

**The Future of Secondary Airports:
Nodes of a parallel air transport network?**

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Abstract

As of 2004, the future of the traditional airlines is at stake. By extension, so is the future for their platforms, their airports. Once air transport became open to unregulated competition, many kinds of innovative companies have challenged the 'legacy' airlines. Whether the innovators focus on passengers (Southwest, Ryanair), integrated cargo (DHL, Fedex) or the airports themselves (Frankfurt/Hahn, Boston/Providence), they fundamentally challenge the traditional business model for airlines. Since the airport business is closely tied to that of the airlines, the presumption must be that the past airport business proposition is also changing.

The paper offers a perspective and presents a unique global set of data on secondary airports. It is based on the observation of their evolution over many years. It includes both the extensive experience in North America, where air transport has been more intensely developed than on other continents, and extended observations of developments in Europe and other continents.

This article suggests that we may be witnessing the development of 3 air transport networks based on distinct airports. These will serve the traditional airlines, the "low cost" carriers, and integrated freight. These networks intersect but, since they have different needs, they will demand and obtain substantial independence. This hypothesis leads to two propositions. The first is that many secondary, "low cost" airports will develop in metropolitan regions, and will undermine many grandiose projects at the major airports. The second is that the development of independent networks will decentralize air transport toward smaller communities, not only to serve these markets, but also to serve the continental market.

The paper closes with suggestions about how existing airport and airline companies might best respond to the possible developments of the innovative, often 'low cost' airlines. In brief, the main thought is that the responsible leaders should coherently support the development of the innovative airlines that may represent their future..

The Future of Secondary Airports: Nodes of a parallel air transport network?

Richard de NEUFVILLE

1. Introduction

Airport and regional planners have traditionally focused their attention on the primary airports associated with major cities, such as Boston/Logan, Frankfurt/Main, and Los Angeles/International. Correspondingly, they have neglected the prospects of secondary airports such as Boston/Providence, Frankfurt/Hahn, and Los Angeles/Ontario. This practice has worked well in the past since the way the airlines concentrate their traffic in markets has meant that secondary airports historically rarely lived up to their expectations – as the case of Montreal/Mirabel illustrates.

However, a new situation seems to be evolving: the development of parallel networks of new airline services, often focused on the secondary airports. The way innovative airlines often concentrate their traffic on the secondary airports may change the situation fundamentally. Airport planners may have to think about the development multi-airport systems in metropolitan areas in new and different terms. To explore this possibility, it is first necessary to think carefully about secondary airports.

Secondary airports in a metropolitan region complement primary airports in metropolitan multi-airport systems. It is thus essential to be precise about what a multi-airport system might be. The following definition is the starting point for this presentation:

"...for the purposes of airport planners and operators, a multi-airport system is the set of significant airports that serve commercial transport in a metropolitan region, without regard to ownership or political control of individual airports." (de NEUFVILLE and ODONI, 2003, p. 132ff):

This definition involves several important points. It:

- focuses on airports serving commercial traffic (and leaves out military bases);
- refers to a metropolitan region rather than a city (and thus may contain several independent cities – such as San Francisco, Oakland and San Jose; or Amsterdam and Rotterdam);

- looks at significant markets (and ignores airports such as Brussels/Liege or Houston/Ellington, serving less than some threshold, for example 300,000 passengers); and
- concerns the total market (not just that portion managed by a specific operator, such as BAA, the London-based airport company).

It may be noted that this definition does not correspond to that of the Airports Council International, whose data reflect their position that "a multi-airport system is an airport operator/authority managing more than one airport within a metropolitan area" (see, for example, ACI 2002). The ACI definition thus excludes London/Luton and London/City from the London multi-airport system. This reflects the fact that ACI obtains its data for member operator/authorities such as BAA. From the perspective of the traveling public and of planners, airports such as London/Luton and London/City definitely do have to be taken into account, as they are here.

Thus defined, multi-airport systems are a significant feature of the airport/airline industry. As of 2001, they already catered to about 1 billion total passengers, well over half worldwide traffic. (de NEUFVILLE and ODoni, p. 134). Their development thus deserves our serious attention. This is particularly so since, as indicated in the next section, the untimely or inappropriate development of multi-airport systems has often led to important financial losses and political embarrassments.

Until recently, multi-airport systems were predominantly a feature of metropolitan areas with the highest levels of originating traffic. Simply put, only the highest levels of locally originating traffic economically justified the existence of second or third airports serving substantial traffic. (Note that high levels of transfer traffic do not promote multi-airport systems, since transfer passengers want to have their connections at the airport at which they arrive. This is a reason that Atlanta only has one commercially significant airport.) Exceptions to this rule have been few; mostly associated with situations such as Buenos Aires in which the primary airport was incapable of handling international or intercontinental traffic, and thus a second airport with longer, wider runways was necessary.

Since the start of the century, however, a new factor appears to be driving the growth of multi-airport systems. This is the development of innovative airlines that connect specialized airports on a wide, sometimes continental scale. These carriers are creating parallel networks of airports, often largely independent of the traditional full-service airports. Low-cost carriers such as easyjet, Jetblue, Ryanair, Southwest, and Westjet seem to be major builders of these new multi-airport

systems. Integrated cargo carriers such as DHL, Fedex, and UPS are adding to this new momentum.

This development already appears to have major implications for airport planning and development. This presentation attempts to define what is happening, and to explore the possible consequences of this phenomenon. The logic of the argument is as follows:

- section 2 motivates the discussion by underlining the numerous, expensive failures in the planning and implementation of multiple airport systems;
- section 3 details the alternative conceptual models that have driven airport planning, the “market concentration” model that recognizes the decisive role of competitors in markets, and the “catchment area” model that focuses narrowly on traffic attractors;
- section 4 provides extensive documentation of the current situation for multi-airport systems worldwide;
- section 5 then evokes the current trends in the development of parallel networks for airline services, that promote the development of secondary airports;
- section 6 illustrates this phenomenon in major important regions worldwide; and
- sections 7 and 8 suggest the implications of these events and offers recommendations as to how future planning processes could deal with them intelligently.

2. Motivation: The Planning Problem

Worldwide, airport owners and planners have made many mistakes in implementing the development of multiple airport systems. All too frequently, major second airports were built prematurely. This resulted in highly visible “white elephants” embarrassing to their owners. These projects often did not earn enough to justify their significant capital costs, and thus represented significant drains on the economy and losses to the owners and operators.

A few examples of the problematic development of multi-airport systems make the point (see de NEUFVILLE, 1965a, for some more discussions). Consider the following cases:

- Montreal: For this city with less than 10 million annual passengers, the Canadian national government built the Montreal/Mirabel airport with the largest area in the world. It forced intercontinental carriers to use this facility while leaving domestic carriers at the close-in Montreal/Dorval airport. This policy deprived the intercontinental carriers of the possibility of easy onward domestic connections and gave them the incentive to relocate flights to Toronto. Montreal/Mirabel thus became the epitome of the underused second airport. Shortly after the Aéroports de Montréal took over the operation of the Montreal airports, around 2000, it effectively closed Montreal/Mirabel, allowing airlines to regroup at Montreal/Dorval. By 2004, the Montreal multi-airport system no longer exists.

- Washington, DC: Washington/Dulles airport was similarly built prematurely. Originally intended to supplant Washington/Reagan as the dominant airport for the capital, it was vastly underused for its first two decades. It catered to only about 3 million annual passengers over most of that period, whereas both Washington/Reagan and Baltimore/Washington each had about 14 million annual passengers. Washington/Dulles only grew to that level after United Airlines established a transfer hub there in the mid 1990s. Before then, it represented an architectural masterpiece but a financial failure.
- London, UK: The UK British Airports Authority built London/Stansted to be a major reliever to the traffic pressures on the primary airport at London/Heathrow. It was not able to achieve that role. For most of its first decade, its traffic languished at around 5 million annual passengers or about 1/10th of the number at the primary airport. More recently, as it has become a center for low-cost airlines (along with London/Luton airport), its traffic grew considerably. Nonetheless, London/Stansted has still been largely underutilized and its mid-field concourses are empty fairly consistently. Meanwhile, traffic at the primary airport London/Heathrow has grown remarkably and is over 3 times as large as London/Stansted.
- Brazil: The national government built substantial international airports as replacements for the in-town airports of its major cities. These new airports, Sao Paulo/Congonhas, Rio de Janeiro/Galeao and Belo Horizonte/Confins, have not substituted for the older airports, however. The in-town and international airports at San Paulo and Rio de Janeiro have about as many annual passengers, while the international airport at Belo Horizonte only has about half a million passengers compared to the two and a half of Belo Horizonte/Pampulha (INFRAERO, 2002).
- Similar accounts can be given of second airports at Buenos Aires, Edmonton, London, Milan, New York, Osaka, Paris, and San Francisco. The problem of premature, over-investment in secondary airports, with the associated big financial losses, exists worldwide.

Airport and aviation planners need to get their policies right on secondary airports. Poorly timed, poorly conceived major investments do not serve their regions well. We need to understand how and why second airports develop successfully.

3. Alternative Models of Airport Traffic

Two models of airport access dominate planning processes:

- The “catchment area” model reflects the notion that passengers choose airports as rain chooses where to flow – strictly according to where the attraction is greatest or the resistance least.

- By contrast, the “market concentration” model recognizes that service providers, in this case the airlines, play an important – often decisive -- role in channeling passengers to airports. They do this specifically by choosing where to locate their services according to a competitive logic that typically trumps notions of aggregate social welfare.

The point of this section is to underline the fact that catchment area models of the distribution of traffic between airports, and thus of the future of secondary airports, are inadequate. Traditional views fail to recognize that disruptive effect of new airlines. Planners need to appreciate the way airlines concentrate around markets, and thus appreciate the potential of innovative airlines to establish poles of attraction around secondary, often previously neglected, airports.

3.1 The Market Concentration Model: Recognition of the two-way competition for market share between airlines and airlines, and between airports and airports, is essential to the proper understanding of multi-airport systems. As FRUHAN (1972) demonstrated empirically -- all else being equal -- the airline with the higher frequency share gets a disproportionately higher market share. The result is that airlines tend to match flights in any given market -- or to withdraw since the competition is too disadvantageous to them when they only have a small fraction of the frequency offered. Airlines with low frequency shares on a route only remain active if they represent a special niche market, as might be defined by a national affinity group or special low-cost service. (see NEUFVILLE and ODONI, 2003) This dynamic that impels toward market concentration or withdrawal is a specific manifestation of a general phenomenon widely apparent in the location of economic activities, as seminally described by LÖSCH, 1967.

When airlines compete over several airports in a market, the market concentration phenomenon extends to where they locate their flights. Airlines tend to concentrate their flights at the primary airport in their market, as well as on a route (de NEUFVILLE and GELERMAN, 1973). The phenomenon can be understood intuitively by considering how any airline might locate an extra flight in a market. The airline will get the most advantage from such a marginal flight by grabbing onto a larger share of a major market, so it will place this flight at the primary airport. Competitors will do the same, and thus the concentration in specific markets. When there is a single unified market, as there was when the airline markets were strictly regulated, then the airlines concentrated their services at primary airports and refused to serve secondary airports that regional planners developed to serve a region. Thus, London/Stansted -- conveniently located geographically -- has never attracted traffic from the traditional, “legacy” airlines.

In this context, secondary airports achieve considerable size when they each serve distinct markets. Thus Paris/Orly vis-à-vis Paris/de Gaulle has had the role of serving specific regions

(Africa and the Antilles) and types of traffic (low fares on Air Inter, as long as that existed). Comparably, London/Gatwick historically developed around cheap fares (Laker and British Caledonian) and allocated markets (South America and West Africa). Likewise in the United States: for example, New York/Kennedy served intercontinental traffic and its feeder services; New York/LaGuardia catered to short-haul traffic; and New York/Newark (now designated as New York/Liberty) was largely empty until it grew as a low-fare center under Peoples Express and then morphed into a hub around Continental Airlines.

3.2 Catchment Area Model: The catchment area model implies that passengers drive the frequency, such that the most convenient airports will have the most traffic. It has been the primary basis for the majority of analytic models for the distribution of passengers to airports. (HARVEY 1987; FUROISHI and KOPPELMAN, 1994) Why this fixation persists is unclear. The observable fact has been that the catchment area model does not describe actual experience, as demonstrated by the cases of London/Stansted in its first decade, and many others. For example, although San Francisco/Oakland is more convenient than San Francisco/International for almost half the passengers around the San Francisco Bay, for decades it only had a fraction of this traffic. Similar statements can be made for Paris/Orly, for New York/Newark before 1980, and for Washington/Dulles until the mid 1990s.

3.3 Comparison: The “market concentration” model is fundamentally different from the common “catchment area” model that passengers and traffic simply flow to the most convenient or attractive airport. Although people obviously do choose convenient airports, there is a vast difference between the two models. The market concentration model, that incorporates the competition between airlines for markets, stresses the importance of airline decisions that ultimately force the passengers to go to the airports at which airlines concentrate their traffic.

The “market concentration” model also stresses the critical importance of markets. When an airline establishes a market that is significantly different from those offered by other airlines, it will be able to concentrate its services at different airports. Thus, the airlines providing the innovative low cost or integrated freight services can – and do – concentrate their traffic at alternative airports, most notably at secondary airports in metropolitan areas.

The market concentration model stressing the importance of airline behavior has the further advantage of being able to account for frequent trend-breaking instances when airline decisions propel the sudden rapid growth of an airport. Thus Manchester/Liverpool grew in a few years from about nothing to over 3 million annual passengers once easyjet developed operations there. Likewise, Boston/Providence grew from about 1 to over 4 million annual passengers in only a few

years because Southwest decided to open a new, low-cost market. Similar airline decisions account for the rapid changes in traffic at Brussels/Charleroi and Washington/Dulles, when Ryanair and United respectively established hubs at these sites.

The market concentration model also implies that secondary airports can gain importance when airlines no longer see further advantage in concentrating their flights. This occurs, for example, when the local level of traffic is sufficiently high so that an airline has little to gain by placing an additional flight at the primary airport, and more to gain by serving the secondary airport. Experience confirms this prediction, as the next section documents.

4. Current Status

The phenomenon of “market concentration” implies that secondary airports should be relatively rare, since airlines concentrate their traffic at primary airports. Consequently, although various airfields might exist in a metropolitan area, many of these will not be able to attract traffic to become serious secondary airports. Thus, in general it has been difficult for regional planners to develop successful secondary airports. The largely empty airports of Montreal/Mirabel and St.Louis/Mid-America are salient examples of this reality.

Nonetheless, secondary airports in metropolitan areas are common. Over the past generation, all metropolitan areas generating more than a threshold level of local originating passengers have significant secondary airports (See Table 1). This phenomenon has persisted over the last 30 years at least. The explanation for this result is that, past some frequency of service, there is little possibility to increase market share by adding flights at the primary airport. Airlines can then exploit the locational advantages of secondary airports and distribute service to these facilities.

What has changed is the level of the threshold. In the early 1970s it was around 8 million annual originating passengers. It has been steadily rising, along with the average size of the aircraft (see de NEUFVILLE 1986, 1990, 1994). A reasonable explanation for this observation is that, when airlines use larger aircraft, as they have done over the years, it takes more originating traffic to reach the level at which increased concentration is not worthwhile.

A few metropolitan areas have had significant second airports even though the total originating traffic from the metropolitan area was less than the threshold (See Table 2). Until recently, these multi-airport systems owed their existence to one of two causes:

- technical: the popular in-town airport did not have runways long enough to serve long-distance aircraft (examples: Belfast, Belo Horizonte, Rio de Janeiro, Taipei);

- political: Some political or military rationale required the development of two airports in a metropolitan region (examples: Berlin, Köln/Bonn, and Moscow).

Table 1: Metropolitan Regions with more Originating Passengers than the Threshold having significant Multi-Airport System (Most recent data, 2002 and 2003)

| Metropolitan Region | Traffic in Millions | | Multi-Airport System |
|----------------------|---------------------|-------------------|----------------------|
| | For Region | Originating (Est) | |
| London | 120 | 47 | Yes |
| Tokyo | 84 | 36 | Yes |
| New York | 84 | 35 | Yes |
| Los Angeles | 75 | 31 | Yes |
| Paris | 72 | 28 | Yes |
| Chicago | 94 | 24 | Yes |
| San Francisco | 53 | 22 | Yes |
| Miami | 50 | 19 | Yes |
| Hong Kong | 47 | 19 | Yes |
| Washington/Baltimore | 47 | 19 | Yes |
| Seoul | 38 | 17 | Yes |
| Osaka | 35 | 16 | Yes |
| Shanghai | 30 | 15 | Yes |
| Boston | 31 | 14 | Yes |
| Atlanta | 75 | 14 | |
| Frankfurt | 49 | 12 | Yes |
| Las Vegas | 33 | 12 | |
| Sao Paulo | 25 | 12 | Yes |
| Dallas/Fort Worth | 55 | 12 | Yes |
| Milan | 27 | 12 | Yes |
| Taipei | 26 | 12 | Yes |
| Orlando | 30 | 12 | Yes |

Source: de NEUFVILLE Multi-Airport Systems database drawn from various reports.

Estimated Originating passengers = (Total Passengers - Estimated Transfers) / 2

More recently, low-cost carriers have catalyzed the development of a number of secondary airports in metropolitan regions that otherwise would not feature such facilities. Table 2 also lists these situations. In such cases, the low-cost airlines have created a separate market, distinct from that existing at the primary airports, and thus are not affected by the dynamic of the concentration model.

Table 2: Metropolitan Regions fewer Originating Passengers than the Threshold having a secondary airport serving at least about 1 million passengers (Most recent data, 2002 and 2003)

| Metropolitan Region | Traffic in Millions | | Second Airport | Reason for Second airport |
|---------------------|---------------------|-------------------|-----------------------------|---------------------------|
| | For Region | Originating (Est) | | |
| Manchester (UK) | 25 | 11 | Liverpool Leeds/Bradford | easyjet |
| Houston | 39 | 10 | Hobby | Southwest |
| Rome | 26 | 10 | Ciampino | Ryanair; easyjet |
| Moscow | 21 | 10 | Domodedovo Vnukovo | Political |
| Düsseldorf | 20 | 10 | Köln/Bonn | Political |
| Glasgow | 18 | 8 | Edinburgh | Political |
| Stockholm | 18 | 9 | Bromma | Historical |
| Brussels | 16 | 8 | Charleroi | Ryanair |
| Copenhagen | 20 | 7 | Malmö | Ryanair |
| Oslo | 14 | 7 | Torp | Ryanair |
| Berlin | 13 | 6 | Schönefeld | Political |
| Buenos Aires | 13 | 6 | Aeroparque | Technical |
| Rio de Janeiro | 11 | 5 | Santos Dumont | Technical |
| Belfast | 6 | 3 | City | Technical |
| Belo Horizonte | 3 | 2 | Confins | Technical |

Source: de NEUFVILLE Multi-Airport Systems database drawn from various reports.

Estimated Originating passengers = (Total Passengers - Estimated Transfers) / 2

Table 3: European Metropolitan Regions with Secondary Airports significant due to the Traffic of Low-Cost airlines.

| Metropolitan Region | Secondary Airport | Low-cost Airline |
|----------------------------|--------------------------|-------------------------|
| London | Stansted | Ryanair |
| London | Luton | easyjet |
| Paris | Beauvais | Ryanair |
| Frankfurt | Hahn | Ryanair |
| Brussels | Charleroi | Ryanair |
| Milan | Orio al Serio | Ryanair |
| Manchester (UK) | Liverpool | easyjet |
| Rome | Ciampino | easyjet, Ryanair |
| Stockholm | Skvasta | Ryanair |
| Oslo | Torp | Ryanair |
| Glasgow | Prestwick | Ryanair |
| Copenhagen | Malmö | Ryanair |
| Hamburg | Lübeck | Ryanair |

Source: de NEUFVILLE Multi-Airport Systems database drawn from various reports.

Table 4: Non- European Metropolitan Regions with Secondary Airports significant due to the Traffic of Low-Cost airlines.

| Metropolitan Region | Secondary Airport | Low-Cost Airline |
|----------------------------|--------------------------|-------------------------|
| New York | Islip | Southwest |
| Miami | Fort Lauderdale | Southwest |
| San Francisco | Oakland | Southwest |
| Boston | Providence | Southwest |
| Boston | Manchester (NH) | Southwest |
| Dallas/Fort Worth | Love | Southwest |
| Houston/Galveston | Hobby | Southwest |
| Los Angeles | | Jetblue |
| Toronto | Hamilton | Westjet |
| Vancouver | Abbotsford | Westjet |
| Melbourne (Australia) | Avalon | Jetstar |

Source: de NEUFVILLE Multi-Airport Systems database drawn from various reports.

Low-cost carriers have also developed secondary airports in the metropolitan areas with the highest levels of originating traffic, those that in any case can be expected to have significant multi-airport systems. Tables 3 and 4 provide details. By documenting the number and distribution of these facilities, they also make the point that low-cost airlines have been significant in the development of secondary airports on a continental scale. In the United States, the association between low-cost carriers and a network of secondary airports dates to the beginning of Southwest, when it began operations between Dallas/Love and Houston/Hobby in the mid 1970s. In Europe, this relationship became significant in the 1990s, with the development of airlines such as Ryanair and easyjet.

The innovative cargo carriers, such as DHL, Fedex and UPS, have also recently contributed to the development of secondary airports, both in metropolitan regions and on a continental scale. Tables 5 and 6 provide details.

5. New Phenomenon: Parallel Network of Airline Services

Parallel networks of airline services are developing in major markets worldwide, alongside the traditional range of full-service airline operations that connect the major airports of the world. Innovative airlines are deliberately developing systems of services based on smaller airports.

These parallel networks have important features that distinguish them from the traditional airline services:

- distinct products, such as “low-cost” passenger or integrated cargo services;
- lack of connectivity with the traditional full-service airlines;
- operations generally focused on uncongested, low-cost airports; and thus
- distinct geographical networks with links that traditional full-service airlines do not duplicate.

The innovative airlines have established separate market niches for themselves. This is most obvious for the integrated cargo carriers (such as Fedex and UPS) who offer seamless, door-to-door service very different from the multi-vendor cargo service customers procure through freight forwarders, airlines and brokers for insurance and customs.

Table 5: Metropolitan Regions with Secondary Airports with significant Cargo Traffic.

| Metropolitan Region | Secondary Airport | Integrated Cargo Carrier |
|----------------------------|--------------------------|---------------------------------|
| Chicago | Rockford | UPS |
| Los Angeles | Ontario | UPS |
| San Francisco | Oakland | Fedex |
| Manila | Subic Bay | Fedex |
| Toronto | Hamilton | UPS, Fedex |
| Brussels | Liege | TNT |

Source: de NEUFVILLE Multi-Airport Systems database drawn from various reports

Table 6: Regional Secondary Airports significant due to Cargo Traffic.

| Region | Secondary Airport | Freight Carriers |
|------------------|--------------------------|-------------------------|
| US Mid-continent | Memphis | Fedex |
| US Mid-continent | Louisville | UPS |
| US Mid-continent | Dayton | Fedex |
| US Mid-continent | Cincinnati | DHL (to 2004) |
| US Mid-continent | Wilmington, Ohio | DHL (after 2004) |
| US Mid-continent | Indianapolis | Several |
| Pacific Gateway | Anchorage | Several |
| Europe Gateway | Prestwick | Several |
| Europe Gateway | East Midlands | Several |

Source: de NEUFVILLE Multi-Airport Systems database drawn from various reports

The low-cost passenger airlines also have their own market niches. These carriers are typically far from cheaper-fare versions of the conventional airlines (although there are exceptions, such as Virgin, Virgin Blue in Australia, and JetBlue). They offer specialized services that make no pretence of competing for business travelers and others that require flexible schedules, complicated routings and connections with other airlines. Their strength is low-cost, point-to-point travel. Although business travelers may use low-cost carriers, and many vacationers choose them once they have the opportunity, these airlines offer such a different service it is possible to say that they do not compete head to head with the traditional versions of full-service airlines. Most importantly from the perspective of secondary airports, the low-cost airlines appear to be almost immune to frequency competition with the full-service airlines, and are thus not subject to disproportionate low market shares if they offer low frequency to their destinations.

The innovative carriers are largely disconnected from the full-service airlines. This is most obvious for the integrated cargo carriers that operate their own aircraft, often from airports they dominate. These carriers schedule the bulk of their flights at night – a pattern totally different from that of the passenger airlines -- so that they can provide over-night service from one business day to the next. The integrated cargo carriers thus are completely independent operationally from the traditional national carriers.

The importance of the integrated cargo carriers needs to be stressed. Their networks are so distinct from those of the traditional carriers that they are largely invisible, even to sophisticated transportation planners. Most obviously, the leading integrated cargo carriers are among the largest airlines in the world. Thus in 2003, Fedex had 339 jet aircraft, ranking 7th worldwide in terms of the size of its fleet, and having more than Lufthansa and British Air. Similarly, UPS ranked 11th and operated 257 jets – more than Air France and Air Canada. (IATA, 2004) More importantly perhaps, they are clearly the richest airlines in the world. Compared to the traditional passenger airlines, their value is 10 to 100 times greater! UPS is about 10 times more valuable than the most important conventional airline, Singapore. Fedex is 50% more valuable than Singapore, British, Lufthansa and Air France together. (See Table 7.)

In this connection, it can be mentioned that the innovative, “low cost” passenger carriers are also financially powerful. As Table 7 indicates, Southwest is the most valuable passenger airline, with a market capitalization 20% more than that of Singapore Airlines. In general, many of innovative airlines are more valuable than their closest traditional carriers: Ryanair is more valuable than British Air (as it has been since about 2002); Westjet is more valuable than either of the traditional Canadian airlines – Canadian has disappeared and Air Canada is bankrupt.

Table 7: Market Capitalization of Airlines
(price per share times number of shares)
In Billions of US Dollars, March 2005
(Innovative Carriers in Bold Face)

| Airline | Value | Airline | Value |
|--------------------|--------------|-----------------|--------------|
| UPS | 86 | easyjet | 1.7 |
| Fedex | 30 | American | 1.4 |
| Southwest | 11 | Japan Airline | 1.1 |
| Singapore | 9 | Alaska | 0.8 |
| Ryan Air | 7 | Air Tran | 0.7 |
| British | 6 | Continental | 0.7 |
| Lufthansa | 5.5 | Northwest | 0.6 |
| Air France | 5.1 | Delta | 0.6 |
| Jet Blue | 1.9 | Westjet | 0.4 |
| Virgin Blue | 1.7 | | |

Sources: google.com; investing.reuters.co.uk; yahoo.finance

Low-cost passenger carriers also typically operate independently of the full service airlines. Most obviously, they often simply do not exist in the standard airline reservation systems. To access their services, it is generally necessary to approach them directly, through the web. Low-cost airlines save money by eliminating commissions to travel agents and international airline reservations systems (from 5 to 10% of the ticket price, typically). Correspondingly, it is as if they did not exist to travel agents and their customers. For example, inquiries to a major travel agent in 2003 about flights from London/Stansted to Amsterdam met with assurances that there were none. In fact, however, Buzz then provided frequent daily direct flights. In short, in order to use the low-cost airlines, one can expect to access them by completely different portals. One enters a parallel travel universe with no travel agents, few paper tickets and no interconnections to other airlines.

In great part, innovative carriers achieve low costs by operating out of uncongested airports. Lack of congestion reduces aircraft delays and the immediate wasted costs of crew and other direct operating costs. It also reduces the padding of the schedules to allow for delays, thus enabling the airline to schedule more flying time per day. Low charges for airport services at uncongested secondary airports are of course immediately beneficial. This means that low-cost

airlines consciously avoid showcase facilities such as Milan/Malpensa, Oslo/Gardemoen, or Vancouver/International and serve modest --even primitive -- facilities such as Milan/Orio al Serio, Oslo/Torp, and Vancouver/Abbotsford. Conversely, a number of airport authorities consciously do not want to cater to the low-cost carriers, preferring to maintain an image as a full-service, up-market airport. The leaders of Hamburg airport, for example, have explicitly stated this position. They chose not to offer Ryanair low-cost facilities -- with the consequence that Ryanair decided to serve neighboring Lübeck instead.

All these factors lead the low-cost airlines to adopt a geographical network that parallels but is substantially different from the traditional networks of the conventional airlines. For example, Ryanair offers service between London, Brussels and Frankfurt via London/Stansted, Brussels/Charleroi and Frankfurt/Hahn instead of through London/Heathrow, Brussels/Zaventem and Frankfurt/Main. Likewise, Southwest will fly you from "Washington" to "Boston", via Baltimore, Manchester or Providence.

6. Regional Cases

The evolution of the parallel airlines networks differs from region to region. This section sketches out these some of these differences.

6.1 European Community: Ryanair, as of 2005 the major low-cost airline in Europe, focuses on serving small secondary airports such as Brussels/Charleroi, Frankfurt/Hahn, and Paris/Beauvais. As Table 4 indicates, it focuses on secondary airports around all the major cities it serves. Although it is only about a decade old in 2005, and thus not fully established, it looks as if it has a good chance to mimic the success of Southwest in the United States (see below).

Easyjet is another major low-cost European airline. It serves somewhat different destinations than Ryanair. Although in England it operates out of secondary airports such as Manchester/Liverpool, London/Luton, and London/Stansted, on the Continent it chooses to offer service into major airports such as Munich, Paris/de Gaulle and Paris/Orly. So its network is more integrated into the established network. Yet its operations are still quite distinct. For example, it sells tickets exclusively through the Internet. Perhaps its business model will be more effective than Ryanair's over the long term. In any event, it is clearly another form of parallel network compared to those of the established full-service airlines.

6.2 United States: Southwest Airlines is the acknowledged role model for low-cost carriers in the rest of the world. It began with service within Texas between two secondary airports that had been abandoned by the majors when they moved to new world-class facilities at Dallas/Fort

Worth and Houston/Bush. Southwest served Dallas/Love and Houston/Hobby. They have maintained this pattern of operating to secondary airports to the extent possible, as Table 4 indicates. While Southwest has been a low-cost airline, it is far, far from insignificant. As of 2003, it was the 4th largest airline in the world in terms of passengers carried (IATA, 2004).). In March 2005 it had a market capitalization of about US\$11 billion, about 20% greater than that of the next most valuable passenger airline in the world (Table 7).

Southwest is not the only low-cost carrier in the United States. As of 2004, there are also AirTran, JetBlue and Spirit. One or more of these may emerge as a major regional or national force and offer substantial head-to-head competition to Southwest, of the kind it had not experienced as of 2005.

Alongside the parallel passenger network, the US integrated cargo companies operate their own networks distinct from those of the traditional national carriers. For example, Fedex serves the West Coast of the United States through its mid-continental hub in Memphis onto San Francisco/Oakland – with onward service through its Pacific Rim hub at Manila/Subic Bay. Similarly, UPS serves West Coast clients via Louisville and Los Angeles/Ontario.

6.3 Canada: Westjet is the Canadian version of Southwest. Indeed, the company models itself explicitly on the American prototype (Westjet, 2002). Founded in 1996, it has grown impressively. According to company press releases it had flown over 3.5 billion passenger seat miles in 2002. As with Southwest, it has pioneered the development of secondary airports in major markets, such as Vancouver/Abbotsford and Toronto/Hamilton.

6.4 Brazil: The country features a triangular pattern of airports connected by domestic airlines distinct from the international services. The three most populous metropolitan areas in Brazil -- Sao Paulo, Rio de Janeiro and Belo Horizonte -- each have a substantial multi-airport system. Through a legacy of aeronautical and political evolution, each has a fairly similar structure: a short runway 'downtown' airport complemented by a major international, intercontinental airport some distance away from the city. (See Table 8) The situation for each city is similar to that of Washington/Reagan and Washington/Dulles, or Milan/Linate and Milan/Malpensa.

Table 8: Pairs of Airports serving the major cities of Brazil (2001 Data)

| Metropolitan Area | Internat'l Distant Airport | | Domestic Close-in Airport | |
|-------------------|----------------------------|------------------|---------------------------|------------------|
| | Name | Traffic Millions | Name | Traffic Millions |
| Sao Paulo | Garulhos | 13.0 | Congonhas | 11.7 |
| Rio de Janeiro | Galeao | 6.0 | Santos Dumont | 4.9 |
| Belo Horizonte | Confins | 0.8 | Pampulha | 2.5 |

Source: INFRAERO, 2002; Rabbani, 2002

Table 9: Top Domestic Brazilian Markets (1st semester, 2002).

Downtown airports in Bold Face.

| Airport Pair | | Passengers, 1000s | Rank |
|----------------------|----------------------|-------------------|------|
| Congonhas | Santos Dumont | 1461 | 1 |
| Congonhas | Brasilia | 596 | 2 |
| Congonhas | Pampulha | 565 | 3 |
| Congonhas | Curitiba | 551 | 4 |
| Congonhas | Porto Allegre | 365 | 5 |
| Garulhos | Salvador | 364 | 6 |
| Santos Dumont | Brasilia | 325 | 7 |
| Santos Dumont | Pampulha | 312 | 8 |

Source: INFRAERO, 2002, Rabbani, 2002

Each of Brazil's multi-airport systems appears to have followed a similar development:

- the downtown airport developed in the 1930s and during World War II;
- the new international airports opened around 1985, and were largely seen as replacement airports; but
- regional commercial and political pressures led to the award of routes between the downtown airports in the early 1990s; which unleashed
- tremendous growth at the downtown airports to the point where, as of 2001, they rivaled and even surpassed the international airports in terms of the number of passengers. Specifically, Sao Paulo/Confins grew 6 fold in the 7-year period from 1994 to 2001, going from around 2 to nearly 12 million passengers annually. Similarly, Belo Horizonte/Pampulha grew about 10-fold, from around 0.2 to 2.5 million, over that decade.

The three downtown airports in these multi-airport systems constitute, in effect, a separate network of passenger traffic, independent of their complementary international airports. Moreover, the flows on this network of physically small airports dominate the domestic traffic in the country, as Table 9 indicates. By contrast, the domestic traffic from their complementary international airports is not significant.

This is truly a remarkable situation: traffic between the major international gateways and the other large Brazilian cities is not significant. The only real way to connect between cities is by using the downtown airports. It is as if there were almost no flights between Paris/de Gaulle and Milan/Malpensa; as if the only way to travel between these cities were to fly between Orly and Linate, for example. However, while this situation is remarkable, it is not unique. A parallel situation exists in Japan, where there are virtually no domestic flights from the international gateways of Tokyo/Narita and Osaka/Kansai, and all the air traffic between these cities continues to be between Tokyo/Haneda and Osaka/Itami.

6.5 Australia: The inauguration of low cost carriers in Australia appears to be catalyzing the development of new low cost airports. Thus Melbourne/Avalon has grown to serving about 60,000 passengers a month (a rate of about 750,000 a year) within a year of the startup of Jetstar. Along the same lines, Coolongatta airport which is close enough to Brisbane to be its second airport, has renamed itself as the Gold Coast airport and committed itself to be the “leisure” (that is, low cost) airport for the region.

7. Implications

The innovative carriers have shown rapid growth and had great economic success. From 1995 through 2003, Southwest grew at compound rate of 12.3% to where it became the 4th largest airline in the world in terms of passengers carried, serving about 50% more clients than either Air France or Lufthansa, and twice as many as British Air (data from IATA 2004 and earlier versions). In contrast, many full-service airlines have stagnated in terms of their traffic and gone into bankruptcy (such as Air Canada, Sabena, Swissair, United, US Airways). These comparative trajectories imply that the parallel networks of aviation services of the innovative airlines are likely to become relatively stronger and more important. They may even go from being interesting but marginal networks to being a major alternative over the next generation. This possibility might completely alter the trends in airport use and our expectations for the future of airport development and airport services.

If the parallel networks for aviation services being developed by the innovative carriers equal that of the full-service airlines, we could imagine some of the following scenarios:

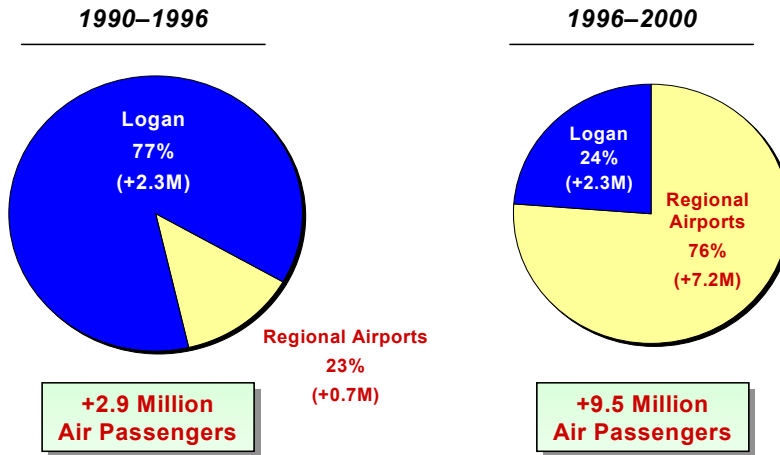
- passenger traffic in metropolitan areas would shift, away from congested expensive facilities such as San Francisco/International and toward low-cost competitors such as San Francisco/Oakland. This has already occurred to some extent. Data for the New England region around Boston illustrates the comparable shift from Boston/Logan to Boston/Providence and Boston/Manchester (see Figures 1 and 2).
- the growth of several major airports could decline or cease, as airlines and passengers demand lower cost facilities at alternative sites.
- conversely, we could expect to see increased and rapid growth at many of the less significant airports, as other secondary airports experience rapid growth similar to that of Manchester/Liverpool, or London/Luton.

These scenarios may not now appear to be the most likely outcome. However, they are entirely possible. They do not require extravagant projections from the current patterns of growth of Southwest and Ryanair, and collapses of airlines such as United, US Airways, Sabena, Swissair, and Olympic. Indeed, as Figures 1 and 2 illustrate, these scenarios may already be occurring.

The fact that the most dynamic, and most financially powerful, carriers are developing parallel networks based on secondary airports poses a significant challenge to the established major airports. In some ways, this challenge might be as stressful as the challenge the innovative airlines have presented to the traditional airlines. Indeed, the established airports have to deal with the fundamental fact that, in contrast to the traditional airlines, they can neither re-deploy nor sell off their capital assets. Whereas airlines can react to the innovative carriers by allocating their flights to different routes or rapidly changing the character of their capital base by buying or selling aircraft, such moves are impractical for airports. Airports cannot reposition their runways or buildings. Airports cannot rapidly build new conventional passenger buildings. Over any short or medium term, airports have to work with the assets they already have. This means that airports are stuck with inescapable, generally high cost structures.

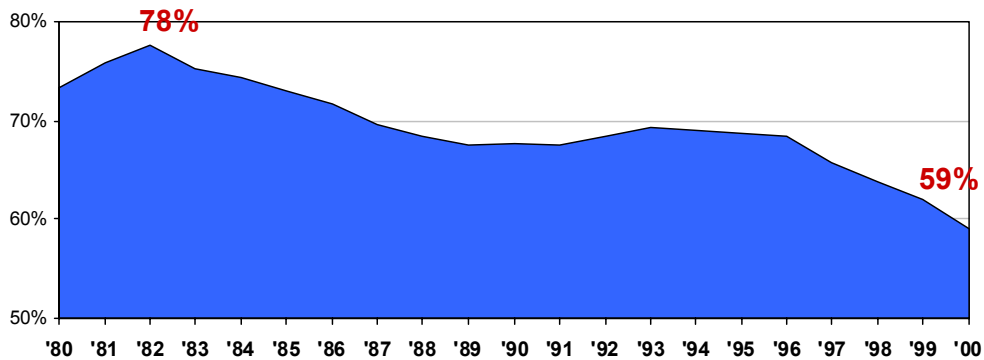
What should the major established airports do to confront this possible challenge?

Figure 1: New England traffic growth shifted from Boston/Logan to Regional Airports along with growth of Southwest at Providence and Manchester (NH) [Source: Louis Berger, 2002]



Regional airports include Providence, Manchester, Worcester, Bangor, Burlington, Hartford, New Haven, and Portland.
 Source: Airport Records and US DOT, Form 41 schedules.

Figure 2: The Boston/Logan traffic share dropped by a quarter over the past 20 years; half of this occurred with the Southwest growth in the late 1990s at Providence and Manchester (NH) [Source: Louis Berger, 2002]



Note: Includes enplaned passengers at Logan, Hartford/Bradley, T.F. Green/Providence, Manchester, Portland, Burlington, Bangor, Tweed New Haven, and Worcester.

Source: US DOT, Form 41 and Part 298/C. Airport records for Logan and various regional airports.

8. Recommendations

The most basic recommendation is that all those concerned with airport planning, design, and management anticipate the possibility that secondary, “low cost” airports will become homes to financially powerful, “low cost” (and thus highly competitive) airlines that will draw traffic away from the established traditional primary airports. The established airports would then be left with high costs, diminishing markets, and thus potentially spiraling increases in average costs relative to those of the “low cost” airports. In short, they would face the same kinds of problems as the traditional carriers have been confronting when dealing with the “low cost” carriers. They may even experience something similar to bankruptcy, as Pittsburgh airport has had to deal with when US Airways – itself in bankruptcy -- abandoned it as a hub.

Good planning does not wait until a problem is visible to all. Responsible planning recognizes the possibility of challenges, even if remote, and develops strategies to deal with them if they come. Just as architects design sprinkler systems into buildings, to protect their structures from the unlikely possibility of fire, so good planning and management will develop contingency plans against threats.

As regards the possible development of parallel air transport networks that might take traffic away from an established airport, what might suitable contingency plans be? The answer must depend on the perspective. From that of the owners of established airports, a migration of their traffic to alternative platforms could be financially threatening, especially if the established airports are left with legacy carriers that are financially weak. Conversely, however, local authorities and communities might benefit from greatly from such a shift. For example, the expansion of Ryanair that has been problematic for Brussels/Zaventem has been a boon for Brussels/Charleroi. To the extent that there are planning authorities responsible for major regions or national interests – which is effectively not the case in many countries -- these tensions create delicate issues. Moreover, any realistic consideration of these issues has to recognize that these overarching organisms may have quite different abilities to influence outcomes, depending on their legal authority, their financial strength, and their ability to influence unregulated commercial interests. Let us consider suggestions for each of these distinct groups.

8.1 Operator Owners of Major Airports: In general, the planners and managers of major airports can face the challenge of a restructured air transport system both proactively and defensively. They can take steps both to reduce the likelihood that the innovative carriers will want to go the effort of establishing themselves at secondary airports, and to minimize the consequences to their operations if the secondary facilities do develop substantially.

Anything the operators of major airports do to reduce or minimize the cost of operating at their facilities will correspondingly reduce the incentives for innovative carriers to go elsewhere. For example, major airports might:

- provide low-cost facilities such as the innovative carriers typically think they need. A number of airports have been taking such steps. Thus the Aéroports de Paris has built an inexpensive building for low-cost passenger airlines and charters. As of 2004, Singapore and Marseille are likewise developing plans for low-cost passenger buildings.
- make the operations on their platform as competitive as possible. In this regard, they should carefully examine the cost structures associated with ground services, baggage handling, and so on. At many major airports, the fees for such services are unnecessarily high; a situation that can be attributed to the monopolistic protected environment associated with governmentally controlled airlines and airports.
- ensure that the innovative carriers will have access to competitive facilities. This may be a difficult managerial task, but is essential – otherwise the new entrants may feel forced to go elsewhere. The task is difficult because the established carriers at a main airport already occupy the most attractive and convenient facilities and are naturally reluctant to turn these over to aggressive carriers that pose a substantial competitive threat. In short, the immediate interest of the traditional carriers is to exclude the low-cost carriers. The interest of the passengers however is to have access to cheaper service, and the long-term interest of the airport is to retain its clients. In this regard, airports should have control over gates so that they and not the airlines can determine who uses their airport.
- do their best to reduce congestion and other delays to aircraft operations so that the innovative carriers can achieve the kind of reliably rapid turn-around times that are such an important factor in their ability to operate their aircraft efficiently.

Defensively, managers of major airports should consider carefully how their financial situation might be affected by losses of traffic to secondary airports. The recent history of San Francisco/International is instructive in this regard. In the late 1990s the airport built a massive new international building designed to serve the desires of the traditional airlines. As of 2004, however, the traffic at San Francisco/International had dropped by a third from its peak (from 41.2 to 28.8 million annual passengers – IATA, 2004) while the market share of the secondary airports increased substantially. The combination of the substantially increased overall costs associated with the massive new construction, and of the great drop in customers, by itself placed great stress on the airport finances. Furthermore, however, San Francisco/International has had to compete on price with the cheaper competitors – just as the traditional airlines have had to compete with innovative carriers – and have renegotiated their agreements with tenants and airlines. The object lesson is to reinforce the basic business principle that it is not wise to build up

expensive, long-term capital assets when the client base may shift easily. In this connection, it will be interesting to observe what will develop at London/Heathrow and Boston/Logan, as both airports bring on major new passenger buildings in the context of a dynamic multi-airport system. As bankers know, it is not good to take on long-term debt for short-term clients.

Owners of major airports may want to preempt the competition by creating and owning secondary airports. In this way, they can hedge their risks of losses at the primary airport through counterbalancing gains at the secondary airports. In this spirit, the management of Frankfurt/Main has taken over the ownership of Frankfurt/Hahn. Likewise, if there is a substantial possibility that secondary airports in a region may grow, the regional authorities should think about safeguarding their viability and making provision for possible future growth by securing suitable land and easements. These efforts could be seen as insurance against the development of the current parallel low-cost networks into a major pattern of airline operations.

8.2 Developers of Secondary Airports: The situation for those interested in the development of secondary airports is quite different. Most immediately, instead of facing challenges, they have opportunities. Typically, they will have considerable assets acquired cheaply. For example, they may control a major runway left over from obsolete military use or otherwise provided by the state – the situation at Frankfurt/Hahn, London/Luton and Paris/Vatry. They will also not have major debts associated with the construction of impressive facilities, but can on the contrary provide passenger buildings at minimal expense. For example, in 2004 Melbourne/Avalon airport spent only € 5 million to provide capacity for about 3/4 million passengers a year – about € 7 per annual passenger. This contrasts with investment costs easily 10 times larger for typical terminals at major airports. (Consider that Terminal T5 at London/Heathrow will cost over € 6 billion, or in the neighborhood of € 300 per annual passenger!). Secondary airports are thus easily low-cost competitors.

The first challenge before secondary airports is to attract airline service. Low cost airlines are free to choose if and where they will offer service, and often have considerable choice. In developed countries, the landscape is often littered with possible airports. This means those interested in attracting airline services to their platform may have to market their facilities effectively. Most often, this in effect means that the airport may wish to “give the airport away”, judging that investments in the success of the airlines are justified by the economic development, jobs and commerce they bring. These investments may also be thought to be subsidies, as claimed in the case of Brussels/Charleroi. However this is viewed, the challenge here is to attract airline service with a palette of features.

The second challenge before secondary airports is to retain airline service or, at a minimum, to avoid major losses if their airlines withdraw for any reason. The fact is that service at secondary airports is notoriously volatile. Established airlines shift their services easily, especially since they avoid major investments in fixed facilities. Thus, Ryanair and easyjet start and stop services to destinations fairly regularly. Start-up airlines often run into financial difficulties and disappear – thus the cases of Buzz, Go, and Air UK in Britain, Crossair in France and Germany, etc, etc. Developers of secondary airports need to be conscious of this reality, and to plan their investments modestly, flexibly, and for the short term until their situation is firmly established.

8.3 Regional and National Planners: The situation for regional and national planners is difficult. At a fundamental level, they face a deep logical contradiction between their inherent task – which is to plan a coherent development of their territory for the greater good of the state – and the practical reality – that is that deregulated air transport both responds to the self interest of the providers and is free to shift its operations to other regions. In short, regional planners looking at the possible development of parallel networks of air transportation have the job of planning what cannot be planned.

Moreover, as regards immediate issues of how to respond to the prospect of parallel transport networks, it is not at obvious where the national interest lies. Nor is it easy to imagine what a coherent calculus of utility might entail, since any attempt to maximize social interest would have to balance competing and conflicting interests. How, for example, does one fairly balance the needs of the Charleroi region for jobs and economic development against economic imperatives of the owners of the major Brussels airport?

These issues furthermore exist in the context where traditional national planning of airport facilities has favored the construction of impressive – and expensive – major facilities, such as those at Paris/de Gaulle, at Frankfurt/Main and now at London/Heathrow. Yet it is far from clear that this pattern has always represented good investment. Indeed, the international terminal Frankfurt/Main built for about € 1 billion in the previous decade was not a success – Lufthansa, the major German airline declined to use it as it could not be adapted to their requirements. And does spending € 6 billion in T5 at London/Heathrow represent the best use of that money from the perspective of the national air transport system?

8.4 Envoi: The single most important recommendation is that airport planners, designers, and managers – wherever located -- consider carefully the challenge posed by the potential development of parallel air transport networks. They should:

- analyze the possible investments taking into account the inevitable uncertainties;

- develop contingency plans that will enable them to respond to the range of possible developments, and
- take suitable actions that will position them to respond effectively when and if necessary.

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Bibliography

AICM -- Aeropuerto Internacional de la Ciudad de Mexico (2003) El AICM en cifras, <http://www.aicm.com.mx/Principal/Corporativo/AICMCifras/Pasajeros.htm>

AIRPORTS COUNCIL INTERNATIONAL, ACI (2002) **ACI World Report**, n° 11/12, novembre./décembre p.19.

AIRPORTS COUNCIL INTERNATIONAL, ACI-Europe (2004) Airport Traffic Report, **Members' Room**, <http://www.aci-europe.com/>

AUSTRALIE, Dept. of Transport and Regional Services, Bureau of Transport and Regional Economics (2004) **Air Transport Statistics, Airport Traffic Data 1992-93 to 2002-2003**, <http://www.dotars.gov.au/>

CANADA, Transport Canada (2003) **Transportation in Canada 2002**, <http://www.tc.gc.ca/pol/en/report/anre2002/add/ta915.htm>

CANDELA GARRIGA J. (2003) **Airport Dynamics Towards Airport Systems**. Barcelone. Airport Regions Conference, <http://www.airportregions.com>

CONGONHAS/SAO PAULO (2002), Homepage do Aeroporto Internacional de Congonhas/Sao Paulo, <http://paginas.terra.com.br/turismo/congonhas/home.html>

CORÉE, Airports Corporation (2004) Air Traffic by Airport, 2003, http://www.airport.co.kr/enprog/stat/air_v.asp

FRUHAN W. (1972) **The Fight for Competitive Advantage: A Study of the United States Domestic Trunk Air Carriers**. Boston. Graduate School of Business Administration, Harvard University.

FUROICHI M et KOPPELMAN F (1994) An Analysis of an Air Traveller's Departure Airport and Destination Choice Behavior **Transportation Research A**, Vol. 28, n° 3, pp.187-195.

HARVEY G. (1987) Airport Choice in a Multiple Airport Region **Transportation Research A**, Vol. 21, n° 6, pp.439-449.

IATA (2004) **World Air Transport Statistics**, Montréal.

INFRAERO (Empresa Brasileira de Infra-Estrutura Aeroportuaria) (2002), <http://www.infraero.gov.br>

LÖSCH A. (1967) **The Economics of Location** [traduit de l'édition allemande de 1939]. New York. Science Edition.

LOUIS BERGER GROUP (2002) New England Regional Aviation System Plan, DRAFT Technical Paper 3: Trends and Trend breakers

NEUFVILLE R. de (1984a) Multiairport Systems -- How do They Work Best? **Airport Forum**, juin, pp. 55-59.

NEUFVILLE R. de (1984b) Planning for Multiple Airports in a Metropolitan Region, **Built Environment** (édition spéciale), Vol 10, n° 3, pp. 159-167.

NEUFVILLE R. de (1985a) Systèmes Métropolitains d'Aéroports -- comment fonctionnent-ils le mieux? **Cahiers de Transport**, n° 300, janvier, pp. 25-30.

NEUFVILLE R. de (1986) Multi-Airport Systems in Metropolitan Regions: A Guide for Policy, **Report to the US Federal Aviation Administration**, Springfield, VA, mars, National Technical Information Service, Springfield, VA.

NEUFVILLE R. de (1990) Successful Siting of Airports; The Sydney Example, **ASCE Journal of Transportation Engineering**, Vol. 116, n° TE1, pp.37-48.

NEUFVILLE R. de (1991) Strategic Planning for Airport Capacity: An Appreciation of Australia's Process for Sydney, **Australian Planner**, Vol. 29, n° 4, décembre, pp.174-180.

NEUFVILLE R. de (1994) Planning Multi-Airport Systems in Metropolitan Regions in the 1990's, **Final Report for the US Federal Aviation Administration**, DTFA01-92-P-012433, May.

NEUFVILLE R. de (1995a) Policy Guidelines for the Option of a Development of a Multi-Airport System, the basis of a Dynamic Strategic Plan to provide the capability for flexible response to future challenges, **Report Prepared for Amsterdam Airport Schiphol, Netherlands**. (disponible à <http://ardent.mit.edu/airports>)

NEUFVILLE R. de (1995b) Management of Multi-Airport Systems: A Development Strategy, **Journal of Air Transport Management**, Vol. 2 n° 2, juin, pp. 99-110.

NEUFVILLE R. de (1996) Policy Guidelines for the Development of Multiple Airports Systems in Major Metropolitan Areas (en japonais) **Issues and Direction of Transport Policy for the 21st Century, Proceedings of the International Symposium for the Commemoration of the Establishment of Institute for Transport Policy Studies**, Tokyo, août, pp. 21-27.

NEUFVILLE R. de (2004) Multi-Airport Systems in the Era of No-Frills Airlines, **Transportation Research Board**, Washington, janvier.

NEUFVILLE R. de, GELERMAN W. (1973) Planning for Satellite Airports, **ASCE Transportation Engineering Journal**, Vol 99, n° TE3, août, pp. 537-552.

NEUFVILLE R. de, ODONI A. (2003) **Airport Systems Planning, Design, and Management**. New York, McGraw-Hill.

RABBANI F. (2002) Airports located at Urban Areas: A Study of Congonhas and Pampulha Airports, projet de fin d'études, cours de l'aménagement des aéroports au MIT.

ROYAUME UNIE., Civil Aviation Authority (2004) **UK Airport Statistics Annual**.
<http://www.caa.co.uk/erg/erg-stats/>

SHANGHAI, Aéroport Internationale (2004) Pudong International Airport Statistics,
<http://www.shairport.com/en/about08.jsp>

U.S.A., Federal Aviation Administration (2003) CY 2002 Commercial Service Airports in the US,
<http://www.faa.gov/arp/plannig/stats/2002/CY02ComServBoard.pdf>

WESTJET (2002) About us, <http://c2dsp.westjet.com/internet/sky/about/index.jsp>