Amsterdam Multi-airport System

Policy Guidelines

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BACKGROUND

This report is addressed to the Board, the General Manager and the management staff of Amsterdam Airport Schiphol, in response to a request expressed during the summer of 1995.

The request was for a report on the viability of a multi-airport system around Amsterdam Airport Schiphol in the Dutch and wider European Union context.

Two premises underlie this question. The first is that the Amsterdam region could have a market of around 60 million annual passengers within about 20 years, the range of responsible planning for large, capital-intensive projects such as major airports. This premise implies an average rate of growth of airline traffic of about 5 percent a year, or close to what has been observed historically. For planning purposes this is an entirely possible scenario -- certainly one that needs careful scrutiny.

The second premise is that traffic of around 60 million annual passengers might require a second airport. This seems plausible because it is the experience elsewhere. Metropolitan regions with that level of traffic, such as London, New York, Los Angeles and Tokyo (as well as many others), feature two or more major commercial airports. Furthermore, environmental regulations may limit the capacity of Amsterdam Airport Schiphol to some lower amount of traffic, for example 45 or 50 million annual passengers, and thus might require a second airport.

A fundamental question is thus: what is the viability of a multi-airport system for the Amsterdam metropolitan region and, more generally, in the Dutch and European Union context? The technical capacity to build another airport is of course not the issue. The real issues concern the economic and operational feasibility:
1. Would the costs be prohibitive compared to the benefits provided?
2. Would the airlines, passengers and cargo shippers actually use the kind of second airport that might be provided?

More specifically, the questions to be addressed are:
1. Is a distribution of traffic in which Amsterdam Airport Schiphol is saturated (with about 45 to 50 million annual passengers), and the second airport has the projected overflow (around 5 to 15 million annual passengers), viable economically and operationally?
2. To what extent would this kind of distribution be stable, given the constantly evolving levels of overall traffic and the competition from other airports?

3. Could a multi-airport system for the Amsterdam region include airports that were some distance away, for example off-shore in the North Sea, at some distance in the Netherlands, or even in a neighboring country?

A good response to these questions must be based both in a deep conceptual and theoretical understanding of the dynamics of the way airlines, passengers and shippers combine to use airports, and in a thorough appreciation of what actually happens in practice.

This response meets these criteria. It is based on over 20 years of research into the operation of multi-airport systems, complemented by worldwide experience in the actual operation of these systems.

CONCEPTUAL OUTLINE

The essential policy problem is**:**

Given limitations on the expansion of a Primary airport for a metropolitan area, due to some combination of technical or political constraints, how do we manage the development of complementary secondary airports -- of a multi-airport system in fact -- in a way that is both effective and economical?

This overall issue involves at least three specific components:
1. Management of Supply: What kind of airport and airport facilities should be created or encouraged to achieve the desirable objectives?
2. Management of Demand: What are the most effective ways of encouraging traffic to develop at the secondary airport or airports?
3. Economic Efficiency: How should the transition to a multi-airport system be managed most efficiently, with the least risk of excessive costs to the complex of interests associated with the airports: the metropolitan area, the airport owners, the airlines, the passengers and shippers using air transport, and the surrounding communities?

The essential difficulty is that:

There are substantial barriers to the creation of effective secondary airports and thus to a multi-airport system. This system will be viable only when specific conditions are met:
1. The level of traffic is high enough (more than around 10 to 12 million originating passengers per year appears to be the normal threshold) to create an effective demand for a non-trivial second airport, and
2. The second airports are sufficiently accessible and economical compared to the primary airport to become effective suppliers of flights and destinations.

The fundamental Supply, Demand and Economic Constraints that create the barriers to the creation of a multi-airport systems are:

1. Capital intensive Cost Structure of Airports: The high initial capital costs of acquiring large tracts of land and building the essential airport facilities, combined with the subsequent relatively low marginal costs of operating a facility, generally create strong economic barriers to the development of secondary airports.
2. Freedom of Customer Choice: Passengers and Shippers can, to a great extent, choose when, how and if they require transport. In a democratic society there are great limits to the extent to which governmental directives can channel traffic to particular modes of transport or particular destinations.
3. Concentration of Flight Operations resulting from the Producers' Responsiveness to Consumer Desires: A competitive market forces suppliers to be responsive to consumer desires. This leads to the concentration of traffic as suppliers locate where customers are and, in turn, the customers in a market prefer to flock to where the most frequent flights and widest networks are available.

The overall planning context is RISK:

The future of air transport is notoriously risky. The general rule is that the forecast is "always wrong".

The comparison of actual levels and types of traffic with previous forecasts demonstrate that practically always there is a large discrepancy between what actually happens and previous forecasts. This shows that the actual future situation is ordinarily substantially different from any prediction made now. Massive uncertainty about the future is to be expected.
Furthermore, analysis of the effects of deregulation indicates that this change has increased the volatility of both the levels of traffic demand and modalities of supply as indicated by the identities of the airlines, their market segments, and their strategies. Deregulation of aviation in the European Union thus increases the uncertainty, variability and risks of airport planning substantially.

These uncertainties, coupled with a natural tendency to risk aversion, properly impel investors to avoid large, long-term commitments whose outcome is so speculative.

The emphasis is, and properly should be, on flexible planning that makes incremental commitments that can be justified either by their economic returns or as insurance against specific economic risks.

The essential policy recommendations are:

To enable the desired objective by maintaining and, where necessary, creating opportunities for the development of secondary airports and multi-airport systems. Specifically:

1. Supply of Airport and Air Transport Facilities: Facilities necessary for the secondary airports should be provided:
    a) Existing airports (such as Rotterdam) and runways need to be maintained, and new facilities (such as Lelystad) should -- where appropriate from the

perspective of metropolitan planning -- be commissioned. In either case these facilities should be kept operational so as to insure that they are available as needed.

b) Keeping these facilities open provides insurance that the entire metropolitan air transport system -- beyond these second airports -- will perform well. The cost of closing these facilities is the loss of the opportunity to serve air transport away from the main port, and they should not be closed and turned into housing sites until alternative airport facilities are available.

c) Suitable access corridors and facilities need to be provided so that the secondary airports can be seen as plausible providers of air transport to the passengers and shippers in the region. The level of provision should, of course, be calibrated to the prospective level of traffic and its rate of growth.

2. Development of Markets: Traffic rights should be granted to, and flights and routes solicited from, providers that could develop concentrations of the type of niche markets of the type that can be effective cores of traffic for secondary airports.
3. Economic Organization: Since the value of secondary airports lies in their long-run contribution to the entire air transport system of a region, rather than solely in their short-run profitability, they should be run as part of a multi-airport system authority or company.

On the other hand, the development of the secondary airports should probably not be left to the discretion of the operator of the principal airport in the region, precisely because these facilities may in the short-run be unprofitable. To insure the long-run provision of these facilities it may be necessary for the region to establish an obligation for the airport authority to create and develop the basic infrastructure for one or more second airports of a multi-airport system.

Structure of the Argument

The first, and absolutely basic point to be established concerns the nature of the barriers to be overcome in establishing secondary airports and a multi-airport system. Failure to appreciate these facts has led to many, very expensive, mistakes worldwide.

This concept is put forward both theoretically and empirically, by reference to the world-wide data on the subject and to specific examples.

The policy recommendations then flow rather directly from the above. In brief, they are to encourage and support the factors that favor the objective, and to avoid those that will be both expensive and wasteful. These should, because of the risk, be carried out as part of a strategy that both avoids premature overcommitments and is flexible to new opportunities.

HOW MULTI-AIRPORT SYSTEMS FUNCTION

What a Multi-Airport System is

A multi-airport system is the set of airports that serve the airline traffic of a metropolitan area. The multi-airport system for London, for example, includes -- among others -- its major airports: London/Heathrow, London/Gatwick and London/Stansted. The fact that a single organization, the BAA, owns and operates these airports reinforces the idea that they are part of a system. Yet unity of ownership or control does not define the system for transport planning and management -- the independently owned London/Luton airport is certainly part of the London multi-airport system.

From the perspective of the users, a multi-airport system properly includes all the airports that effectively serve the region. For example, the Baltimore airport is effectively part of the multi-airport system serving the Baltimore-Washington region, even though it is in a different
state and under different ownership than Washington/National and Washington/Dulles airports. It is even called the Baltimore/Washington International Airport.

The fact that airports associated with different cities and jurisdictions can now be part of the same multi-airport system needs to be stressed. This concept is a definite shift from past thinking, when planners generally assumed that airports served "catchment areas", that the Baltimore airport only served Baltimore, the Washington airports only served Washington, and so on.

The change to a functional, geographic definition of a metropolitan airport system results from worldwide changes in urban and regional structure. The combined effect of population growth and the spread of rapid modes of transport such as motorways and high speed, intercity rail systems, has been to extend cities over much wider areas, merge cities into each other, and create metropolitan regions that function as a unit despite traditional boundaries. Thus as a practical matter Baltimore and Washington merge as a market for air transport, even though their centers are 60 km. apart. Many Washington suburbanites find it more attractive to use the Baltimore airport than either Washington/National or Washington/Dulles.

Airline airports can be considered part of a multi-airport system if they are either:
1. as close as one of the existing major airports for a significant fraction of the metropolitan region, in particular the suburban centers of traffic, or
2. officially so designated by local authorities.

The criterion of accessibility applies according to the context. Around Tokyo, where urban travel is comparably difficult, it includes airports within about 2 to 3 hours. In the United States it includes all airports within about an hour of the suburban centers of a region, which are often located some distance from the traditional city center. For Boston, for example, the multi-airport system properly includes three airports

(Providence, Rhode Island; Manchester, New Hampshire; and Worcester, Massachusetts) that are closer in time to Bostonians along the ring road than the main airport (Boston/Logan), although two of these airports serve the capitals of different states.

The second criterion applies only in special situations. The most obvious case is that of Sao Paulo/Viracopos, the international airport located some 100 km. from the city center over difficult roads.

Military facilities, general aviation airfields inaccessible to substantial airline service and private airports closed to the public are not part of multi-airport systems for air transport. They must be considered in the context of air traffic control. They can be excluded, however, when considering how to develop airport capacity to serve airlines, passengers and cargo.

Impetus for Successful Multi-Airport Systems

In the context of serving passengers and cargo, a multi-airport system is successful to the extent that the primary airports can provide competitive service and that the airlines and passengers use the secondary airports to some significant degree. The multi-airport system may thus not be a success if:

1. The traffic at the primary airport is excessively limited, it may not be able to compete effectively against the major airports in other metropolitan regions. For example, since Tokyo/Narita is limited to one runway and international traffic almost exclusively, it is not competitive with Seoul as a hub for traffic across Northeast Asia, much to the detriment of Japan Air Lines. If Amsterdam Airport Schiphol were excessively limited, it might similarly not be attractive compared to Frankfurt, to the detriment of KLM.
2. The secondary airport is underutilized compared to its cost, it is a failure as a transport investment, regardless of its technical features and architectural beauty. London/Stansted -- over built for its prospective traffic -- might now be an example of such a failure.

Successful multi-airport systems must be more likely to exist in metropolitan areas with a high level of airline and passenger traffic: the greater the traffic, the more likely that there will be enough to justify a second airport and a multi-airport system. Yet a high level of passenger traffic is clearly not sufficient: Atlanta and Frankfurt are among the busiest airports on their continents, but neither is part of a multi-airport system.

The primary airport will be an economic success for the region and its major airline if it can provide the range and frequency of flights that enable it to compete effectively with the major airports in other major metropolitan areas. As regards Amsterdam Airport Schiphol (and KLM), it should maintain its ability to offer a number of flights and a range of destinations equivalent to, if not better than, those available at its nearest major competitors such as Frankfurt, London, and Paris.

A second airport will be a transport success if it is sufficiently attractive, in comparison with the alternative primary airport, to draw a sizable clientele. To develop successful second airports, it is necessary to understand the factors that make them attractive.

The attractiveness of an airport is always defined in comparison to its competition. Passengers and airlines will not use an airport when they can get better service elsewhere. To develop multi-airport systems, and second airports in particular, it is necessary to understand this competition.

Success Factors for Primary Airports

The Passengers' perspective

For long-distance passengers and shippers, a primary airport in a metropolitan region is attractive when it provides convenient access to desired flights and destinations compared to alternative primary airports in other metropolitan regions. In choosing flights between Stockholm and Bordeaux for example, customers can choose to route through Amsterdam, London or Paris. The choice of airport of course also generally implies a choice of airline: KLM for traffic through Amsterdam, British Airways for traffic through London, etc. Which airport and which airline benefits from the traffic depends on the attractiveness of the airport compared to the competition.

Long-distance customers for air transport consider at least three factors when choosing an airport for connecting flights:

1. The range of destinations available, importantly a function of the local rules governing flight patterns -- thus the Paris airports are unattractive for many transfers because Paris/de Gaulle has virtually no domestic flights, and Paris/Orly has only restricted connections outside of France;
2. The frequency of service, largely a function of the overall level of traffic at the airport; and
3. The reliability of the schedules, which is greatly influenced by the number of the runways.

Local actions that limit the destinations that can be served from the primary airport, that constrict the traffic, or preclude the construction of adequate runways thus make the airport less attractive for long-distance customers for air transport. While these actions may favor the development of secondary airports, they may have an overall negative impact. The point is that planners should not lose sight of the need to maintain the competitiveness of the primary airport (such as Amsterdam), while trying to develop secondary facilities.

The Airlines' perspective

In a deregulated environment, such as the one developing now in the European Community, airlines have considerable choice about which airports they serve. Airlines based in at one airport, as KLM is at Amsterdam Airport Schiphol, may easily develop

major bases elsewhere. They will do so when their primary base airport does not provide them with sufficient capabilities, at the right price, to enable them to compete effectively.

To illustrate the way airlines shift their operations when their home base is too restrictive or too expensive consider three cases:

1. United Airlines -- restricted by the high cost and congestion at its main base (Chicago/O'Hare) has established both a second major hub at the new Denver Airport (serving about 15 million annual passengers) and a new maintenance base at Indianapolis.
2. Delta Airlines, bothered by the congestion, delays and inadequate terminals at Dallas/Fort Worth (already established as a hub competing with its historic base in Atlanta), has since 1994 largely transferred those hub operations to Cincinnati.
3. Northwest -- principally based at Minneapolis/St. Paul -- has set up a second major hub at Detroit.

The point is that planners must not assume that the major airline based at the primary airport in a metropolitan region must always serve that airport as it has in the past. Specifically, the planners concerned with Amsterdam Airport Schiphol should not assume that KLM will neither move major operations (such as maintenance bases) nor build up alternative hubs at other airports (such as Vienna).

Success Factors for Secondary Airports

The Passengers' perspective

For passengers and shippers, a second airport is attractive when it provides convenient access to desired flights and destinations compared to the alternative primary airport. In thinking about this, it is necessary to distinguish between originating and transfer traffic.

Originating traffic consists of the persons who either live in the metropolitan region (for example, Amsterdam) or have been staying there for a while before flying out.

Transfer passengers on the other hand go strictly between flights: thus a traveler between Boston and Paris might, because of service or fares, fly on KLM and change at Amsterdam. Transfers require easy connections.

Most importantly, transfer passengers do not want to change between airports. Rather than do so, they prefer to connect through some other hub. This has been the experience worldwide, and is fully demonstrated by the experience at London/Heathrow, New York/Kennedy and Tokyo/Narita: extremely few travellers transfer from these main gateway airports to another airport in their metropolitan area. Transfer traffic thus does not constitute a sizable market for second airports. The focus needs to be on the passengers that originate in a region.

Originating passengers seeking access to flights and destinations consider two major factors:
1. The geographic accessibility of an airport, and
2. The frequency of departures to their destinations.

Passengers consider the time it takes both to get to the airport and to wait for a flight.

Airports with minimal levels of frequency and small networks are unattractive. Passengers routinely by-pass close airports to use more distant airports that provide better service. Frequency of flights to any destination is a key aspect of the value of the service to passengers. Airlines recognize this and respond accordingly.

The Airlines' perspective

Airlines generally have considerable choice about which airport they serve in a multi-airport system, and choose according to their commercial advantage. Sometimes they have to use a second airport for technical reasons. This is the case when the runways at the primary airport are too short for long-range aircraft, as they are for example at Milan/Linate, Taipei/Shen Shan, and Washington/National. These exceptional cases modify the general rules.

A second airport is commercially attractive to airlines if it provides a good market. That is obvious. The subtlety comes in understanding how airlines decide when the market at a second airport is worthwhile.

Airlines continually try to optimize the use of their major assets, that is their aircraft. Specifically, the airlines allocate flights to routes, by means of large-scale optimization programs. These procedures have the great virtue of being able to account not only for the value of individual flights but, most importantly, for the multiplier effect of concentrating flights in a market. Understanding this multiplier effect is the key to appreciating the distribution of traffic to secondary airports.

Theory and experience indicate that the market share achieved by an airline is disproportionate to its "frequency share", the fraction of the total flights it offers in a market (Fruhan, 1972; de Neufville, 1976; Cohas, 1993). An airline that offers 60% of the flights in a market may, for example, get 75% of the passengers. Airlines that dominate a market will achieve higher yields and greater profits. Airlines thus try to concentrate their flights to dominate markets, or at least prevent competitive airlines from doing so. This is the competitive dynamic that leads airlines to match flights on specific routes.

Because of this multiplier effect, the profitability of allocating any flight to a route is not determined merely by its own loads. An additional flight in a major market reinforces the value of the other flights in that market. When airlines consider the possibility of allocating flights to secondary airports, they thus have to consider not only whether they can achieve competitive load factors in the secondary market, but whether there is sufficient additional traffic that will compensate for the loss in the airline's market share in the major market. This is a subtlety that analysts all too often ignore.

This competitive dynamic that leads airlines to match flights on routes also leads them to allocate flights to the primary airports rather than provide service to second airports. This is a stable result of the competitive game between airlines (Gelerman and de Neufville, 1973).

When airlines have the choice, they tend to allocate flights to secondary airports either when their primary airport is heavily congested or has so much frequency that there is little penalty to allocating a flight elsewhere, which occurs only when the primary airport has very high levels of traffic. In short, airlines voluntarily use second airports only when the metropolitan traffic is substantial -- the threshold at which this occurs is discussed in the special section on the next page.

Pattern of Concentration in a Multi-Airport System

The dynamics of the competition between airlines thus establish a pattern of concentration of traffic among the airports in multi-airport systems. The evidence demonstrates this quite clearly. As Table 1 indicates, the second busiest airport in a multi-airport system now typically has 3 times less traffic than the busiest airport.

As a rule, second airports only now have more than 30% of the traffic of the busiest airport if there are overwhelming political or technical constraints to the concentration of traffic. At Tokyo, Washington, Osaka and Montreal for instance, the government mandated international flights to use more distant airports. In Paris, the French government directed its national carrier, Air France, to serve Paris/de Gaulle. The more accessible airports in Washington, Taipei, Houston/Galveston and Buenos Aires have technical restrictions that force flights to use second airports.

Second airports will also have traffic comparable to the primary airport when the traffic to the metropolitan region is so large that it saturates several major airports. This situation only exists in the busiest centers of air transport, currently New York and London. Note that the traffic to these regions still concentrates noticeably, as indicated by the relatively low levels of traffic at their third, fourth and fifth airports.

The pattern of concentration of traffic is so important that it extends to the type of traffic that locates at secondary airports. The traffic at the several airports in a multi-airport system differ not only in size but in character. Each airport tends to concentrate on its own market. Secondary airports, being smaller, tend to serve niche markets. The traffic that does develop at second airports is not just a random spill-over of traffic that does not get served at the principal airport in the system. The traffic at secondary airports is normally a concentrated block of specialized traffic, often represented by just one dominant airline, as Table 2 indicates.

This pattern of concentration of air transport is an example of a larger phenomenon. It is a commonplace of location theory and urban planning that services concentrate. Cities thus have financial districts, theater districts and so on.

The concentration of traffic at specific airports in a multi-airport system is inevitable. It has withstood many governmental attempts to alter it, in London and Washington in particular (for detailed examples see the case studies in Annex 3, and also de Neufville, 1986 and 1994). Traffic concentration is a persistent phenomenon that airport managers must deal with realistically.

Threshold of Viability for a Second Airport

The combination of the passengers' perspective that leads to a focus on originating passengers, with the airlines' perspective that emphasizes concentration of flights at the primary airport, implies that multi-airport systems can only be successful when the level of originating traffic is quite high. The evidence validates this conclusion.

The worldwide data on all the metropolitan regions with the most traffic (Table 3) illustrates a simple and most important proposition:

> Above a threshold level of originating traffic from a metropolitan region, the multi-airport system will be successful. Below this level it is only successful if the primary airport is limited technically or if special political circumstances apply.

The threshold for successful multi-airport systems is now around 10 million originating passengers a year. It has been rising over time, along with the introduction of wide-body aircraft, the improvements in air traffic control and peak spreading -- all of which permit more frequent operations from existing runways. A decade ago this threshold was about 8 million originating passengers a year (de Neufville, 1984a, 1984b, 1985a, 1985b). If the trend continues, the threshold may reach 12 million originating passengers a year sometime after the year 2000.

Table 4 completes the inventory of multi-airport systems worldwide. As can be seen, multi-airport systems for regions with less than 10 million originating passengers a year exist almost exclusively from technical necessity or overwhelming political reasons. The situation for Oslo is not yet resolved: in principle an expanded Gardemoen will be the only airport for the region and Oslo/Fornebu will close. Glasgow and Edinburgh perhaps ought not to be considered part of a multi-airport system, these cities are about 80 km. apart which may appear considerable although it is not in other contexts. The lack of any salient examples of multi-airport systems with less than 10 million originations that are successful for commercial reasons validates the concept of the threshold for success.

Traffic Volatility

Traffic at second airports is especially volatile and variable compared to traffic at major metropolitan airports. It tends to fluctuate by large percentages over the short term. This phenomenon complicates both the physical and the financial planning for second airports.

The natural uncertainties in traffic (see de Neufville, 1976 for example) are amplified at secondary airports, because their traffic is small. A shift of traffic from one airport to another obviously has a relatively much larger effect on the smaller facility: what is comparatively small for the big airport is ten times as significant for an airport with only a tenth of the region's traffic -- as typical of many second airports.

The volatility of traffic at secondary airports is further increased because these are often dominated by specialized carriers. When the activities of these smaller airlines shift, as they frequently do, the traffic at the secondary airport can change radically both in level and in character.

The recent experience at Chicago/Midway illustrates the problem, see Table 5. In 1990 and 1991 its total annual traffic was both small (around 6 million total passengers, that is 3 million emplanements or about 10% of the Chicago traffic) and specialized, since Midway Airlines accounted for about two-thirds of the passenger traffic. When Midway Airlines ceased operations in November 1991, the effect on Chicago/Midway was tremendous: the airport lost not only about one-third of its traffic but also around $700,000 a month in concession revenues (Cohas, 1993). Meanwhile, any impact on the traffic at Chicago/O'Hare was barely perceptible.
The volatility of traffic at any airport is usefully defined as a percentage change around its long term trend (de Neufville and Barber, 1991). Specifically, a practical formula is:

Volatility = [(Actual Traffic - Trend Traffic)/Trend] 100

The higher volatility of traffic at second airports was demonstrated analytically by Cohas (1993). He examined three multi-airport systems, those of New York, San Francisco and Washington, using quarterly data over the eleven-year period of 1980 through 1990, and found that the volatility of traffic at the secondary airports was clearly higher than at the primary airports. Table 6 gives the details.

Traffic is, furthermore, much more volatile in a deregulated environment than under strict regulation that prevents airlines from rapidly changing their routes, fares or frequency of service (de Neufville and Barber, 1991). For regions experiencing deregulation, such as the European Union in the 1990's, it can be expected that the traffic at secondary airports will be doubly volatile -- once because of the airlines' new freedom to move operations, and again because of the greater vulnerability of secondary airports.

Traffic at the secondary airports with less than 1 million total passengers (that is, less than 500 thousand emplanements) can be expected to be most highly variable. The statistics in Table 7 illustrate some possibilities.

PLANNING ISSUES

The appraisal of how and why multi-airport systems develop brings three issues to the fore. First, managers of larger airports need to develop a vision, a strategy of how and

where they will develop the multi-airport system they already or may soon have. Second, they should develop relatively modest programs of investment at second airports, suitable to the relatively low levels of traffic at these platforms. Third, they should insist that these plans be flexible, and can easily be adapted to various levels and types of traffic.

A Strategic Vision

Since multi-airport systems seem inevitable for large metropolitan areas, airport managers in those regions ought to plan actively for their intelligent development. Specifically, they need to determine and acquire sites for prospective second airports. If airport planners do not secure a site early, the natural growth of the built-up areas of the city will tend to preclude the most accessible, desirable sites.

All regions with 10 to 15 million annual passengers probably should develop a vision of how they will develop their multi-airport system. These regions may have 30 to 40 million annual passengers in about 15 years, and thus be beyond the threshold for a successful multi-airport system. (This assumes that the compound rate of growth of air traffic is in the plausible range of between 5 to 7 percent annually.) Experience shows that it may easily take 10 to 15 years to select, acquire and develop a site for a second airport.

From the planning perspective, it is thus urgent for Amsterdam Airport Schiphol to address the question of a possible second airport for the metropolitan region. The airport management has in fact been doing this in word and in deed. This report itself is an indication of their planning consideration. The purchase of Lelystad airport northwest of Amsterdam and their ownership of Rotterdam airport constitute tangible evidence of their actions.

Securing a site for a second airport insures that future developments will be possible. As it is impossible to determine what kind of airport will be needed so far in advance, no major investments in facilities are appropriate until needs are demonstrated. However, if a site is truly to represent an option for future development, it must actually be an airport. If the site looks like a nature preserve, as does the land set aside for the one-time putative Toronto/Pickering airport, its later transformation into an airport may be politically impossible.

To secure a site as an option for future development, it seems necessary to lay down some kind of runway and establish some pattern of use. This is what the developers of the Fort Worth/Alliance airport did. Similarly, if Amsterdam Airport Schiphol wishes to have Lelystad as a viable option as a second airport for the future, it will be important to open this site to larger, long-range aircraft.

Managers in regions that already have several active airports should likewise define how they will develop these facilities. They need to make sure that their investments will accord with the patterns of relatively low, specialized traffic that are characteristic of

second airports. In short, they ought to avoid the kind of financially wasteful investments apparently typified by the expensive, and virtually unused passenger buildings at London/Stansted.

Incremental Investments

When future demands are certain, it makes sense to build large facilities, achieve economies of scale and thus reduce the present value cost of providing for some level of need. There is a trade-off between the economies of scale that accrue to a design and the cost of the money required to build in advance of need. The determination of the optimum level of construction in advance of need is quite straightforward (see de Neufville, 1990b, for a textbook presentation).

When future demands are quite uncertain, as they have been for second airports, it is wasteful to build far in advance of need. This is because an over built facility can be a white elephant if anticipated demands do not materialize. This is what happened at London/Stansted, Montreal/Mirabel, Munich, New York/Newark (where the owners literally boarded up a major terminal for more than a decade), and at Washington/Dulles (which was under utilized for nearly 20 years).

When there are risks, prudent managers buy insurance. In the case of constructed facilities, the obvious insurance against having white elephants is to build facilities only incrementally, according to demonstrated need. The cost of this insurance is the loss of economies of scale and the resulting higher costs per unit of capacity. The value of this insurance is, of course, the potential savings that result from not having to pay for capacity that turns out to be unneeded.

The optimum level of insurance to buy as a hedge against uncertain future levels of traffic is easy to calculate by decision analysis. The idea is to maximize expected value by weighting the consequences of possible futures by their estimated probability (see de Neufville, 1990b, for a textbook presentation). This method is at the heart of the dynamic strategic planning procedure described in the next section.

Uncertainty in the traffic at second airports concerns more than the level of traffic. The type of traffic at secondary facilities is also quite changeable. A decade ago, no designer anticipated that Washington/Dulles would develop as a transfer hub for United Airlines, or that Los Angeles/Ontario would become a major cargo center for UPS, which still is primarily a trucking company.

Because the type of traffic is variable at second airports, the configuration and the nature of the facilities ought to be flexible. For example, the planners should design passenger buildings that can easily be reconfigured to accommodate different proportions of domestic and international traffic, or of transfer and terminating traffic.

DEVELOPING THE POLICY

Dynamic Strategic Plan

Dynamic strategic planning is the approach to take when the future cannot be forecast accurately. The approach is:

1. Strategic, in that it takes the long term view; and
2. Dynamic, in that it recognizes and thus anticipates the need to adjust plans to meet the actual circumstances that eventually prevail.

This approach consists of three elements (Clark et al, 1996):

1. Recognition of the risk;
2. Analysis of the consequences of different choices at different periods, using what is known as "decision analysis" in operational research; and
3. Choosing a strategy of development that commits only to immediate decisions and that buys flexibility to respond to future developments.

A most practical way to recognize the risk of investing in second airports is to collect data on similar facilities, in similar contexts, over the previous 10 to 20 years. This exercise will demonstrate that forecasters do not manage to anticipate correctly what the traffic will be a decade hence, which is a minimal period for major construction. The exercise will also provide a reasonable approximation of the range of variation in the forecasts and the probability of specific deviations from the most likely forecast. As a result, managers should have a fair assessment of the real risks they face.

With the estimates of risk, managers can estimate the consequences of alternative investments using decision analysis. Since the future is uncertain, these outcomes are assessed as expected values (see de Neufville, 1990b, for a textbook explanation of the method). The analysts will associate these results, together with the possible range of outcomes, with each of the scenarios for phasing investments over time that are under consideration. With the recent development of computer programs to do this on personal computers, this seemingly arduous task is quite easy. Once these results are available, it is relatively simple to choose the best strategy to initiate.

Choosing an initial strategy of development only commits to a first phase, of course. Because the future is uncertain, good planning will respond to whatever events unfold. Good managers will therefore choose their investments in later phases according to how the market and traffic have developed. To insure that they can do this, they will have chosen designs that are flexible -- these are the ones that will emerge as preferable from the decision analysis.

Doing dynamic strategic planning is comparable to playing chess well: the planner considers many moves ahead, but commits to only one move at a time -- moreover the decision-maker chooses this move to provide flexible response to future challenges, either to protect against threats or to exploit opportunities.

In practical terms for planning multi-airport systems, dynamic strategic planning leads to:

1. Safeguarding the possibility of developing major additions to capacity in the future, by reserving the sites for new runways, second airports in the system, and the access corridors, and by maintaining, through actual use, the operating rights at these locations; while
2. Building up incrementally the capabilities of the primary and secondary airports in the system -- to give the region the accessibility to compete effectively with other regions for business, industrial and touristic activity

This is the approach so far taken successfully for the development of the multi-airport system for Sydney, Australia (See de Neufville, 1991). In that case, the Federal Government recognized the desirability of both developing more airport capacity where it would do the most good immediately (at the existing primary airport of Sydney/Kingsford Smith) and providing future capacity for the region, when and if it would be needed, by reserving a sufficient site for at major second airport (at Badgery's Creek, now named Sydney/West).

Appropriate Plans for Second Airports

The number and length of the runways is a key consideration in planning second airports. The requirements are quite limited however, especially for situations where the primary airport offers one or more runways capable of serving intercontinental flights -- which is the case at Amsterdam Airport Schiphol. One runway may be sufficient (as at London/Gatwick or Tokyo/Narita, both of which serve approximately 20 million annual passengers).

Two parallel runways are preferable operationally, from the point of view of flexibility and capacity. More are unlikely to be needed for a single second airport. The capacity available through 2 parallel runways can be enormous. While this capacity depends on the type and mix of aircraft used, their schedules, and the seasonal variations in demand, the experience at London/Heathrow demonstrates that it can exceed 45 million annual passengers. For a second airport, which by definition has less traffic than the primary airport, capacity of this magnitude can be expected to be sufficient.

Because second airports naturally serve niche markets of some sort, it is often convenient that the capacity of the second airports be distributed throughout the metropolitan region. This enables these facilities to serve distinct local markets. A majority of the largest multi-airport systems are thus served by several second airports, each with their own particular markets (see Table 2). The London multi-airport system is a good example of this phenomenon: London/Heathrow is a full-service intercontinental hub, London/Gatwick is more oriented toward lower fare and vacation traffic, and London/Luton specializes in serving holiday tours.

Proper planning requires not only that the sites be identified and reserved for future development, but that the rights to operate the site as an airport be established and

maintained. If these rights are not secured, the site reserved for additional capacity may become useless for airports. This is what happened at Toronto: because no runway was built at Pickering, the intended site for the second airport, this area now has that practical status as a nature preserve and is highly unlikely ever to be used as planned (see case study in Annex 1).

To maintain the rights to use a site for a second airport, effective planning requires that at least a minimal runway be laid down and that a pattern of operations be established. This is what has been done in the Dallas/Fort Worth metropolitan area. In this case, a third airport has been established at Alliance, near Fort Worth. At the present time, and probably for many years, there is no need for Alliance airport from the point of passengers and shippers. The right to operate at this site is maintained by day and night training flights from major airlines.
Maintaining the rights to use a second airport also involves establishing and maintaining the access corridors to the site. If a second airport is ever to function effectively, its users must be confident that they can reach it conveniently from the ground. The planning for these connections should be seen as an integral part of the planning for a second airport, as was done for Washington/Dulles (to which a dedicated 4 lane highway was built) and as being done for Sydney/West, the prospective second airport for Sydney.

Developing Traffic at Second Airports

This section considers how traffic can be developed at a second airport in a metropolitan region, while the first or primary airport remains active. This is the situation to be addressed in the Netherlands, where there is no realistic consideration of shutting down Amsterdam Airport Schiphol.

The situation must be considered carefully. It is completely different from two other cases which can also lead to second airports, those that occur when:

- An old airport is closed in favor of a completely new airport -- as happened in 1995 with the opening of the New Denver Airport, or
- The old airport is limited by short runways and a new airport is required to serve the longer range aircraft -- as was the case when Paris/Orly was developed to replace Paris/Le Bourget as the commercial airport for Paris.

When the old airport is closed, it is easy to transfer traffic -- all airlines and shippers accept the idea that they must move their operations (even if the old airport remains technically open, as Paris/Le Bourget is for the Paris Air Shows). When the airport remains commercially open, however, the transfer is much more problematic. When Dallas/Fort Worth opened in 1973 all the existing airlines contracted to transfer their operations from Dallas/Love Field, but a new airline (Southwest) came in and took a dominant share of the short-haul traffic away from the previously leading airlines -- a commercial disaster for airlines such as Braniff (which no longer exists). Likewise, the development of traffic at the new Osaka/Kansai airport has been very slow since the

Japanese airlines have not transferred their operations from Osaka/Itami (see case study in Annex 1).

When the old airport is limited by its runways, some of traffic will move voluntarily from the older airport to the new site. In a commercially open economy however, much of the traffic may remain at the limited primary airport, as airlines choose to serve distant points through connecting service. This is the situation that prevails at Washington (see case study in Annex 1).

For a second airport that complements an existing primary airport, traffic develops most naturally around niche markets that do not require the range of connections and the frequency of flights provided by the main or principal airport. These may be:

1. Shorter range flights on highly traveled routes, as traffic between the second airports in the San Francisco and Los Angeles multi-airport systems, or from the Chicago/Midway airport;
2. Specialized clienteles such as vacation travelers (as at London/Luton), low cost operators looking for inexpensive service (such as Southwest Airlines at Miami/Fort Lauderdale or possibly Valuejet at Boston/Worcester), or integrated cargo carriers (as at Los Angeles/Ontario or Toronto/Hamilton -- see case study in Annex 1); or
3. Hub operations from a major carrier that wishes to set up an independent base in the metropolitan region (as United Airlines at Washington/Dulles, or SAS/Continental at New York/Newark -- see case studies in Annex 1).

These kinds of flight operations, those that can fairly easily be separated from the activities of the principal airport, are those that should be cultivated in order to develop traffic at a second airport. Worldwide experience indicates that these are the air transport markets that naturally and effectively develop at second airports (see Table 2).

Attempts to force blocks of traffic from the principal to the secondary airports have either not worked or been massively expensive ineffective. In particular, the attempts to force “International” or long-distance traffic to move to a second airport, separating it from the national or shorter-range traffic has largely been a failure. This is because the long-distance, intercontinental traffic naturally needs to connect with local flights that will connect the passengers and cargo with their ultimate destinations. The case studies of Osaka, Paris and Washington in Annex 1 illustrate this phenomenon.

It should be stressed that the development of niche markets at the second airports generally has an importance far beyond their apparent level of traffic. The specialized traffic served by niche markets is typically concentrated in particular periods. The fact that these concentrations are handled at the second airport rather than the primary airport can be very significant, if not crucial, for the good operation of the system. Two examples illustrate the point:

1. London/Luton serves only about 4 percent of the traffic at London/Heathrow (see Table 1). However, these couple of million passengers are concentrated during the peak summer months -- at that time London/Luton may serve as much as 10

percent of the traffic, an increment that might overwhelm the principal airport in this peak period.
2. Toronto/Hamilton serves relatively few flights compared to the principal airport of Toronto/Pearson, but these flights from integrated cargo carriers occur during the night -- if Toronto/Hamilton were not available, Toronto would not be able to offer the kind of rapid cargo service now available. (See case study in Annex 1).

Financing Second Airports

Traffic at a second airport is almost certain to develop slowly. Furthermore, the initial clients at the second airport are likely to be niche operators attracted by low costs. The revenues at a second airport are thus likely to be low for some time. Yet the infrastructure necessary to establish second airports -- the runways, buildings and access transport
-- can be expensive. The question is, how should second airports be financed?

From a financial point of view, it is important to keep the costs of the second airport relatively low. This might seem obvious, but it is often not. Planners and architects for a new airport in an important metropolitan region typically wish to make a statement, and are inclined to build monuments. The new facilities at London/Stansted and Osaka/Kansai are obvious examples of this phenomenon (see case studies in Annex 1). Relatively inexpensive facilities, such as those at Miami/Fort Lauderdale, are the ones that will both attract cost conscious airlines (such as Southwest), and will be most cost-effective.

Even when the infrastructure and operating costs of the second airports are kept low -- for example by reusing existing airports or military airfields, and by constructing minimal passenger facilities -- the revenues are quite likely to be inadequate. This is the pattern for most second airports, at least at the start. What should be done then?

Proper financial planning for second airports recognizes their contribution to the multi-airport system. It recognizes that both in the short term and in the long term they facilitate the operations at the primary airport. This occurs in two ways, by:
1. Insuring that the metropolitan region has the air transport capacity it will need in the future -- in essence by providing an option on the uncertain need for airport capacity which, as financial analysts can appreciate, has a value that increases with the uncertainty of the need; and
2. Reducing congestion at peak periods, which can be most valuable, since the cost to the airlines of delays is easily on the order of Nfl.100.-- per minute for a major aircraft and its crews, so that the reductions of several minutes of average delay to the tens of thousands of aircraft in the peak periolds is easily worth around Nfl.10 million/year, a savings which can justify a substantial capital investment.

In this connection it should be noted that even small shifts of traffic, in the range of a few percent of the total, can reduce congestion costs at the main airport considerably. This is because at peak periods the costs of congestion at the primary airport increase

very rapidly -- exponentially -- with small increases in the total level of congestion. Thus a small reduction in the summer traffic (corresponding to an even smaller reduction in the yearly total) can be very worthwhile. [Technically, the delays are proportional to the ratio of 1/(1-p), where p is the degree of saturation of the capacity of the airport. Thus a change in the degree of saturation from 95% to 90%, cuts the congestion in half, from 1/(1 - .95) to 1/(1 -.90) that is from 20 to 10.]

Because the second airports contribute to the performance of the system, they should be financed by the system in some way. Either they should be supported by the regional or central government, that wishes to insure the future strength of the region, or they should be carried by a multi-airport organization such as the Port Authority of New York and New Jersey, or BAA plc (which operates the three largest London airports).

APPLICATION TO AMSTERDAM

Based on the preceding discussions, this section specifically addresses the questions that motivated this report:

1. Is a distribution of traffic in which Amsterdam Airport Schiphol is saturated (with about 45 to 50 million annual passengers), and the second airport has the projected overflow (around 5 to 15 million annual passengers), viable economically and operationally?
2. To what extent would this kind of distribution be stable, given the constantly evolving levels of overall traffic and the competition from other airports?
3. Could a multi-airport system for the Amsterdam region include airports that were some distance away, for example off-shore in the North Sea, at some distance in the Netherlands, or even in a neighboring country?

Viability of Traffic Allocation

The traffic allocation of about 45 to 50 million annual passengers at Amsterdam Airport Schiphol, and the projected overflow (around 5 to 15 million annual passengers) at second airports is certainly viable operationally. Examples demonstrate the proposition. Two cases provide almost exact models:

1. The London metropolitan region features Heathrow airport with about 50 million annual passengers, and Gatwick airport with about 20 million (along with 3 minor airports of 3 million annual passengers or less);
2. The Los Angeles region has Los Angeles International with around 45 million annual passengers, complemented by three airports with around 5 million annual passengers each (Ontario, Orange County and Burbank).

The general worldwide experience is that the median percent of traffic at the second airport is around 1/3 of the traffic at the primary airport. While the specific levels vary widely between regions (see Table 1), this figure further validates the notion that the allocation of about 45 million annual passengers at Amsterdam Airport Schiphol and 15 million at second airports is operationally viable.

The question of the economic viability of this allocation needs to be considered carefully. The answer depends both on the costs associated with the second airports, and on the extent to which these costs are carried by a multi-airport authority or company.

Airports with low costs for their operation and infrastructure are more likely to be economically viable on their own. Thus London/Luton, which has virtually no capital costs to repay since its facilities were largely inherited from a former Air Force base, appears to be an economically viable operation. The London/Stansted airport on the other hand features both a large modern terminal with advanced features (such as an internal automatic people mover system), and a dedicated railroad link to the center of London (Liverpool Street Station) -- it is unlikely to cover its costs in the foreseeable future.

Second airports with very high costs, such as any second airport built on a man-made island in the sea, are unlikely to be economically viable under any standard commercial accounting practice. The new Osaka/Kansai airport illustrates the point: the total revenues from the airport now amount to only about 1 percent of the capital invested in the airport island. As the example of the new Denver airport illustrates, revenues would have to be about 10 times greater to provide a reasonable return on the investment, while covering operating costs.

The ability to cover costs from its own operations should however not be the measure of the economic merits of a second airport. As indicated in the previous section on Financing Second Airports, second airports create benefits to the entire multi-airport system. A proper evaluation of their economic merit must consider these system benefits, and should allow for payments from the system or the region to cover these benefits.

The implication for Amsterdam is that a multi-airport system making use of relatively available facilities, such as Rotterdam or Lelystad, has a good chance of being economically viable according to reasonable investment practices. On the other hand, a specially built second airport in the sea, such as Osaka/Kansai, is unlikely to be economically viable in any commercial sense.

Stability of Traffic Allocation

The question of the stability of the traffic allocation must be considered in a least two ways, from both the short and long term perspective.

In the short term, as the second airport is developing and finding its role in the multi-airport system, the level of traffic at the second airport is likely to be relatively unstable. The data in Tables 5, 6 and 7 illustrate this phenomenon.

In the longer term, once the second airport has established its role in the multi-airport system, its relative level of traffic is likely to be relatively stable. In this context, the shifts will occur mostly do to major economic realignments that affect the market segments associated with the second airport. The experience of London/Gatwick illustrate this point. When the British airlines were highly regulated and British Airways was owned by the Government, London/Gatwick was guaranteed certain traffic rights, and had about a third of the total London traffic. Now that the British have deregulated air transport and privatized British Airways, the role of London/Gatwick has changed to the extent that it now serves only about a quarter of the airline traffic through London. Despite this shift, the level of traffic through London/Gatwick has remained about constant at 20 million annual passengers.

Planners for the development of the multi-airport system for the Amsterdam metropolitan region must thus recognize that the allocation of traffic to the second airports is likely to be uncertain during the development phase. This phase could easily last ten to twenty years -- which has been the experience around Washington for example (see case study in Annex 1).

Larger View of Multi-Airport System

The question of whether a multi-airport system for the Amsterdam region could include airports that were some distance away requires careful thought. The important issue to be considered is not really distance, either in space or in time, but accessibility to markets, that is, to passengers and shippers.

Many second airports are quite removed from the center of their metropolitan regions, which demonstrated the possibility of having a second separated from the center of the region. Worldwide, they may be far away in terms of:

1. Distance, such as Los Angeles/Ontario, San Francisco/San Jose, Miami/West Palm Beach, and Boston/Providence;
2. Time, such as Tokyo/Narita; or
3. Both distance and time, as Osaka/Kansai.

The possibility of having airports far from the center of metropolitan regions is a result of the relatively recent change in the nature of cities. With the development of motorways, and a denser network of rapid trains, the cities have become metropolitan areas easily stretching a 100 or more kilometers from the traditional centers of the city. This is certainly the case for Los Angeles, Osaka, San Francisco and Tokyo for example. There is no reason why the same phenomenon might not apply to the Amsterdam metropolitan region: it would in fact seem to be reflected in the notion of the Randstaat.

The real question to be faced is whether, and specifically under what circumstances, a distant second airport can be economically and operationally successful. This resolves into a question of whether the airlines will want to serve these distant points, and this in

turn is largely a question whether there are reasonable markets at these locations. To the extent that reasonable markets exist at the distant locations, as at Los Angeles/Ontario, San Francisco/San Jose and Boston/Providence, then there is a reasonable opportunity for the distant second airport to be a success.

It should be understood in this context that the alternative to a distant second airport associated with the metropolitan area, is a really distant airport associated with a competitive metropolitan area. If airlines feel constrained at the primary airport at a metropolitan area, and see no local alternative with a reasonable market, they may move substantial portions of their operations to quite different cities. In this vein Northwest/KLM in 1995 relocated a substantial portion of its hub operations away from Boston, after having previously moved them from New York/Kennedy. Similarly, Delta Airlines by the end of 1995 completed the shift of many of its hub operations away from Dallas/Fort Worth to Cincinnati.

For airlines serving Amsterdam Airport Schiphol, for KLM in particular, the alternative to a distant second airport without a natural market (for example off-shore in the North Sea or in a neighboring country) might be to shift some hub operations away from Amsterdam -- to Vienna for example.

If a second airport has a reasonable natural market, for example at Rotterdam, then it is conceivable that this location could develop into a substantial second airport as part of the Amsterdam (or perhaps the Netherlands) multi-airport system.

ANNEX 1 -- CASE STUDIES

These summary case studies have been chosen for their relevance to Amsterdam. Two of them concern close competitors in the European Community (London and Paris). It is important to consider these situations in the European Community, as they must be especially relevant to Amsterdam. They also illustrate three issues that Amsterdam Airport Schiphol and the Netherlands generally will have to consider in the years ahead:

1. The importance of the government role in siting new airports;
2. The limits on the government role in developing the traffic at the second airports; and
3. The effects of the market structure -- regulated or deregulated -- on the future of second airports.

Two other cases (Washington and Toronto) come from North America. These further illustrate and emphasize the above points, and also bring into focus the importance of niche markets for developing and sustaining second airports.

A fifth case study (Osaka) illustrates the economic and operational difficulties of developing a major airport in the sea.

Table 8 summaries the main topics covered by these cases.

Table 8: Factors illustrated by the case studies of Multi-airport systems.

Factor Shown	Multi-airport System				
	London	Osaka	Paris	Toronto	Washingtn
Govern-ment role in siting					
Govern-ment role in devel-opment					
Effects of Regulated markets					
Cost Inef-fec large* 2nd airports					
Niche Markets					

* Note: A large second airport refers to one designed to serve major transcontinental or transoceanic traffic, for example London/Stansted, Montreal/Mirabel. This contrasts with smaller second airports such as London/City or Toronto/Hamilton.

London

Background

The multi-airport system for London includes 5 airports:
1. Heathrow, by far the largest with about 50 million annual passengers;
2. Gatwick, with about 20 million annual passengers, which used to be the hub of operations for British Caledonian Airlines and thus had exclusive rights on traffic to Western Africa and Latin America for the London area;
3. Stansted, which along with the previous two, is owned and operated by a private company BAA plc;
4. Luton, owned and operated by the local municipality, and which has a thriving business of about 3 million annual passengers, mostly on holiday tour packages; and
5. London City, a privately owned downtown airport near the financial center with about 0.2 million annual passengers.

Points to be made

The development of the multi-airport system around London, serving the whole south-east of England, illustrates four factors:
1. The important role of government in defining and establishing the site for second airports;
2. The limits on government action to shift traffic to secondary airports; and specifically the way deregulated markets make it virtually impossible for governments and planners to force traffic to major second airports in advance of need;
3. The role of niche markets in the development of second airports; and
4. The problems with over-expensive, premature development of second airports.

Government role in siting secondary airports

Government action has been an essential part of the establishment of the London multi-airport system. It played a strong role in the development of London/Gatwick, as described below, and was central to the development of London/Stansted.

London/Stansted is the third largest airport around London, and was recently developed by the British Airports Authority, the Government agency that has since been privatized and become the BAA plc. This development took place on the site of a former Air Force base, where the essential runway and taxiways were already in place. The investment in the airfield was thus relatively inexpensive.

The Government however spent lavishly at London/Stansted, on the construction of a modern central terminal building, midfield satellites and an internal people mover or train system, thus creating a miniature Atlanta or new Denver Airport. It also arranged for the construction and operation of a private railroad connection from the airport to

the rail network into central London. The overall investment in the infrastructure and the operation of London/Stansted has thus been very significant.

All this investment occurred well in advance of any real market. The current and foreseeable traffic at London/Stansted does not justify the investment on economic terms. No developer acting solely on economically rational grounds would have undertaken this investment.

The development and continued operation of London/Stansted has thus been dependent both on the political will of the government to establish this facility, and its insistence that it be supported by the multi-airport system.

Limits on government role in development

The London multi-airport system offers an excellent example of the limits on the power of government to foster traffic at second airports, both in a regulated environment, and in the current deregulated context. In the regulated environment, the Government was able to grow traffic at London/Gatwick to a remarkable extent when it could intervene with its regulatory powers, but it was relatively powerless in the commercial sector. In the current deregulated context, the Government has not yet been able to grow traffic at the second airports to any significant degree.

London/Gatwick grew during the 1960s and 1970s largely as a result of the Government's "two-airline" policy. During this period the Government effectively divided the important international routes due to British airlines between the airlines owned by the Government (BOAC and BEA, the predecessors to British Airways) and the privately owned British Caledonian (BCal). BCal operated out of London/Gatwick and had the exclusive operating rights to Western Africa and South America (it also, at various times in different ways shared traffic rights with the Government airlines to parts of Europe, the southern part of the United States, and within the United Kingdom). The growth of London/Gatwick was virtually guaranteed by the way the British Government allocated its international traffic rights. Roughly speaking, if someone wanted to fly from London to Lagos, say, they had to pass through London/Gatwick.

By eliminating competition between the airports for a broad range of traffic, the British Government insured the development of the second, otherwise much less competitive airport.

On routes where competition prevailed, however, the British Government was noticeably unsuccessful of diverting traffic from London/Heathrow to London/Gatwick. For example, for an extended period the Government agency that regulated fares within Britain allowed BCal to have lower fares from London/Gatwick to Glasgow and Edinburgh than were permitted from London/Heathrow. This policy had no perceptible effect.

In the current deregulated context, where BCal has become part of British Airways, there is free competition between the second airports and the principal airport of

London/Heathrow. In this situation the second airports have fared poorly. London/Stansted only has some 6 percent of the traffic of London/Heathrow, even though the Government has offered the United States airlines free, "open skies" access to this facility. London/Gatwick would appear to be doing well, since it still serves about 20 million annual passengers, as it did 10 years ago -- in fact it has lost considerable market share to London/Heathrow, now serving only around 40 percent of its traffic, compared to about 50 percent a decade ago.

Niche Markets

The London case illustrates the importance of niche markets in developing second airports. As described above, the original strong growth of London/Gatwick was largely due to its protected market for travel to certain destinations.

The holiday, cheap fare market has also been a major factor in the development of London's second airports, as it has been elsewhere, for example at Paris/Orly and New York/Newark. The holiday traffic is a good candidate for locating at second airports for two reasons:

1. It is especially price sensitive, so that the airlines in this business look for airports which are less expensive, and these are often second airports which neither offer nor charge for the full range of world class services;
2. It occurs during the peak periods, when the congestion at the primary airports is worst, and when the cheap fare traffic is often actively discouraged, for example by peak period pricing.

A generation ago, much of the cheap fare, charter traffic was thus centered on London/Gatwick, and contributed significantly to its traffic and development. Currently, much of this traffic is focused on London/Luton, and accounts for its relatively high level of traffic considering its limited, low-grade facilities for passengers, aircraft, and ground access.

Problems with over-expensive second airports

London/Stansted is a classic example of a second airport developed far too lavishly for the prospective traffic. Other excellent examples of this phenomenon are New York/Newark and Osaka/Kansai.

At London/Stansted the British Government spent lavishly on the construction of a modern central terminal building, midfield satellites and an internal people mover or train system, thus creating a miniature Atlanta or new Denver Airport. It also arranged for the construction and operation of a private railroad connection from the airport to the rail network into central London.

These large investments at London/Stansted are particularly remarkable in the context where second airports normally:

1. Struggle to develop traffic (see the section on Developing Traffic at Second Airports), and

2. Attract airlines looking for inexpensive facilities.

In the event, London/Stansted illustrates how large investments at second airports can be wasteful. The policy of developing this facility as a viable part of London's multi-airport system did not require this level of investment.

To appreciate the degree to which London/Stansted was over built one only has to go and visit. Unfortunately, it is difficult to reach because there are so few flights.

Osaka

Background

The Osaka multi-airport system includes the major airport, Osaka/Itami and the new Osaka/Kansai which opened in 1994:

1. Osaka/Itami serves over 20 million annual passengers and is thus comparable to Amsterdam Airport Schiphol.
2. The new Osaka/Kansai was built at a total cost of around US$ 25 *Billion*, including the railroads and highways necessary for access (but not including most interest costs on capital since most of the funds were expended interest-free from government sources). Osaka/Kansai currently has the monopoly on international flights to the larger Osaka region (known as Kansai) but so far only serves less than 2 million annual passengers.

Points to be made

The Osaka case underlines three major issues:

1. The critical role of Government in taking the long-term view and creating the possibility of a second major airport;
2. The enormous difficulty, even in a tightly disciplined economy, of forcing traffic to develop at secondary sites which are not commercially attractive; and
3. The huge economic cost of premature, cost-ineffective development of second airports -- in this case the operational losses are extremely and needlessly high.

Government role in siting secondary airports

The central government was absolutely crucial for the creation of the Osaka/Kansai airport. No other entity could organize the enormous finance (about US$ 25 *Billion*), the extensive rail and highway facilities, and the huge environment effects of leveling substantial hills to provide the fill needed to create a major island in 20 m. of water.

Moreover, the central government was crucial in the transfer of substantial traffic to the new Kansai/Osaka airport. The pre-existing Osaka/Itami airport -- which is still the primary airport for the region, is both fully capable of handling all types of aircraft and is more convenient for most passengers because it is closer to the center of Osaka and to the high-speed Shinkansen railway.

To establish Osaka/Kansai as a major airport, the central government ruled that all international flights from the Kansai region had to go through this facility. They in effect forced the intercontinental and regional traffic from the older site to the new airport.

Limits on government role in development

While the government was crucial to the establishment of Osaka/Kansai, it was relatively powerless to make this airport as the main port for the Osaka region. While succeeding in a limited way, the government failed in its main objective.

The government's original plan was to close the airport convenient to the city center, Osaka/Itami, because of its environmental impacts (noise and pollution) on the surrounding areas. These adverse effects were, in fact, a major motivation for the creation of the Osaka/Kansai second airport. This plan failed.

The population that worked around and used the old airport of Itami refused to let this convenient airport be closed, when faced with the alternative of having to move to the distant and relatively inaccessible second airport. They complained strenuously about the pollution when they had nothing to loose, but once the consequences of closing the airport became apparent, they preferred the jobs and convenience to the improvements in environmental effects.

This case thus illustrates how the government policy is determined by strong local interests -- in the case of Osaka the government was first pushed to spend enormous sums to create an airport that would have little environmental impact, and then pushed to invalidate the rationale for this investment, by keeping the convenient airport open.

An obvious lesson for airport planners would seem to be that they should do their best to avoid such reversals of policy, by helping the regional and national authorities recognize the consequences of limiting convenient main ports and the relative importance to the local communities of their jobs as against the environmental effects.

Problems with over-expensive second airports

In competition with the popular, convenient Osaka/Kansai airport, Osaka/Kansai attracts very little traffic -- only about a tenth as much.
Even though the fees at Osaka/Itami are about the highest in the world, the revenues are totally insufficient to pay the cost of the investment.

As the cost of the Osaka/Kansai airport alone, without the new rail line, highways and the 3 km. bridge, is about US$ 12 *Billion*, annual revenues of between US$ 500 million to 1 Billion would be required to pay just the cost of any reasonable financing (4 to 8%, including inflation). The costs of operations, maintenance would be extra. [For comparison, the cost of the New Denver Airport was around US$ 4 *Billion* , which requires annual revenues of about US$ 400 million to pay for the operations and repay the financing.]

The actual revenues of Osaka/Kansai airport are far, far below what would be needed to pay for the project -- even though the landing fees are about the highest in the world, about US$ 10,000 per operation. At the present rate these fees generate only about US$ 100 million a year, only about one-tenth of the minimum that would be required to justify the facility economically.

Osaka/Kansai is, like London/Stansted, an example of where a major investment in a second airport is not justified by the level of traffic that can be expected in a reasonable future. The big difference is that Osaka/Kansai cost about 10 times as much as London/Stansted, and is 10 times more of an economical failure.

Paris

Background

The Paris multi-airport system consists of two main commercial airports, Paris/de Gaulle and Paris/Orly, both of which served about 25 million annual passengers in 1994:

1. Paris/de Gaulle was built in the 1970s and has been developed around Air France, which was forced by the government (its owner) to move to there from Paris/Orly.
2. Paris/Orly over the last two decades has been the premier airport for domestic flights in France and the center of operations for Air Inter. It has also been the airport that serves Africa and the Caribbean, as well as holiday tours.

Points to be made

The Paris case is a history of what can happen when the Government controls domestic traffic, virtually absolutely. In such a situation, many things are possible that are totally impractical elsewhere. Even then, however, there are considerable limitations on what a Government can do to force the development of second major airports.

To understand this case study it is important to understand the great and almost unique power of the French government to influence the development of airports and air traffic over the past generation. During that time, the French Government could:

1. Make major decisions about land use by decision of the central government (a power which has since been greatly, during the 1981-1995 Mitterand presidencies, delegated to lower communities);
2. Force the major domestic airline to move its operations (because the government owned it) despite the consequent commercial losses (which it is no longer, by decision of the European Community, allowed to subsidize); and
3. Supply capital inexpensively, at highly favorable rates (because it then controlled the banks and other major sources of financial credit).

The case then shows how Government action was critical both to the construction of the new major second airport, Paris/de Gaulle, and to the uniquely successful development of traffic at this site. This success was however only achieved after some 20 years of intense, expensive effort which is unlikely to be duplicated in any other context.

Government role in siting secondary airport

The role of the central government was absolutely crucial in establishing Paris/de Gaulle as the second airport for Paris. In the French tradition, this was decided at the highest levels of government and imposed on the situation, without any meaningful local consultation in the sense that it is understood either in the Netherlands or in the United States or the United Kingdom. (Block, 1975)

Furthermore, the central government was the source of the investment capital, either directly or through the government owned banks of state controlled pension funds. Much of this was at highly preferential rates, such as 3%, well below the rate of inflation. The exact details are unavailable, however, because of the lack of transparency in the accounts publicly available.

Finally, the central government ensured that significant traffic would be present at the new Paris/de Gaulle airport by forcing the government-owned carrier, Air France, to locate there. This decision involved considerable traffic losses for the national carrier, since the French internal traffic remained centered on the primary airport, Paris/Orly, where it then would transfer to foreign airlines, such as Lufthansa, rather than to the national carrier at a distant airport. These traffic losses caused by the displacement to the underutilized new second airport had to be compensated by government subsidies.

Meanwhile, the Government also adopted a policy to favor Paris/de Gaulle by turning Paris/Orly into a second class airport (aeroport bougnole) by focusing Caribbean, African and holiday traffic to this platform

These kinds of efforts are of course unavailable to most governments, that have neither such authoritative powers over land use nor the ability to force airlines to adopt uneconomic policies through force and subsidies.
The case of the development of Paris/de Gaulle thus cannot be taken as a model for other cities or regions.

In the quite long run, these efforts were effective. After about 20 years of these government efforts Paris/de Gaulle now has more traffic than the long-time primary airport, Paris/Orly. When it takes that long for the massive efforts used by the French government to take effect, one can only imagine how long it will take for comparable development of second airports to occur in any other country, whose central government is less directive.
Limits on government role in development

Commercial realities limited the efforts of the French government to develop the second airport of Paris/de Gaulle as it wished. The fact is that Paris/Orly as the primary airport remained more attractive to most passengers and thus to most airlines.

The privately managed major domestic airline, Air Inter, absolutely resisted transferring its operations away from the primary airport. It recognized the huge commercial consequences of moving to the smaller second airport, and would not risk its future.

The judgment of Air Inter that transferring its operations to Paris/de Gaulle would be commercially unsound is being demonstrated by recent developments. The French government has now bought Air Inter-- by merging it with Air France -- and has been transferring much of its operations. The consequence appears to have been two-fold: a drop in traffic for Air Inter, and the replacement of many of its services at Paris/Orly by new independent French airlines and by British Airways, operating by itself and through its subsidiary, TAT.

Effects of Regulated Markets

The actions of the French government favoring the development of the second airport of Paris/de Gaulle have only been possible in the highly regulated markets that have prevailed in Europe (and especially France) until recently. Until the competition rules of the European Community began to liberalize the restrictions, many of the airline routes within Europe, and particularly with respect to France, operated under pooling arrangements whereby the national airlines of two countries, such as France and Spain, would regulate the amount of airline capacity on a route, and would split the revenues.

These pooling and regulatory arrangements shielded the airlines from competition and thus made it possible for them to avoid the competitively induced phenomenon of concentration. Without these arrangements, the airlines would have been motivated to seek advantages over each other, and would have concentrated their traffic to the primary airport.

The effect of regulatory constraints on the development of second airports can perhaps be most easily demonstrated by observing the way economic deregulation has taken traffic away from secondary airports and concentrated it on the primary airports.

The most obvious example of the effect of deregulation on second airports concerns London, where since deregulation the percent of London traffic through the second airport of London/Gatwick has fallen from about 50 to only 40 percent (see London case study).

Another example concerns Edmonton. Since the Canadian deregulation, the share of the Edmonton traffic through Edmonton/International airport dropped precipitously in favor of the more convenient Edmonton/Municipal.
In general, deregulation favors competition and leads to concentration.

Thus the French policy promoting the balance of traffic between the two Paris airports has become vulnerable as greater airline competition develops in the European Community. For example, to the extent that foreign airlines (for example, British Airways) wish to serve Paris/Orly -- which is the airport closer to the majority of Parisian airline travelers who predominantly live in the southern part of the Paris region -- and are now virtually free to do so, it is possible to anticipate a new growth of traffic at the long term primary airport of Paris/Orly.

Toronto

Background

The Toronto multi-airport system consists of 3 active commercial airports:
1. Toronto/Pearson with about 18 million annual passengers;
2. Toronto/Island, a downtown commuter airport with about 0.15 million currently; and
3. Hamilton, which has established itself as a cargo center in recent years, in large part as a result of the night time curfew in place at the main international airport. Hamilton is about 100 km away from the center of Toronto.

Additionally, there is an undeveloped site for the second major airport that was planned in the 1980s, Toronto/Pickering.

Points to be made

Toronto makes an interesting comparison with Amsterdam Airport Schiphol because of its comparable level of traffic.

In a positive sense, the Toronto case is particularly useful because it illustrates the way a specialized form of air transportation (cargo in this instance) can become established at a secondary airport and thus reduce the congestion and the environmental effects of the primary airport.

In a cautionary sense, however, the history of airport development around Toronto illustrates the failure of the government to develop a coherent strategy for the flexible development of second airport facilities, as and when needed. The planners for the putative second airport at Pickering acted as if their only choice was whether to build a major airport. They should have recognized however, as suggested in this report, the value of partial development of the site to ensure its availability for future development.

Niche Markets

Since the early 1990s, Hamilton airport has grown as a center for air cargo for the Toronto metropolitan area. Integrated air cargo carriers serving the Toronto region -- such as Fedex, Purolator and UPS -- have established themselves at Hamilton, to avoid the noise curfews and other restrictions on operations that have been imposed on the main airport, Toronto/Pearson.

This development has been most helpful for the welfare of the community. It considerably reduces the pressure on the main airport, both from the additional traffic and from the reduction of noise in the critical night-time hours. It thus facilitates the rational operation of the main airport.

The integrated air cargo carriers also apparently find this arrangement most convenient. Although the distance between their clients in the Toronto region and

Hamilton airport is generally greater than their distance to the main airport, this inconvenience is compensated by the simplicity of the facilities at Hamilton, and the absence of operational restrictions, that appear to make it cheaper and more convenient for the integrated air cargo carriers to operate out of the secondary airport.

Hamilton in this regard plays a role in the Toronto region similar to that of Los Angeles/Ontario airport in the Los Angeles basin.

This niche market at Hamilton has developed for two reasons:
1. There is a night time curfew at Toronto/Pearson, which makes it impractical for the courier carriers to provide their over night flights at the main airport.
2. The cargo/courier airlines are distinct from the ordinary air carriers and can easily separate their operations. Indeed, they are often better served if they do, which is the reason they seek out secondary airports -- such as Hamilton, Los Angeles/Ontario, or Manila/Subic Bay (a new hub for Fedex).

It should be said that the development of Hamilton airport as a cargo center is not widely known, even in Canada. This is because it is not represented in the aviation statistics issued by Transport Canada. These official data are based on the cargo waybills of general carriers, and therefore unfortunately miss the cargo that comes in all-cargo aircraft with only one client -- the case of the cargo/courier carriers such as Fedex, Purolator and UPS. Thus this very real phenomenon is invisible from the official statistics.

Government role in siting secondary airport

The Canadian government was essential in the identification of a site for a second airport, at Toronto/Pickering. Without the driving force of the government looking ahead toward possible long-term needs, this site would not have been reserved. This occurred in the 1970s, at which time the national Government acquired land for the airport.

However, the Canadian government did not build any airport infrastructure at the site. At present it is undeveloped and functions, as a matter of practice rather than plan, as a nature preserve. After some twenty years in this condition, it seems highly unlikely that Toronto/Pickering will ever develop as a second airport for the Toronto region.

The fact is that the development of this supposed second major airport was launched prematurely, well before the traffic in the metropolitan region could -- on the basis of the worldwide evidence documented in this report -- remotely support two major airports. Once this reality was recognized, the plan to develop the second major airport at Toronto/Pickering was effectively abandoned.

The Toronto metropolitan area was fortunate in this regard that it came to understand the futility of trying to develop a second major airport prematurely before large sums of money were spent on construction. The nearby Montreal metropolitan area was considerably less fortunate.

In Montreal a second major airport, Montreal/Mirabel, was actually constructed prematurely: it now only serves 2 to 3 million annual passengers. The multi-airport system at Montreal is thus economically, operationally and thus commercially inefficient. The forced division of Montreal air traffic, international going to Montreal/Mirabel and domestic and US traffic going to Montreal/Dorval, has made Montreal inconvenient for transfer operations. Passengers, shippers and airlines have thus routed these operations through Toronto, to the general disadvantage of Montreal.

Toronto was fortunate to have the opportunity to observe the consequences of premature and inappropriate development of a multi-airport system close at hand. It thus could avoid the major mistake of premature over investment.

The mistake made at Toronto was that no airport facilities were built at the Pickering site, which thus did not remain credible as a possible airport. The option of eventually developing Toronto/Pickering, as and when needed, thus has been lost. Having recognized the cost of premature investment and abandoned the development of a major facility, the planners failed to recognize the value of making some investments to preserve future options. In effect, the planners threw the baby out with the bath water.

Washington

Background

The multi-airport system around the capital of the United States actually serves two major cities: Washington itself and the city of Baltimore. It consists of three commercial airports:

1. Washington/National, the downtown airport within 3 kilometers of the White House. It is limited to serving medium size and smaller aircraft, and has been processing about 14 million annual passengers for a generation.
2. Washington/Dulles, the “international” airport opened in 1973 (check date). For about the first 20 years it generally served about 3 to 4 million annual passengers. Most recently, United Airlines established a hub at the airport and the traffic has about doubled.
3. Baltimore/Washington airport, between Baltimore and Washington and serving both cities, although mostly Baltimore. For most of the last 25 years it has been the second busiest airport in the Washington metropolitan region.

Points to be made

The Washington case study basically underlines the great difficulty of Governments to force the premature development of second major airports and, in a privatized commercial economy, their virtual inability to do so. Complementarily, it indicates how secondary airports do develop around niche markets, in this case around a hub established by a major airline (United Airlines in this case) that decided to impose itself on the region.

More specifically, the case illustrates:

1. The critical role of the Government in taking the long-term view and creating the possibility of a second major airport;
2. The enormous, virtually insurmountable, difficulty in a free market economy of forcing traffic to develop at secondary site which are not commercially attractive;
3. The economic inefficiency of prematurely large investments in anticipation of traffic; and
4. The role of special, niche markets in developing second airports.

Government role in siting secondary airport

For Washington, as elsewhere, Government action was decisive for the development of the major second airport of Washington/Dulles. In this case, unique for the United States, the US Federal Government played the important role as both owner and provider of capital funds.

The national government was able to play this unique role for the United because the capital area for the city of Washington, the District of Columbia, was basically run by the Federal Government directly. More specifically, the Washington/National airport was run by the US Bureau of National Capital Airports. Elsewhere in the United States, the airports are the responsibility and the property of local administrative entities such as cities, counties or special purpose "authorities".

In the event, about 25 years ago the Federal Government acquired a large area West of Washington, built some magnificent facilities including a 17 mile (27 km.) special purpose motorway solely for the use of the traffic from the outer peripheral motorway (the Washington Beltway) to Washington/Dulles airport (and inaccessible to anyone else!).

All this was only possible because the enormous resources of the national government were available to construct this magnificent facility.

Limits on government role in development

The plan for Washington/Dulles assumed that the traffic would flow naturally to this new facility and that its traffic would soon surpass that of the crowded Washington/National airport. This was not to be, and Washington/National still has 50% more traffic that the Washington/Dulles second airport.

To help the development of Washington/Dulles, the US Federal Aviation Administration set up a "600 mile" ("1000 km") rule, according to which all flights going more than 600 miles from Washington would have to leave from Washington/Dulles (see US FAA, 1992a and preceding versions). All international flights would also have to use this new airport. In principal these rules should have guaranteed that Washington/Dulles would have a lot of traffic. This plan did not work, however.

The airlines recognized that their customers by far preferred to use the easily accessible Washington/National airport, just a few minutes by taxi from all the important government buildings in the capital, and hated to use Washington/Dulles which was not only far away but virtually inaccessible when traffic was low and the frequency of busses or taxis was low. The airlines consequently arranged to circumvent the Federal intentions.

The airlines got around the 600 mile rule by simply scheduling flights to distant points, such as Los Angeles across the continent, via intermediate "stops" at cities within the

limits. At the extreme, they virtually used “touch and go” operations, landing briefly merely for the purpose of meeting the letter of the regulations.

Airlines likewise got around the regulations on international flights by selling international departures from Washington/National with a change of aircraft at some intermediate point. The London flight from Washington/National would operate domestically to Boston, for example, and the passengers for England would deplane, walk across the corridor to the transatlantic aircraft. As recently as 1990, there were more flights to London and Tokyo leaving from Washington/National than from Washington/Dulles. [This has no changed since the longer range aircraft can fly non-stop between these cities, and intermediate stops can be avoided altogether, as they could not previously.]

Furthermore, cities more than 1000 km. from Washington resented having to make technically unnecessary intermediate stops, and exerted political pressure to gain exceptions to the rule. The Mayor of Chicago reputedly got President Kennedy to arrange for an exception, as a token for his support. At any event, within a few years the 1000 km and international rules were virtually meaningless.

The net result of these competitive pressures was that for about 20 years the traffic at Washington/Dulles stayed at a really low level compared to its capacity and compared to that of the Washington/National primary airport. It was between 3 to 4 million passengers a year, compared to the about 14 million for the primary airport.

Problems with over-expensive second airports

The Washington/Dulles second airport was uneconomical. Its traffic was a mere fraction of its capacity. The principle of having a second airport capable of intercontinental aircraft (which cannot use the primary Washington/National airport) could have been established with only one runway and much more modest facilities.

The cost-inefficiency of the original plans for Washington/Dulles are immediately evident on the ground. The private four-lane motorway serving Washington/Dulles is capable of handling 25,000 vehicles per day in either direction, yet it served a modest average of 10,000 passengers a day, many of whom did not go into Washington itself and did not use this motorway.

Niche Markets

The traffic at second airports around Washington illustrate the importance of special markets for developing these facilities.

For most of the past 25 years, the second most active airport around Washington has been the Baltimore Washington International Airport. It owes its success to two major factors. One of these is its geographic accessibility to a major regional market, that of the city of Baltimore, which is comparable in size and population to Washington. More importantly, the Baltimore Washington airport thrived two niche markets: those of being

a hub for US Air and preceding airlines, and for inexpensive flights from the East of the United States to Europe.

A special market has also been key to the recent development of Washington/Dulles. It has become the East Coast hub for United Airlines, complementing its other major hubs at Chicago and Denver. This decision by United Airlines to take advantage of the large unused capacity and excellent facilities at Washington/Dulles, was the factor that doubled the traffic at Washington/Dulles in a couple of years.

Decisions by specific carriers to base operations at second airports is, in general, essential to the success of these facilities. Unfortunately for planners, these decisions cannot be scheduled. Planners should consequently be cautious about developing large capacity at second airports far in advance of any such commitments.

ANNEX 2 -- REFERENCES

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[1] These regulations have been continuously updated over the years, in particular by the provisions starting in 1986 for transferring slot allocations. See the sections 93-13 and -15 (1969), -19 and -20 (1970), -22 (1971), -25 (1972), -27 (1973), -46 (1984). -49 (1986), -57 and -59 (1989), -61 and -62 (1991), -65 and -66(1992), -68 (1993).

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[2] The original rule 93-37 (1981) has been amended many times, for example: -38, -41, -41, -42, -43, -44 (1981); -54 (1986).

ANNEX 3 -- TABLES

[i] Prof. de Neufville has been active in Airport Systems Planning for over twenty years, and has been studying and working on the issue of second airport since the major strategic study for Mexico City. In addition to over 50 research papers and reports, over 130 theses and dissertations and his book on "Airport Systems Planning," he has participated in major airport projects worldwide. Since 1976, Prof. de Neufville has also served as Founding Chairman on the MIT Technology and Policy Program, a graduate program designed to educate young men and women for leadership on policies for technological systems.