Planning Airport Access in an Era of Low-Cost Airlines

Richard de Neufville

Planning for future airport access should reflect the rise and prospective dominance of low-cost airlines. Air transport now serves a mass market, focused on costs. Increasingly, metropolitan airport passengers use multiple airports. Many airport employees ride public transportation to work. Together, these facts undermine the case for special-purpose, high-speed modes of airport access and argue for more cost-effective modes of public transport that distribute both passengers and employees effectively over metropolitan regions. While some extensions of municipal rail transit systems may be appropriate, planners should pay close attention to a range of rubber-tired, high-occupancy vehicles which can respond to the evolving needs of travelers and employees such as bus rapid transit.

Richard de Neufville (ardent@mit.edu) is a professor of engineering systems and of civil and environmental engineering at the Massachusetts Institute of Technology. His latest text is *Airport Systems Planning, Design, and Management* (McGraw-Hill, 2003, with Amedeo Odoni). In addition to teaching and research, he has consulted on airport-related projects in cities such as: Amsterdam, Athens, Atlanta, Bangkok, Boston, Brisbane, Chicago, Denver, Kuala Lumpur, London, Los Angeles, Manila, Mexico City, New York, Paris, San Francisco, Singapore, Sydney, Toronto, and Washington, DC.

Journal of the American Planning Association,
Vol. 72, No. 3, Summer 2006.

The air transportation industry is changing fundamentally; low-cost carriers are killing the competition. This long-term trend has undermined the industry's previous structure, procedures, and business models, and these changes have consequences for airport access. Airlines and airports now have neither the money nor the appetite for grandiose projects. While massive airport buildings planned many years ago are still being inaugurated (as at Bangkok/Suvarnabhumi, London/Heathrow, Madrid/Barajas, Singapore, and Toronto), the focus is increasingly on low-cost airport buildings and facilities (de Neufville, 2006). Singapore, while still in the process of constructing its long-planned, luxurious, billion-dollar Terminal 3, proceeded with a budget terminal for only $25 million, or about one tenth of the per passenger cost of Terminal 3 at capacity.

Planning for airport access should focus on the companies that have resources, and avoid taking on long-term obligations for clients that have neither money now nor good future prospects. This is elementary good business practice. Yet the point needs emphasis. We all too easily assume that past players represent the future, and neglect emerging leaders. Thus, Boston built a $400 million passenger building to Delta's specifications, opening it shortly before that airline went bankrupt. As Delta shrinks its network and services, someone will have to wrestle with how to lease this space. This challenge is particularly great because low-cost airlines use space quite differently from the legacy carriers.

The Rise of Low-Cost Airlines

Traditionally, air travel has succeeded by projecting an image of premium service. At one time, air travel was a luxury for the rich. More recently, national government regulation protected cartels of established airlines (until 1978 in the United States), allowing them to exclude or drive out competitors. As oligopolists, airlines positioned themselves to offer numerous frills (in the 1970s, piano bars on regular transcontinental flights) and to exact high fares. Consistent with this market positioning, airlines encouraged and ultimately funded huge signature airport projects. Many of the great urban monuments of the last 50 years have been airport buildings designed by notable architects, including:

- Paul Andreu (Paris/de Gaulle and Shanghai/Pudong);
- Sir Norman Foster (London/Stansted and Hong Kong/Chep Lak Kok);
- Helmut Jahn (United at Chicago/O'Hare and Bangkok/Suvarnabhumi);
- Kishio Kurokawa (Kuala Lumpur),
- Renzo Piano (Osaka/Kansai);
- Richard Rogers (T-5 at London/Heathrow and Madrid/Barajas);
- Eero Saarinen (Washington/Dulles and TWA at New York/Kennedy); and
- Moshe Safdie (Toronto and Tel Aviv).

Each of these latest buildings costs in the range of one billion U.S. dollars. Terminal 5 at London/Heathrow has a price tag of around $8 billion. Airport planners conceived and implemented comparably expensive, showcase, access projects to complement these airports, such as the $1.2 billion 19-mile magnetic levitation (maglev) train to Shanghai/Pudong airport from an isolated suburban terminus.

The decline of luxurious air travel gained momentum with the economic deregulation of aviation in 1978 in the United States, and since has spread worldwide. The next countries to permit unregulated economic competition between airlines were Australia, Canada, and the United Kingdom, followed by the European Union in the early 1990s. Since 2000, China, India, Thailand, and other Asian nations have opened up airline competition. The process has been gradual, as it takes competitors some time to break into the market against the sustained opposition of the traditional airlines. By 1995, following 15 years of deregulation in the United States, the competitors (known descriptively as the "low-cost" carriers) accounted for only about 8% of traffic (Morrison & Winston, 2005). This negligible market share did not affect overall patterns of the industry. But a decade later the situation has changed entirely. Low-cost carriers now control the future of air travel in the United States. This may surprise casual observers. The long-established ("legacy") carriers have commemorated their 75th anniversaries, and occupy "fortress hubs" (American at Dallas/Fort Worth, Continental at Houston/Bush, Delta at Atlanta, Northwest at Minneapolis/St. Paul, and United at Denver and Chicago). Leading airports' showcase terminal buildings are associated with traditional carriers, such as those of Northwest in Detroit and United at Chicago/O'Hare. Yet by 2005 well over 50% of U.S. revenue-passenger-miles were flown on the low-cost carriers or on traditional airlines matching their fares (Morrison & Winston, 2005).

Similar stories are emerging elsewhere. In Canada, low-cost Westjet has been humming along while one of the two traditional legacy carriers (Canadian) went bankrupt and merged with the other legacy carrier (Air Canada), which then also went bankrupt. In Europe, Ryanair and easyJet have grown rapidly and are now among the strongest passenger airlines in the world. In total, low-cost airlines already account for around one third of all traffic in the European Union. Likewise, in Brazil, Gol is gaining rapidly while the national flag carrier, Varig, meanders through bankruptcy and possible liquidation. In Asia, AirAsia, Lion Air, and Valueair, all nonexistent at the turn of the century, carried 6% of all traffic by 2004 (International Air Transport Association [IATA], 2005).

The rise of integrated freight airlines such as UPS, FedEx, and DHL is further eclipsing the legacy carriers. FedEx has more major jet aircraft than Lufthansa, British Airways, or Air France, and UPS is in the same league (IATA, 2005). These carriers have seized the lion's share of the market for profitable air cargo and are developing their own networks of services independent of those of the legacy carriers.

Economic Consequences

The rise of the low-cost carriers, whose business paradigm is to increase efficiency, has irrevocably reduced the cost structure and lowered the real price of air transport. Real average U.S. airline revenue per passenger mile has dropped almost 60% since deregulation. In 2004 dollars, average fares went from around 27 cents per passenger mile in 1980 to around 12 cents per passenger mile in 2004. (Morrison and Winston, 2006).

This change in business practices has sent many traditional carriers into bankruptcy, as Table 1 indicates. Their business plans and work rules make it unprofitable for them to compete head-to-head against the low-cost airlines. As Figure 1 shows, average costs for the seven legacy carriers are about 15 cents per available seat mile compared to about 9 cents for the low-cost carriers. Where the low-cost carriers set the prices, the legacy carriers lose. Ted, a spin-off of United, and Delta's Song charged low fares, but their operating costs were still high. Neither lived up to expectations. Although US Airways has claimed to be a low-cost airline (US Airways, 2005), its actual costs per passenger mile are about twice as high as those of Southwest and JetBlue. The legacy carriers succeed in markets protected from low-cost carriers, such as on international routes where access is controlled by foreign governments, or into or out of fortress hubs like the one for Northwest in Minneapolis/St. Paul.

Table 1 shows that investors clearly value the non-legacy carriers. Their market capitalizations (number of

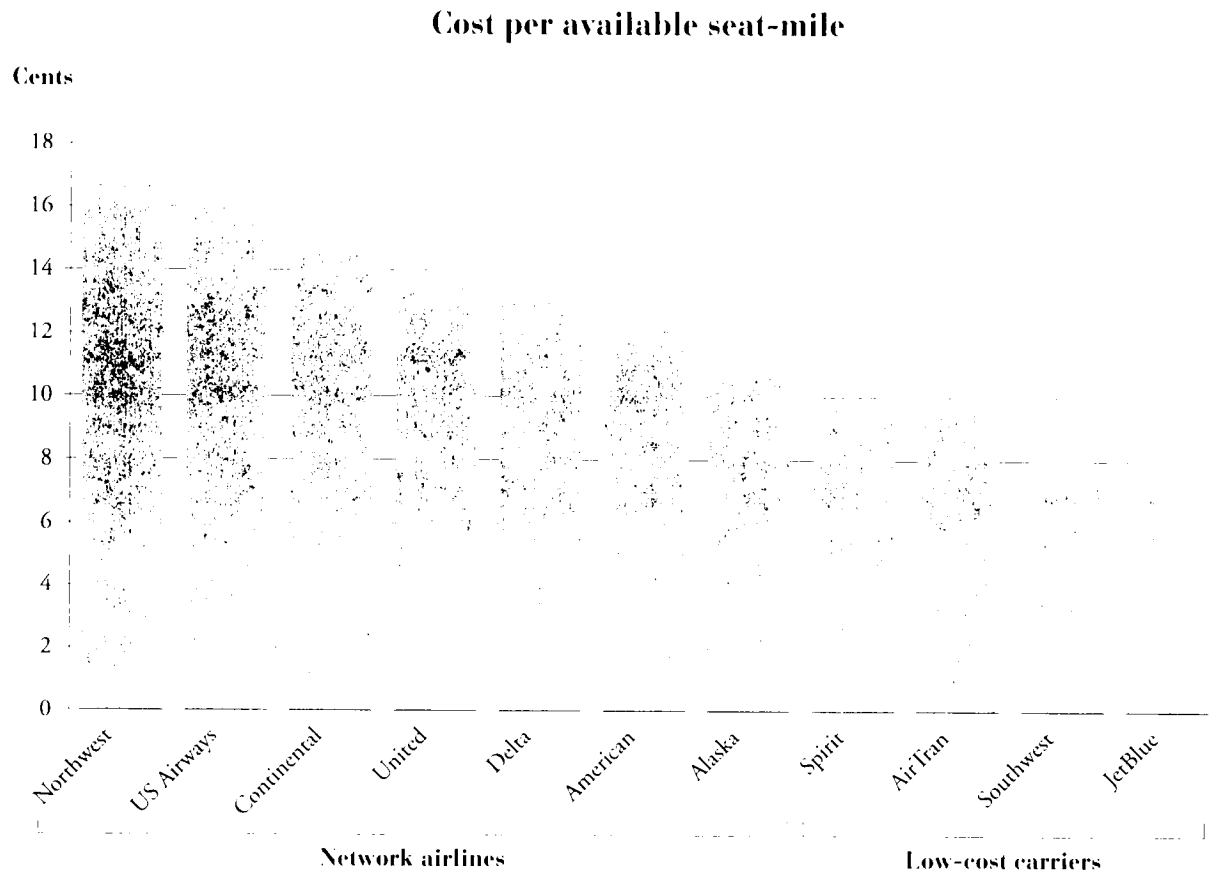

Figure 1. U.S. air carriers' domestic operating costs per available seat-mile, third quarter 2005.
Source: Bureau of Transportation Statistics, 2005.

shares multiplied by market price per share) reflect investors' views of their current situations and future prospects. Southwest is by far the most valuable passenger airline in the world, with a market capitalization that almost equals those of British Airways, Air France, and Lufthansa combined, and is three times greater than the combined value of all the U.S. legacy carriers.

Characteristics of the New Leaders

Low-cost carriers operate differently from the legacy carriers. (See, for example, Barrett, 2004.) Legacy carriers may fire workers and slash pay to reduce their costs, but this alone does not make them resemble Southwest, JetBlue or AirTran. Successful low-cost airlines share two key strategies; they avoid airports with congested airspace, runways, and taxiways and also avoid expensive capital projects. This is important for airport access planning because it emphasizes secondary airports. Thus beyond their main hubs in Memphis and Louisville, FedEx and UPS have major hubs at such airports as Chicago/Rockport, Los Angeles/Ontario, San Francisco/Oakland, and Toronto/Hamilton. Southwest uses the Providence, RI and Manchester, NH airports rather than Boston/Logan, Fort Lauderdale instead of the Miami airport, and the Oakland airport instead of that of San Francisco.

Avoiding Congestion

Avoiding congestion permits low-cost airlines to achieve aircraft productivity often more than 50% greater than that of the legacy carriers (Warnock-Smith & Potter, 2005). The low-cost carriers minimize unproductive time on the ground and in the air. They avoid traffic in the air that delays landings or keeps aircraft on "ground holds" at distant airports. They also avoid airside delays that keep the aircraft on the ground waiting to land or take off, queuing up for a open gate, or taxiing long distances. The most obvious way low-cost carriers pursue this strategy is to cut turnaround time on the ground to a minimum

Table 1: Airline type and bankruptcy status in descending order of market capitalization, November, 2005.

Company name	Airline type: Integrated freight	Airline type: Low-cost	Airline type: Legacy	Currently in bankruptcy	Market capitalization (U.S. $ billion)
UPS	x				82.0
FedEx	x				28.0
Southwest Airlines		x			13.0
Singapore Airlines			x		9.0
Ryanair		x			7.0
British Airways			x		5.5
Lufthansa			x		5.0
Air France			x		4.3
Gol Tranportes Aereos		x			3.9
American Airlines			x		2.3
easyJet		x			2.1
JetBlue Airways		x			1.9
Virgin Blue		x			1.3
AirTran Airways		x			1.3
Japan Airlines			x		1.0
Alaska Airlines			x		0.9
Continental Airlines			x		0.9
WestJet		x			0.4
Delta			x	Yes	≈0
Northwest Airlines			x	Yes	≈0
Air Canada			x	Yes	≈0
United Airlines			x	Yes	≈0
US Airways				Yes	≈0

Source: Retrieved from finance.yahoo.com in November, 2005 and industry estimates.

(about 25 minutes in the case of Southwest, in contrast to the more typical hour for the traditional carriers). Aiming to save time is part of what leads low-cost carriers to use secondary airports in metropolitan regions, which generally incur less delay, as Table 2 shows.

Airports with congested airspace are typically older facilities with intersecting runways and cramped airside layouts inherited from the mid-20th century, such as Boston/Logan, Chicago/O'Hare, New York/Kennedy, and Philadelphia. They are not necessarily those with the greatest traffic. The newer Atlanta, Dallas/Ft. Worth, and Denver airports serve more passengers, but are relatively uncongested on the airside.

Though the low-cost carriers prefer uncongested airports, they will serve airports with severe airside delays when the market opportunities outweigh the disadvantages. Thus, JetBlue operates out of New York/Kennedy and

Table 2: Delays at primary and secondary airports serving the San Francisco metropolitan area in April, 2006.

	Primary airport	Secondary airport	% of flights arriving within 15 minutes of schedule
San Francisco International Airport	x		33
Oakland International Airport, Oakland, CA		x	23
Norman Y. Mineta San Jose International Airport, San Jose, CA		x	23

Source: Bureau of Transportation Statistics, 2006.

Boston/Logan and Southwest is in Philadelphia. As legacy carriers shrink, low-cost carriers will increasingly have more such choices, particularly in metropolitan areas with multiple airports.

Avoiding Expensive Airport Facilities and Services

Low-cost carriers also reduce costs by avoiding expensive ground facility rents. Traditionally, airlines could afford to neglect the cost of ground facilities, which were small compared to their other costs. A $20 per passenger airport fee like that charged at many big airports is a negligible part of a $500 fare, but not of a $100 fare. Low-cost airlines use older, less expensive facilities, and, most importantly, use their space more intensely so that they require less. Even when they pay comparable rents per square foot, they pay far less per passenger served.

Low-cost airlines also pay attention to their passengers' costs for parking and other airport fees. Southwest attracts passengers to its flights both through low fares and through the lower costs passengers incur traveling to and using secondary airports.

Dispersing Airport Traffic

A secondary airport is any airport that effectively serves and competes for passenger traffic from a large conurbation, whether or not it is in the same state or even the same country. Such airports typically have lower levels of traffic, fewer air traffic delays, and less expensive facilities. Southwest serves passengers in the greater Boston area with airports in Providence, Rhode Island, and Manchester, New Hampshire. These cities are 70 and 50 miles away from Boston, but are closer to a significant fraction of travelers in the area than is Boston/Logan. Similarly, Malmo, Sweden is effectively a secondary airport for Copenhagen, Denmark, as a bridge connects the two cities. Table 3 lists secondary airports served by low-cost airlines in large metropolitan regions.

A remarkable redistribution of airport traffic across major metropolitan areas has accompanied the rise of the low-cost carriers. Traffic at primary airports in metropolitan multi-airport systems (such as Boston/Logan, Miami/International, San Francisco/International and London/Heathrow) has grown slowly or even dropped, while traffic at the corresponding secondary airports (Boston/Providence

Table 3: Low-cost carriers serving secondary airports.

Metropolitan region	Secondary airport	Low-cost airline
Boston, MA, USA	T.F. Greene International Airport, Providence, RI	Southwest Airlines
Boston, MA, USA	Manchester-Boston Regional Airport, Manchester, NH	Southwest Airlines
Brussels, Belgium	Brussels South Charleroi Airport	Ryanair
Copenhagen, Denmark	Malmo, Sweden	Ryanair
Dallas/Fort Worth, TX, USA	Dallas Love Field	Southwest Airlines
Frankfurt, Germany	Frankfurt Hahn Airport	Ryanair
Glasgow, Scotland	Glasgow Prestwick Airport	Ryanair
Hamburg, Germany	Hamburg Lübeck Airport	Ryanair
Houston/Galveston, TX, USA	Houston Hobby Airport	Southwest Airlines
London, UK	Stansted Airport	Ryanair
London, UK	London Luton Airport	easyJet
Los Angeles, CA, USA	Long Beach Airport	JetBlue
Manchester, UK	Liverpool John Lennon Airport	easyJet
Melbourne, Australia	Melbourne Avalon Airport	Jetstar Airways
Miami, FL, USA	Fort Lauderdale-Hollywood International Airport	Southwest Airlines
Milan, Italy	Aeroporto Internazionale di Orio al Serio	Ryanair
New York, NY, USA	Long Island Islip MacArthur Airport	Southwest Airlines
Oslo, Norway	Torp Sandefjord Lufthavn	Ryanair
Paris, France	Aeroport de Paris Beauvais Tille	Ryanair
Rome	Aeroporti di Roma-Ciampino	easyJet, Ryanair
San Francisco, CA, USA	Oakland International Airport	Southwest Airlines
Stockholm, Sweden	Stockholm Skvasta Flygplats	Ryanair
Vancouver, BC, Canada	Abbotsford International Airport	WestJet

and Boston/Manchester; Miami/Fort Lauderdale, San Francisco/Oakland and San Francisco/San Jose; and London/Stansted and London/Luton) has soared, doubling or tripling in some cases. Table 4 shows that primary airports in metropolitan multi-airport systems have been losing their dominance.

Almost all primary airports are vulnerable in this way since, with few exceptions, the metropolitan areas that generate many air passengers have multiple, significant airports. In the United States, this is true of Boston, Chicago, Dallas/Fort Worth, Houston, Los Angeles, Miami, New York, Orlando and Washington DC. Worldwide, this list includes Frankfurt, London, Milan, Moscow, Osaka, Paris, Rome, Tokyo, and many others. A handful of cities do not have sufficient local traffic to support a secondary airport and provide exceptions to this rule. (de Neufville, 1995; 2005) Atlanta is an example of this phenomenon. Although it has been the busiest airport in the world in terms of the number of passengers (over 83 million total passengers in 2004), 75% or more of these passengers transfer between aircraft. Thus only about 20 million local Atlanta passengers require airport access. Denver, Detroit, and Minneapolis are other examples of busy airports with relatively small numbers of passengers needing local access.

The redistribution of airport traffic has wide-ranging implications for metropolitan development. Increases in airport services have helped make Providence, RI and Manchester, NH more desirable business locations, and are exerting centrifugal forces on development in the greater Boston area. Fort Lauderdale is growing due to synergy between its airport's development around Southwest Airlines, and the spread of the cruise business away from Miami. Indeed, Fort Lauderdale has now surpassed Miami International as the preferred gateway to the region for traffic from the New York area. Similarly in Britain, the growing importance of London/Stansted airport, the secondary London airport that has expanded from 5 to 15 million annual passengers in the past decade with the growth of Ryanair, is helping to transform adjoining Cambridgeshire into what is known as "Silicon Fen."

Table 4: Primary airports' shares of passengers using all airports in the metropolitan area, 1994 and 2004.

Metropolitan region	Primary airport	Market share 1994	Market share 2004
Boston	Logan International Airport	90%	72%
Miami	Miami International	69%	56%
San Francisco	San Francisco International Airport	68%	58%
London (UK)	Heathrow Airport	65%	53%

Source: Author's data.

Less Desirable Modes of Airport Access

Special-purpose, high-speed, fixed-route access has been a much-heralded response to problems of airport access in many metropolitan areas. Rapid connections between the city center and the airport are supposed to facilitate passengers' trips to the airport, and close the discrepancy between the speed of air travel and sluggish ground movement in urban areas. To this end, transportation planners, airport authorities, and civic leaders have implemented many special-purpose projects terminating at airports, and are considering many others, as Tables 5 and 6 show. These are in addition to the airport extensions added to metropolitan transit systems in Chicago, Philadelphia, Portland (Oregon), San Francisco, Saint Louis, Washington and cities overseas.

Such projects are expensive to build. They require extensive construction in congested urban areas, grade separations achieved by tunneling or elevated pathways, and stations that designers have to shoehorn into densely built, central airport areas. They are much more costly than road links because trains cannot bend around tight corners and thus often require extensive tunneling under foundations in built-up areas (as at Amsterdam/Schiphol, London/Heathrow, Minneapolis/St. Paul, Paris/de Gaulle, and Tokyo/Narita). For example, the AirTrain link between New York/Kennedy airport and the metropolitan rail network cost between $1.5 and 1.9 billion for 8.4 miles of track, or about $200 million a mile. (Port Authority of New York and New Jersey, 2003; 2005) The Heathrow Express rail connection from Paddington Station to London/Heathrow was built at a cost near $800 million (£450 million) for a line about twice as long as that for New York/Kennedy, but this was in large part because it took advantage of long portions of existing track. (Harris, 2001) Even the light rail system built to the Minneapolis/St Paul airport cost over $800 million dollars, largely due to the extensive tunneling under the airport and its runways.

Special-purpose fixed links to airports also have relatively few riders, which drives up the cost per ride. For example, an airport serving 25 million total passengers a year, like Boston's Logan, may engender 20 million airport trips per year or 50,000 passenger trips per day spread over the metropolitan region, of which only a fraction have

Table 5: Examples of special-purpose airport-access links.

Country	Metropolitan area	Airport	Technology
United States	New York	John F. Kennedy International Airport	People mover
United States	New York	Newark Liberty International Airport	People mover
China	Shanghai	Pudong International Airport	Maglev train
France	Paris	Paris Orly Airport	Automatic train
Malaysia	Kuala Lumpur	Kuala Lumpur International Airport at Sepang	Monorail
United Kingdom	Birmingham	Birmingham International Airport	Maglev train

origins or destinations near rail stations. Thus, the BART extension to San Francisco International airport (serving around 33 million passengers a year) started with about 6,500 daily trips (Tomach, 2003), less than 10% of the capacity of most such rail lines.

Two examples illustrate the high cost per rider of special purpose links to airports. In the case of the Heathrow Express, a private organization is responsible for the project and attempts to cover all operating expenses and recover capital investments. Thus, its fares approximate the average cost per user. Although as noted above, using existing track made it comparatively inexpensive to build, its second-class fare is about £15 (about $27) for a one-way ticket. (London Heathrow, 2005) Publicly supported projects have lower fares, but subsidies mask their true costs. In New York, the airport levies a $3 "passenger facility charge" on each of the 35 million passengers through New York/Kennedy each year, and uses this revenue of over $100 million to help pay for the construction and operation of the AirTrain. The subsidy now amounts to around $30 per trip. The regular AirTrain fare is $5 per user. Even this subsidized fare is too high for airport employees, who pay about what it costs to ride the New York mass transit system.

Few final destinations are located at central points served by fixed rail even in dense cities like New York or London. Meaningful data on this phenomenon are difficult to obtain, because most surveys of airport access describe "downtown" areas of several square miles. Advertisements for the New York City AirTrain claim to connect the airport and Manhattan in "less than 45 minutes" (Port Authority of New York and New Jersey, 2003). Although passengers can transfer to a commuter train at Jamaica Station and get to Penn Station in that time, most air travelers do not wish to end up at Penn Station. Popular Manhattan destinations such as Times Square, the East Side, the Village, and Wall Street are 1 to 5 miles away and to reach them passengers must either get themselves and their bags up several levels to one of the outside taxi stands,

Table 6: Special-purpose airport-access links under consideration in North America.

Metropolitan area	Airport
United States	
Las Vegas, NV	Ivanpah Airport
Los Angeles, CA	Los Angeles International Airport
Miami, FL	Fort Lauderdale–Hollywood International Airport
Miami, FL	Miami International Airport
San Francisco, CA	Oakland International Airport
San Francisco, CA	Norman Y. Mineta San Jose International Airport
Seattle-Tacoma, WA	Seattle-Tacoma International Airport
Washington, DC	Washington Dulles International Airport
Canada	
Montreal, Quebec	Montréal–Pierre Elliot Trudeau International Airport

wait for some time, and then drive through the city; or negotiate underground trains and then walk to their final destination. Most door-to-door trips to or from the airport turn out to be far longer than 45 minutes.

Such underestimates of travel time may partly explain the overly optimistic forecasts for rail ridership noted by Flyvbjerg, Holm & Buhl (2005). The forecast for the AirTrain from New York/Kennedy airport was for 32 million passengers a year, or about 90,000 per day. (Oats, 1998). In its first year, AirTrain carried about 10,000 paying riders per day. Similarly, the initial traffic on the BART extension to San Francisco International Airport was about 6,500 daily passengers, about 40% of that forecast (Tomach, 2003). Most users of the AirTrain (about 20,000 per day) rode the free shuttle service connecting various buildings at the airport. (Port Authority of New York and New Jersey, 2004)

In short, special purpose, high-speed airport access systems do not provide good value. The door to door travel times belie claims of "high speed," and costs are high both absolutely and compared to alternatives. (For further details see de Neufville & Odoni, 2003, and de Neufville & Mierzejewski, 1972.) As air transportation changes to emphasize economy it becomes even more desirable to develop cost-effective modes of airport access.

Because of the change in the airline industry, airport access now requires integrating the airport nodes into broadly based urban transportation networks, not special services to a privileged clientele. To meet the needs of both airline passengers and airport employees, future airport access systems should be affordable and should distribute riders to and from their homes, offices, and hotels dispersed across the metropolitan area.

Airport access planning should focus on the door-to-door trips of the travelers. Travelers choose their travel according to the entire effort (in time, money, and other aggravation) that they have to spend to get from place to place. Many people travel in couples or families, with several bags, from some noncentral area. These travelers are sensitive to the difficulties of making connections on their way to and from the airport, and the many fares they may have to pay.

Airport employees account for a large share of the trips on public transport to airports, and the busiest airports provide tens of thousands of jobs. These employees travel both ways (as airport passengers do not) creating a market comparable to serving airline passengers in places like Minneapolis, on the New York AirTrain, and on the BART extension serving San Francisco/International. Commuting employees and travelers motivated by low airfares are generally not prepared to pay for premium modes of airport access, as a recent survey of the Port Authority of New York and New Jersey showed (Port Authority of New York and New Jersey, 2004). As a result, the market for airport access now aligns more closely with the traditional market for urban public transport.

More Desirable Modes of Airport Access

Various approaches could provide affordable, distributive service. One possibility is to tie airport access seamlessly into a broadly distributed metropolitan transit network, though this is possible only in cities already possessing such services. In those cases, an airport stop is a logical and effective addition to the network. In the United States, the connections between the O'Hare and Midway airports and the Chicago transit system, and between Washington/Reagan and the Metro system, provide good examples of this. Examples are more common in Europe, as in Amsterdam, Frankfurt, London (Heathrow Piccadilly Line), and Paris (de Gaulle RER connection). In all of these systems, a person can enter the system at the airport and use it at reasonable cost to get close to many destinations throughout the city.

Remaining opportunities for airports to connect to mass transit systems are rare in North America. Vancouver is designing such an addition, projected to cost $1.4 billion for 12 miles of regular transit line with 16 closely spaced stations (Greater Vancouver Transportation Authority, 2006). Toronto could have a similar connection between its transit system and the airport. On the other hand, the proposed connection between Dulles airport and the Washington, DC, Metro system would extend 23 miles into the exurbs and have widely spaced stations. This project, with an estimated cost upwards of $2 billion, is unlikely to provide affordable, distributed service for either airline passengers or employees (Associated Press, 2006).

The other major alternative is to use rubber-tired modes of transport. Such services provide few technical difficulties, have low capital costs, can be expanded or contracted incrementally, and their capacity can be redeployed as needed. Various suitable bus or van airport access systems exist in many North American regions. Most of them are privately owned and operated, but some are publicly managed. Typically, private services operate several lines, each oriented toward a different portion of a metropolitan area, and each trip collects or distributes passengers within the defined zone. For example:

- The "Super Shuttle" (http://www.supershuttle.com) is a nationwide consortium that in 2006 operates in 18 cities across the country. Travelers make reservations online to be picked up or delivered at the door. The service coordinates these bookings, assembles passengers, and provides a personalized, but collective, service from airport terminal to home, office or hotel.
- Continental Airport Express (http://www.airportexpress.com) provides a similar service both to main tourist centers and door-to-door throughout the suburbs.

Comprehensive guides to similar services can be found at http://www.shuttlefinder.net/. Each service has its own specialties and peculiarities, but collectively they provide attractive means to provide the desired door-to-door service that travelers desire.

Boston provides examples of public airport access by bus. The Logan Express bus service offers direct bus service

to three suburban locations, similar to the private services mentioned above. It serves about 3,300 riders daily, at a cost in the range of $12 to 15 million a year (Massport, 2003). Thus it serves one third of the New York AirTrain's traffic for around one tenth the cost, for a three to one advantage.

Boston is also pioneering the use of bus rapid transit (BRT) for airport access. BRT uses rubber-tired vehicles that operate in dedicated rights-of-way or on existing road systems (Hardy, Stevens, & Roberts, 2001). This flexibility reduces construction costs drastically. In Boston, the BRT "Silver Line" serves Logan airport and connects directly into the regular subway system at South Station (Schimek, Darido, & Schneck, 2005; U.S. Federal Transit Administration, 2006).

A number of political and regulatory issues stand in the way of using rubber-tired vehicles for airport access. The airport shuttle services often find it difficult to get licenses to serve important regions, in part because taxi companies seek political protection from such competition. Airports typically tax airport shuttle services heavily, charging them some combination of rental fees and a percentage of their revenues, in sharp contrast to the subsidies often provided to rail services. Planners should help rewrite the terms of engagement between cost-effective, distributive services and airport and municipal authorities.

Conclusions

The air transportation industry is changing dramatically, and planning for airport access should evolve compatibly. Under the new model, low-cost carriers operate significantly differently from the traditional legacy carriers, notably by dispersing airline traffic more broadly across multiple airports serving the same metropolitan area, and by aiming to reduce airport costs of all kinds. These shifts reduce the clientele and stakeholder support for special purpose rail projects and call for airport access that is both inexpensive and capable of distributing and collecting passengers over a broad area.

Rubber-tired modes of transport are more flexible, and comparatively easy and cheap to implement, and thus more suitable than rail for publicly funded airport access. BRT initiatives developed by the Federal Transit Administration point the way to good solutions. Indeed, some prominent observers believe that such systems represent much of the future of public transit (Institute of Transportation Studies, 2006). In addition, private bus and van services increasingly provide cost-effective services to a clientele that fixed-route systems cannot serve. Transport planners wishing to increase the proportion of travelers using shared airport access services (as opposed to private vehicles or taxis) should work on reducing the administrative and political obstacles to such services.

Acknowledgements

This article has benefited from the advice and suggestions of numerous colleagues in the industry over the years. Most immediately, the thoughts, comments, and corrections of Craig Coy of Massport, Jeffrey Hamiel of Minneapolis St. Paul International Airport, Harley Moore of Lea + Elliott, and Regine Weston and half a dozen anonymous reviewers and editors have been most immediately helpful. Naturally, they are not responsible for the final product.

References

Associated Press. (2006, March 23). *Cost for first leg of Metro to Dulles projected at $2B.* [Lead story on Washington radio station WTOP's webpage] Retrieved June 27, 2006, from http://www.wtopnews.com/index.php?nid=30&sid=734488

Barrett, S. (2004). How do the demands for airport services differ between full-service carriers and low-cost carriers? *Journal of Air Transport Management, 10*(1), 33–39.

Bureau of Transportation Statistics. (2005). *Third quarter 2005 airline financial data.* Retrieved June 27, 2006, from http://www.bts.gov/press_releases/2005/bts058_05/html/bts058_05.html

Bureau of Transportation Statistics. (2006). *Airline on-time statistics and delay causes.* Retrieved June 27, 2006 from http://www.transtats.bts.gov/OT_Delay/OT_DelayCause1.asp?pn=1

de Neufville, R. (1995). Management of multi-airport systems: A development strategy. *Journal of Air Transport Management, 2*(2), 99–110.

de Neufville, R. (2005). Le devenir des aéroports secondaires: Bases d'un réseau parallèle de transport aerien? *Cahiers Scientifiques du Transport, 47*, 11–38. Available from http://ardent.mit.edu/airports/ASP_papers/VF%20Cahiers%20S%20du%20Transport%20AVRIL%2005--%20Neufville1.pdf

de Neufville, R. (2006). Accommodating low-cost airlines at main airports. *International Airport Review, 1*, 62–65.

de Neufville, R. & Mierzejewski, E. (1972). Airport access—A cost-effectiveness analysis. *ASCE Journal of Transportation Engineering, 98*(3), 663–678.

de Neufville, R. & Odoni, A. (2003). *Airport systems planning, design, and management.* New York: McGraw-Hill.

Flyvbjerg, B., Holm, M., & Buhl, S. (2005). How (in)accurate are demand forecasts in public works projects? The case of transportation. *Journal of the American Planning Association, 71*(2), 131–146.

Greater Vancouver Transportation Authority. (2006). *Translink.* Retrieved June 27, 2006 from http://www.translink.bc.ca/Plans_Projects/Richmond_Airport/default.asp

Hardy, M., Stevens, W. & Roberts, D. (2001). *Bus rapid transit vehicle characteristics,* Washington DC: MTS-Mitretek Systems. [Distributed by the U.S. Federal Transit Administration as FTA-DC-26-7075-21001.1] Retrieved June 27, 2006, from http://www.fta.dot.gov/7639_7667_ENG_HTML.htm

Harris, K. (2001). On the rails. *Jane's Airport Review, 13*(6), 14–15.

Institute of Transportation Studies. (2006). *The 2006 Mel Webber Lecture: Is bus transit our best bet? Sir Peter thinks it could be.* Institute of

Transportation Studies News Archive, University of California, Berkeley. Retrieved June 27, 2006, from http://www.its.berkeley.edu/news/peterhall.html

International Air Transport Association. (2005). *World Air Transport Statistics.* Montreal: IATA.

London Heathrow. (2005). In *Airwise: The airport and air travel guide.* Retrieved June 27, 2006, from http://www.airwise.com/airports/europe/LHR/LHRexpress1.html

Massport. (2003). *Logan Express rates to increase.* Retrieved June 27, 2006 from http://www.massport.com/about/press03/press_news_lexincrease.html

Morrison, S. A. & Winston, C. (2005, September 28). *What's wrong with the airline industry? Diagnosis and possible cures.* [Statement before the United States House of Representatives Committee on Transportation and Infrastructure, Subcommittee on Aviation.] Retrieved June 27, 2006, from http://www.economics.neu.edu/morrison/research/house050928.pdf

Oats, D. (1998). AirTrain—A reality? *The Queens Courier.* Retrieved Jan 20, 2006 http://www.queenscourier.com/archives/1998?lead092498.htm

Port Authority of New York and New Jersey (2003, April 15). *AirTrain JFK to resume testing this month; Passenger service expected to begin this year; AirTrain safety oversight board created. Press Release 51-2003.* Retrieved June 27, 2006, from http://www.panynj.gov/AboutthePortAuthority/PressCenter/PressReleases/PressRelease/index.php?id=343

Port Authority of New York and New Jersey. (2004, June 9). *AirTrain JFK welcomes its one-millionth revenue passenger, Press Release 73-2004.* Retrieved June 27, 2006 from http://www.panynj.gov/AboutthePortAuthority/PressCenter/PressReleases/PressRelease/index.php?id=533

Port Authority of New York and New Jersey. (2005). *AirTrain Facts.* Retrieved June 27, 2006, from http://www.panynj.gov/facs1.html

Schimek, P., Darido, G., & Schneck, D. (2005). *Boston Silver Line Washington Street bus rapid transit (BRT) demonstration project evaluation.* Washington DC: U.S. Federal Transit Administration and U.S. Department of Transportation.

Tomach, R. F. (2003, September–October). BART inflates SFO counts: COLMA riders improperly added to inflate results. *California Rail News, 17*(2), 4.

U.S. Federal Transit Administration. (2006). *Bus rapid transit demonstration projects. Boston, MA: Massachusetts Bay Transportation Authority, the Silver Line—project description.* Retrieved June 27, 2006, from http://www.fta.dot.gov/initiatives_tech_assistance/technology/brt/projects/2401_ENG_HTML.htm

US Airways. (2005). Retrieved October 29, 2005 from http://www.americawestvacations.com

Warnock-Smith, D. & Potter, A. (2005). An exploratory study into airport choice factors for European low-cost airlines. *Journal of Air Transport Management, 11*(6), 388–392.