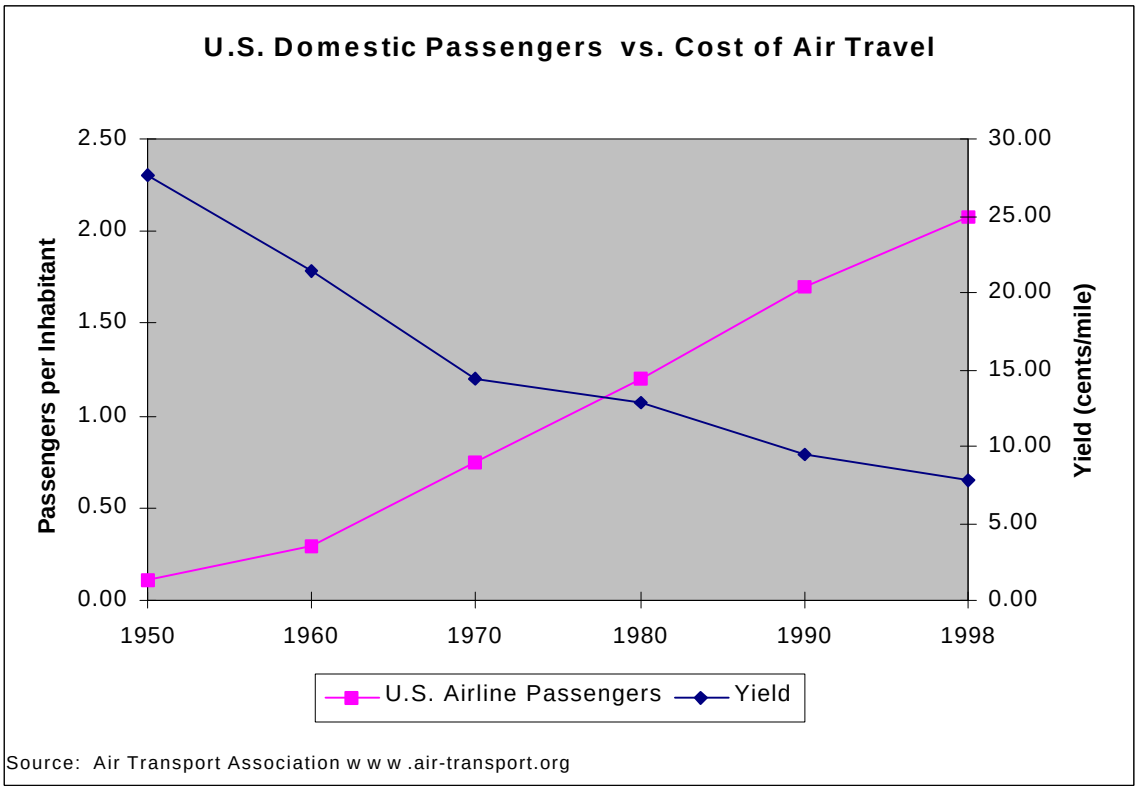
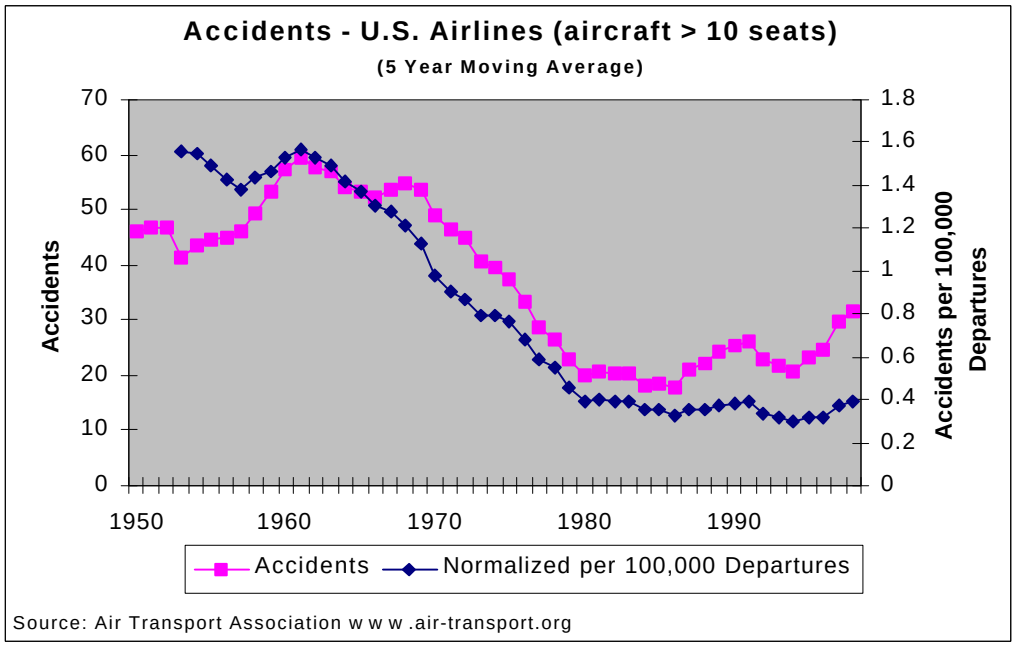


Figure 2: Rise in Traffic has mirrored decrease in overall costs of air travel.



Source: Air Transport Association w w w .air-transport.org

Figure 3: Accidents and Deaths per Trip have dropped by a factor of 2 to 3.



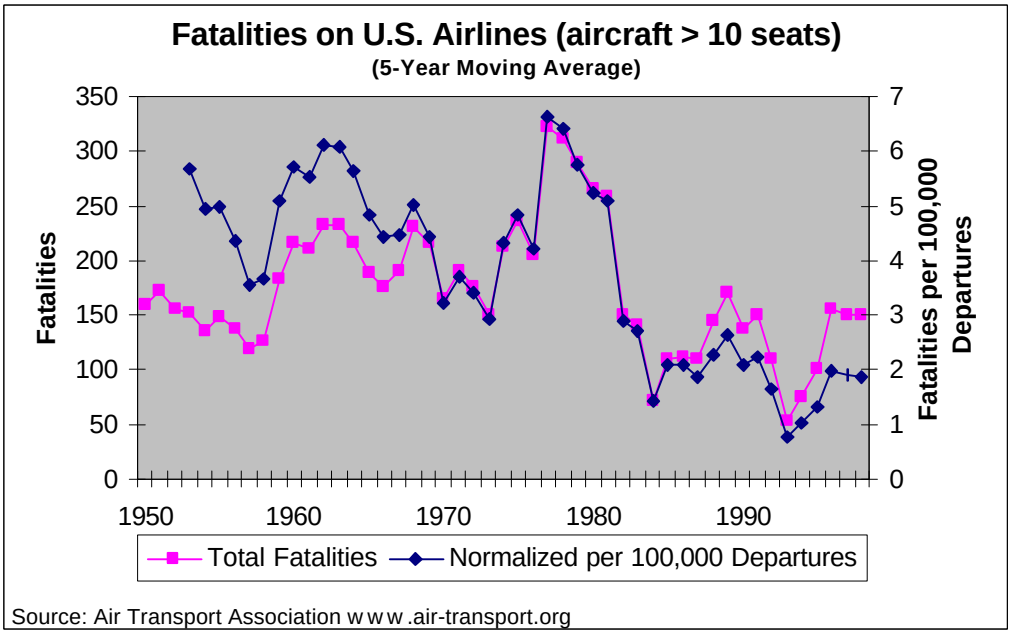
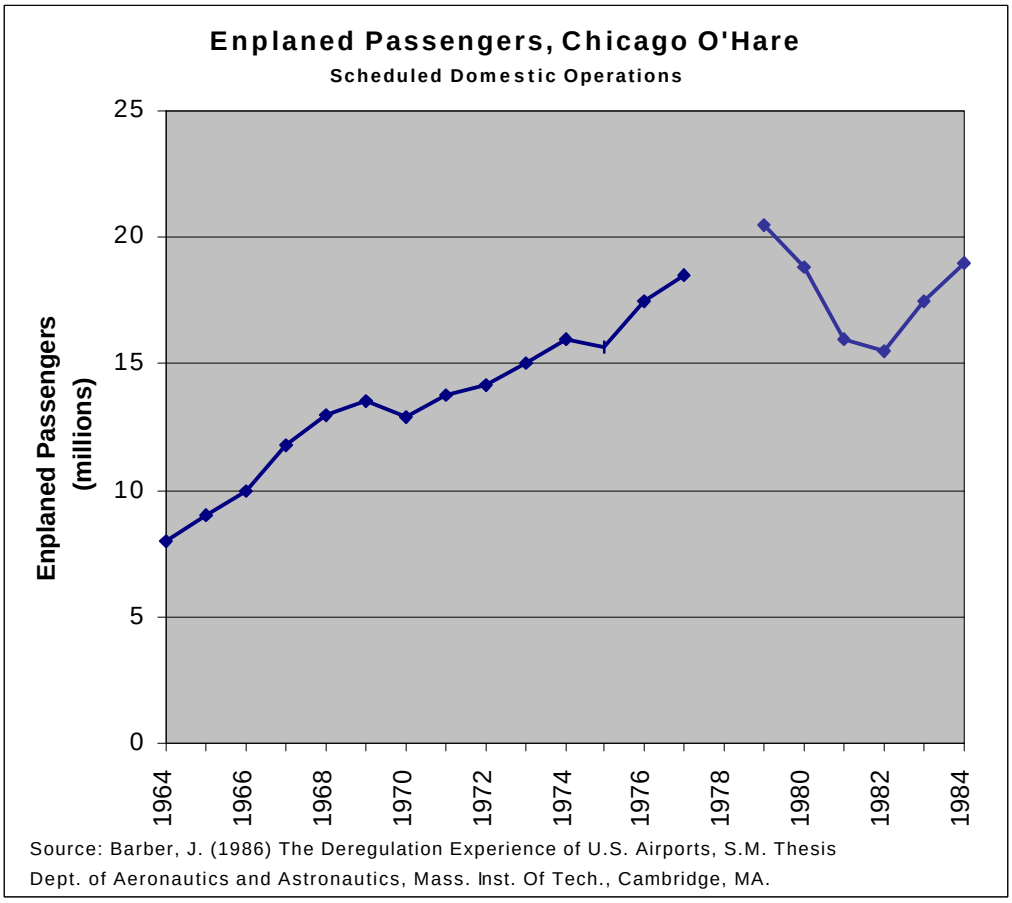


Figure 4: Example of Increased Volatility of Traffic in current, deregulated environment Traffic at Chicago/O'Hare before and after 1978



Source: Barber, J. (1986) The Deregulation Experience of U.S. Airports, S.M. Thesis Dept. of Aeronautics and Astronautics, Mass. Inst. Of Tech., Cambridge, MA.

Figure 5: Ten-year forecasts are easily off by +/- 30 %