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Airports in the 21st Century
Proceedings of a Conference

April 20, 2000
Washington, D.C.

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Preface

GEORGE W. BLOMME
Airport Planning and Technology Systems
Conference Moderator

The Transportation Research Board and Federal Aviation Administration cosponsored a one-day conference in Washington, D.C., on April 20, 2000, to review the outlook for airports in the 21st century. The Conference focused on development that is expected to take place at major metropolitan airports to help accommodate growth in air travel during the next 25 years.

The program considered the major technological and institutional measures that may be combined to increase the capacity of the airport system and to help meet the rising demand for air transportation. Industry experts presented information on the prospects for improved airport infrastructure, aircraft technology, and air traffic control technology in relation to future capacity requirements. The process of planning and undertaking major airport improvement programs was examined from the perspective of regional planning, environmental compatibility, and economic implications.

The Conference provided practitioners and policymakers with an opportunity to review the changing context of airport development and to discuss changes in areas such as research, planning procedures, and institutional roles and responsibilities in order to meet future requirements.

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Welcome Address

JANE GARVEY
Federal Aviation Administration

Good morning, and welcome to Airports in the 21st Century. I am delighted with the agenda we have today—the "what" we are going to cover. But I am even more pleased by the "who"—you, the participants. We have among us the best minds in airport planning and development. Gathered here today are the people who must frame the conversation about airports, who must take the long view, who must articulate public policy considerations, and who must work together to chart the course to take us into aviation's second century. So thank you for your commitment.

We all know that airport planning involves some very tough issues. We just pulled some of the recent headlines: "Salvaging an Airport Pact" was in the April 3, 2000, *Los Angeles Times*. The next day, "Miami Airport Agrees to Reduce Noise Pollution after Years of Complaints" was in the *Miami Herald*. Then, 2 days later, "Opposition Mounting to Hanscomb Expansion," said *The Boston Globe*. So, we're seeing those headlines and seeing those issues across the country.

Certainly, airport planning poses some real challenges. Today, I think we really have an opportunity to explore those challenges and, in a sense, change the conversation. That is what I would like to begin to do today—change the conversation about aviation and change the conversation about expansion.

It certainly requires re-examining our own public policies. I think that is as true at the federal level as it is at the local level. It means understanding the system needs of aviation in an economy, and at the same time, balancing those needs with the community and environmental concerns. I know that is easier said than done.

Most of all, I think what we are going to be asking ourselves, and asking our colleagues over the next several years, is to bring the political will to the constituencies and to bring the constituencies together to make some very hard choices. Kate Lang likes to remind me that it can be done. She cites Louisville and the noise mitigation action being taken there. The town of Minor Lane Heights along with many of its families will dissolve, move and will re-emerge as a new town, far away from the sound of jet engines. We know that as airport directors, many of you are wrestling through some of these issues.

The stakes are enormously high. Globalization is here to stay. It is upon us. Our children know remote corners of the world the way they know their own backyards, and when we think of a global economy and a global culture, it is impossible to think of it without a strong aviation system. So we know that we have to assure the health and growth of aviation.

Everyone in this room could probably cite examples of how aviation has made an enormous contribution to the economy of the region they are from. We know that we measure those contributions in the hundreds of billions of dollars. We know airports are the engines of economic growth and we know that in the 20th-century airports forever changed our nation's economic, social, and geographic landscape—just as the railroads did in the 19th century. We also know that more changes are ahead. But we also know that aviation's contributions cannot be taken for granted, nor can we take its future for granted. It is going to take leadership and it is going to take a real partnership on both

of our parts to coordinate our actions to have the greatest positive influence on aviation's future contributions.

We know our nation needs aviation infrastructure for the 21st century. We also know that it has two key elements. I think sometimes we tend to divide this discussion and that is a real mistake. The two key elements are the airside—the air traffic control, and the airports. We simply cannot have one without the other. We remind ourselves of that constantly in our air traffic control modernization discussions. We can modernize the airside and the technology on the airside, but if we try and do that without dealing with the airports, we will simply have a failed solution.

In terms of the air traffic control system, I think we are making real and measurable progress in modernizing the system. We have a long-range plan. Russ Chew (American Airlines) knows that we have, for the first time in history, an historic agreement with the industry and a consensus on where we are headed, and we are doing it incrementally. No more taking on large projects and never seeing them through to deployment, we are now going at it methodically, one step at a time.

As for adding ground capacity, we all know that putting down the concrete takes time. Sometimes it takes even more time than the technology. Planning new airports, acquiring land, and addressing the community's concerns are a complex and very often contentious process. The lead times for adding ground capacity are long, which is why we don't have a moment to lose. Our busiest airports are straining at the seams. We know that to help relieve this congestion we need to invest in additional gate and terminal capacity. We need new and expanded runways, taxiways, and aprons, and we need improved ground access systems.

I'm interested in hearing Matt Coogan's comments at lunchtime today, because I think as we go through some of these issues the sort of interconnectedness between the airside and some of the ground side issues become very clear.

We need to plan far ahead. The conversation that we continue today began in January at the TRB's Annual Meeting when Professor Richard de Neufville presented his paper on airports in the 21st century. If you haven't had a chance to take a look at that, you really should. It has a lot of wonderful ideas about the future, marked by growth, marked by globalization and increasing commercialization of the airports. As Professor de Neufville cautions, we cannot precisely predict the future, and because of that, we have to remain flexible and ready to adapt to unexpected changes.

At that meeting, a panel of aviation experts highlighted some of the concerns about how well we will be able to meet the rise in demand for air transportation. Today, what I hope we will do is examine those options in greater detail and discuss the measures necessary to meet future requirements.

We have a good starting point for discussion. This year 2000 has already been a good one for aviation and airports. Just 2 weeks ago, President Clinton signed the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century into law. That bill addresses some key aviation issues. To begin with, it is a 3-year bill. We said we needed that ability to plan ahead. We needed that kind of predictability. It gives us that by taking us through fiscal year 2003. This provides a strong foundation for the planning stability that we need, and it also provides some very strong funding for future infrastructure—both on the airport side and for the modernization of the air traffic control system.

We are already building for that future right now. Billion dollar airport expansions are underway at Miami, Florida; Dallas/Fort Worth (DFW), Texas; Salt Lake City, Utah; St. Louis, Missouri; and Orlando, Florida. Around the nation plans are underway for as many as 16 new runways at our 25 busiest airports. We're also deploying new technologies to enhance airport capacity. Two of the technologies in our Free Flight phase 1 program are helping to enhance capacity at large hub airports. TMA (Traffic Management Advisor)—now fully operational at Fort Worth Center—is helping controllers increase the arrival rate at DFW airport by 5 percent. Another tool that the controllers are using is helping to increase total operations at DFW by up to six aircraft per hour.

All of those projects renew, replenish, and augment the infrastructure. There are other equally effective ways to address ground transportation requirements. One is regionalization—looking at several airports in a region as part of a regional air transportation system. We are moving away from looking at just one airport in isolation.

On both sides of the country, in New England and Southern California, two airport authorities are wrestling through this issue, and again it is not without complications and not without challenges.

Massport has the Boston/Logan airport that is certainly the primary gateway for New England. T.F. Green in Providence, the Manchester Airport, and Worcester serve passengers who don't live as close to Logan. That regional approach in Massachusetts is making a difference. Massport says that about 64 percent of the people who fly in New England today fly out of Logan and that is compared with about 80 percent in the early 1980s—so that is good news.

In Los Angeles, the nation's second largest city, the Los Angeles World Airports authority operates LAX Airport as the primary airport, with Ontario, Van Nuys, and Palmdale rounding out its system of airports. These four airports serve a major portion of the Southern California air transportation market.

But, along with regionalization, I think that we need to look at other ways to approach the problems and that is why I think it is so important to see the other modes here today, because just thinking of aviation in isolation is a mistake. But, how can we leverage some of the other modes and how can aviation best be leveraged to create a system for the traveling public? That is really what we are trying to do.

We know that there are no simple answers to these questions. We also know that there is no silver bullet. We know that we have traditionally thought that pouring concrete was the answer, and as I've cited, those 16 runways will certainly help; but it won't be enough, even those 16 runways cannot close the capacity gap. Our best estimate is that the current level of air traffic exceeds the capacity of the 25 busiest airports by more than 1 million operations per year. That means nearly a 9 percent shortfall in capacity. Even after all 16 runways are taken into account, it appears that the gap between demand and capacity will widen in the future because of the steadily rising demand for air transportation. That widening gap threatens more congestion, more delays, and more lost time and resources.

Exploring all the options is really what we want to do. Most importantly though, and I think what is at the heart of these issues, is the challenge of how we find that difficult balance between the needs of the nation, the needs of a system that we look at nationally, and the concerns of local communities. I will tell you that every day I gain new respect

for people like John Martin and Jim Wilding and others who wrestle through these issues on a daily basis. That is why we have the experts here today.

You are the experts and what we are asking you to do is to help us shape a new public policy.

There are a great many questions that we can ask. Questions like

- Should mature airports be rebuilt into modern, high-efficiency facilities?
- What is the role of surplus military airfields?
- Can larger aircraft be more efficient users of scarce capacity?
- What about the impact of regional jets?
- What gains can we realistically expect from technology advances and aircraft design and air traffic control technology?
- What about technology gains to further reduce noise and improve air quality?
- What is the role of regional planning?
- What are the appropriate roles of federal government, the local government, and the airport authorities?
- How can we effectively leverage our respective positions to bring about solutions?

These are tough questions, but I'm absolutely confident that they can be answered and that the beginning of the answers will be found in this room today.

I read a wonderful article that Anna Quindlen wrote in *Newsweek* not long ago. In that article she tells us that history is most often written in terms of inventions and events, revolutions and revolutionary ideas. But, she says it is essentially the story of people. If you get lucky, you can see history being made—luckier still to participate in its making. I think we have an opportunity as we begin to approach the second century of aviation to really create that history.

I look forward to today's discussion and I'm delighted that I'm here. Thank you very much.

Outlook for the Future

RICHARD DE NEUFVILLE
Massachusetts Institute of Technology

First of all, I'd like to thank you very much, Administrator Garvey, for creating the opportunity for us to think about this topic. I really appreciate your leadership in creating an environment in which we can ask and try to respond to some of the important issues of what and why and wherefore, that takes us out of day-to-day problems. I think this effort is really valuable because, if we somehow understand aviation systems a little better, it can lead to tremendous savings on billion-dollar projects. Even a few percent of a billion-dollar project is still a lot of money. So, I'm very grateful for this time of leadership and look forward to future events of this sort.

In opening, I want to talk a bit about what is happening in aviation system planning. The theme I want to bring out is that we are going to have to be thinking about systems of airports on the regional level, about complexes of regional airport systems. We are going to have to recognize that the changing structure of the industry is almost certainly going to change the way we plan. It will go from a generally governmentally directed, organized, and executed planning system to one in which large corporations and global companies will do much more. You may not share my vision of this, but it is a plausible vision and one that may radically change the way we approach our problems.

Let's think first of all about the background. We have to take on board in the beginning that growth is the key piece. Whatever the growth is going to be, it is almost certain to be long-term and sustained as it has been in the past. We are talking about continuing real decreases in the cost of airport transportation as we go to larger aircraft, more efficient operations, and more low-frills operations. Whether or not that exists beyond the kind of level of advance we have achieved in the United States (for example, by Southwest), worldwide it is certainly going to exist. We have lower prices, lower accident rates, partnership airlines, and more convenient service. Just to bring that out, here is a graph of the growth rate nationally and internationally; we're talking about traffic that doubles every 15 to 20 years. That has happened in the past and who knows the future, of course, but there are cases that show it is likely to continue.

Growth is driven, I think we have to agree, by lower prices. This second graph shows the drop in costs, in cents per mile on a real basis. It shows the rise of traffic in terms of passengers in the United States. One way or another, on average the prices have been and are being driven down on a long-term basis. The most elementary economics shows that this leads to big increases in traffic.

Even if growth stabilizes in the United States, growth is continuing internationally. So we can expect, at the very least, to have much more travel to the United States driven by price decreases and, of course, driven by our neighbors who are increasingly wealthy and who will travel in a globalized market.

Another key factor is the fact of globalization and they way it manifests itself in the airline business. On the one hand we have airline partnerships, such as Star and Oneworld. We are seeing the effective creation of global airline enterprises. Even if

they do not merge their corporate structures, they are beginning to work together as large airlines.

In parallel, we have other groups working together. We have global airport groups such as the British Airports Authority (BAA) taking up management activities across a large number of airports internationally. We are seeing groups that will have large capitalization and worldwide patterns of similar management. This is going to change the way we think about airports because our planning partners are going to be large corporations who do this on a grand scale in many places and who really know their business. Not that we don't know our business, but larger corporation managing many projects will have a depth of understanding which may surpass what we typically have now.

Another element of growth that is important to observe is that we have, in fact, been having significant increases in airport capacity on a generational basis. I can remember when the same runways that basically exist today at Boston/Logan had a rated capacity of about half of what they provide today. We have had capacity increases in many ways, including longer operating hours, more control, more efficiency—without very radical technological development for the FAA and the air traffic controllers. This pattern is likely to continue, if not at the main crowded airports, then on a regional basis. Thus the capacity of the Boston region has increased tremendously over the last years. This is not because Boston/Logan has increased its capacity, but because regional airports such as Boston/Providence—I call it Boston/Providence because it is part of the metropolitan system even though it is in another state and has totally independent management—has increased its capacity from about 1 to 5 million passengers a year. We have been fortunate to live in a relatively benign environmental context. Not that noise issues aren't a powerful concern but that, relatively speaking, aircraft operations have gotten much quieter. This has made our job much easier. Unfortunately, this state of affairs is likely to stop. The reductions in noise levels from Stage 1 to Stage 3 aircraft are diminishing. In the next 25 years, we are likely to have noise levels increase way above what they are now, and this is going to be a major problem for traditional older airports—Boston, New York, all those near downtown areas. It will be less of an issue in places such as Denver, Colorado, or Orlando, Florida, where airports are sited differently.

Finally, we are also seeing the development of multi-airports systems, composed of regional complexes or airports that, although they may not have the same ownership or management like the Port Authority of New York and New Jersey, are operating together. From the passenger's point of view, the fact that you have Boston/Logan and then you have Boston/Manchester in New Hampshire and Boston/Providence in Rhode Island is irrelevant. From a functional point of view these airports are part of the Boston metropolitan airport system and operate as such. The same thing can be said of New York, Washington, Miami, Houston, Dallas, Los Angeles, and San Francisco. These metropolitan multi-airport systems are a tremendous development of the last generation. These systems of secondary airports provide significant regional capacity. These second airports predominantly serve particular kinds of traffic—whether in terms of cargo at Los Angeles/Ontario or lower-fare traffic at Boston/Providence serving Southwest.

What can we expect from the future? I think we can perceive that there is going to be tremendous growth, in part because, relatively speaking, we are increasingly wealthy, in part because the world is having more free time. Maybe you and I feel we never have a free moment to ourselves, but in terms of longer vacations and things like

that, there is a worldwide trend for more free time and we are certainly going to see large international growth.

But there are clearly some question marks. We simply do not know what will happen. After the fact, because of all the changes that occur in the world, the forecast is always wrong. It is nobody's analytic fault, but that is the way of the world. It is at all times unpredictable. Certainly in a deregulated, international environment, the volatility of traffic is very high as airlines change patterns (such as when Delta moved its hub from Dallas to Cincinnati), as airlines rise and fall competitively and so forth. There are, of course, all kinds of possible technologies that will change things.

Given the trends, we can reasonably estimate that over the next generation, by 2025 for example, the traffic will be two or three times what it is today. Given that our planning horizons take on the order of 10 years to get major projects accomplished, we are talking about having to double, if not triple, our existing capacities over this time.

In addition to more international traffic, which is a given, we also have to recognize a large increase in specialized cargo. I would like to show you a slide that brings this out. Because of our personal experience as travelers and our historical dealing with passenger traffic, we tend to forget what is already on the horizon: the enormous worldwide growth of integrated cargo carriers— United Parcel Service (UPS), Federal Express (FedEx), DHL, TNT, etc. This slide shows their market capitalization at a particular date. Obviously it changes every day, but it is still reasonably correct. Market capitalization is the way the market values the company. On that basis, UPS or FedEx could easily take over any of the major airlines; it would be chump change for them. Ten percent of UPS stock would acquire United or American Airlines. That is important because it shows that integrated cargo is a large business. This is where the money is in many ways. Cargo is going to be a driving force in the airport business. UPS and FedEx own on the order of 500 aircraft each. They are among the biggest airlines in the world. They are going to help shape the capacity we provide.

What else is happening? Let me suggest that we are seeing the emergence of a new class of mega-airports. These are the airports with large and long parallel runways. Denver, Orlando, and Dallas/Fort Worth are examples. They are emerging worldwide, at Kuala Lumpur and the new Bangkok for instance! We are seeing an emergence of a new class of NLA—not new large aircraft, but new large airports! How about their environmental characteristics? Most of them are built fairly far out in the middle of nothing. Denver or Kuala Lumpur is 20 to 30 miles from the center of the city, where noise effects are going to be minimal and you can expect 24-hour operations. With the new class of large aircraft, these airports can be the gateways for intercontinental travel. For example, in the United States the current gateways are Boston, New York, San Francisco, Los Angeles, and Miami. The gateways of the future may well be Denver, Orlando, Montreal/Mirabel, and other places. The capacity will be provided completely differently, on a 24-hour basis in major new places—not at traditional gateways.

At the same time we can see the emergence of a group of niche airports serving particular types of markets. One example is the airports serving Southwest; these are relatively smaller airports such as New York/Islip, Boston/Providence, and Miami/Fort Lauderdale, which are serving the relatively less expensive class of traffic, and are booming. We see this in the United States and elsewhere in Europe. We also can notice the cargo airports that are developing in a number of places.

We need to place all this in the context of the development of a different form of airport management. Consider the consequences of global airline partnerships such as Star and Oneworld. They demand bigger blocks on the airport and create design issues I won't talk about now. They also create pressures on airport management. The trend is for large producers to simplify their supply chain. Major companies find it much too complicated to deal with thousands of suppliers; they want to deal with a few who will work with them on a coherent basis and integrate into their computer systems and so forth. They want a consistent, world-class supply chain. This trend puts significant pressure on airport managers. It provides opportunities for organizations, companies specifically, prepared to service these airline groups on a consistent worldwide basis. Airlines operating in Frankfurt, Germany, Thailand, or Chicago want to have the same reservation system, the same charging system. They will integrate these into their computer systems; they won't have nickel and dime processes at different places. This phenomenon is important. It will drive the development of airport management services.

I see the emergence of worldwide, world-class airport organizations similar to hotel chains. Think about Hilton or any hotel chain that has a worldwide organization of training and preparation of consistent services to operate profitably. They may actually own a property, but normally don't. They don't necessarily make long-term investment decisions about whether to build a hotel, but they operate it. They sell their services to owners because they offer high-quality management. As you have probably seen in many cities, a hotel can convert from one brand to another brand because the owners decide they want a different level of service.

This trend is making obsolete local political airport management. I don't mean political control. I personally believe in political control of the airport system regionally and locally. However, the management of these properties and their commercial direction may in many ways be increasingly in private or company hands. This will change the nature of the planning process, the operation process collectively. Think about it. If we have three or four major airline blocks and a similar number of major airport companies that have tied together operations around the country, we are going to have a planning process very different from what we have been used to. It would no longer be a one-off operation here and there, with everything very different locally.

So I think we might want to focus on complexes or regional airport systems, multi-airport systems, and major airports, some of them very much larger than we are used to. We will see more new large airports, surrounded by mid-sized airports having 10 million or more passengers, but servicing specialized functions such as cheap fare, international, transfer, or cargo traffic. These regional complexes will be serviced by major clusters of airlines working together and supported by major suppliers in terms of airport management companies operating across the United States and internationally. Those elements will together lead to a very different kind of planning process. I don't know exactly what that will be, but to assume that the situation in which we now operate will continue over the next 25 years would probably be a mistake. What I have outlined is one possibility. More generally I'm simply suggesting that things may be different and that we ought to try to understand what they might be.

I look forward to learning from you and your thoughts about these issues and to continuing this process in the years ahead. Thank you very much.

Infrastructure and Technological Considerations of Airport Capacity

Introduction

GEOFFREY GOSLING
University of California at Berkeley

The development of a system of airports to meet the air transportation needs of the 21st century will pose a significant challenge to those responsible for developing the plans, regulations, and funding mechanisms to support this development.

In the first presentation of the morning session, Professor de Neufville has identified in more detail many of the trends that will shape the context within which this development will occur and the issues that will need to be addressed. In particular, these include growth, globalization, and commercialization trends.

Paramount among these issues that need to be faced will be the need to increase the capacity of the system, as Professor de Neufville noted, to handle the growth in demand within the constraints imposed by the desire to minimize the adverse environmental impacts of aviation activities. Administrator Garvey has commented on this need to recognize the interests of those who surround airports, along with the need to satisfy the economic drivers and the economic benefits that flow from aviation.

This, of course, will require ways to measure the inevitable trade-offs involved and to communicate this information to the public and to the decision-makers in a balanced way so that the implications of specific decisions are understood as well as possible under the circumstances, and appropriate mitigation measures can be defined and implemented. This is not only a legal requirement, but also a moral one.

As implied by some of Professor de Neufville's remarks, airport development decisions will impact future generations, both positively and negatively, for a long time to come. Once built, runways are hard to move. An important issue that arises in this debate over how best to meet the future capacity needs is the question of how much help we can expect from new technology, since this affects not only how many new runways we will need, but where they should be located. As noted by Professor de Neufville, there are other infrastructure issues that will also be affected by technology developments as well, including terminal building requirements and ground access considerations.

This topic of the way in which technology will influence infrastructure requirements formed the focus of the remainder of the morning session, in which three very knowledgeable speakers addressed different aspects of this issue.

Jeffrey Thomas of Landrum and Brown addressed the type and location of future airport infrastructure needs. Robert Kelley-Wickemeyer of Boeing explored how aircraft technology might enhance airport capacity. Finally, Professor John Hansman of the Massachusetts Institute of Technology discussed the role of future air traffic control technology.

Airport Infrastructure
Where and What Kind of Development?

JEFFREY THOMAS
Landrum and Brown

I have been asked to address the topic of where and what kind of airport development will be required. In a market-driven aviation system under a first-come, first-serve operating premise, passenger and shipper demands will answer that question, and development will occur where it is needed. I think if the system evolves in the way de Neufville outlined, with corporate interests more and more running airports, it will further amplify the focus on airports where the demand lies.

Air travel is chosen over other modes of transportation because it is convenient in terms of time and cost. In competing markets, when you have a comparable choice of destinations, frequencies, and fares, your choices are basically made in terms of an airport's accessibility. Between regions, that is expressed as trip time and the convenience of your overall trip. Within a region, it is expressed as the access convenience of the ground trip travel time to the airport. This characteristic of demand pretty much determines the airlines' preferences for providing service at airports in any locale.

Aviation activity within the U.S. system has, and will remain, highly concentrated in the largest airports and major urban areas where airport investments are most needed and most difficult to obtain. In 1988, the top 10 airports handled 35 percent of the passengers and 21 percent of the commercial aircraft operations. The top 50 airports in the same year handled 80 percent of the passengers and 56 percent of the aircraft operations. These concentration percentages have been like a rock over the last 30 years, whether before or after deregulation. We have a very concentrated system.

Passenger and cargo demand within the major urban areas also is, and will remain, highly concentrated. The passenger densities per square mile in four of the major urban areas served by multi-airport systems are shown on Slide 4—New York, Washington, Chicago, and Los Angeles. In each region, major airports occur in the areas of highest density demand.

In terms of concentration, the Los Angeles system is probably the most developed airport system in the U.S. It certainly is the broadest, covering a sprawling 9,500 mi^2 region and is currently served by seven commercial service airports, four others that pretend to play such a role, and two others that should play such a role but may never do so.

Slide 7 overlays origin-destination (O-D) demand—in this case domestic—on that region, with the densities as you can read in the legend. The highest densities being in the red and green area, yellow being rather high-density demand areas, and the balance of the region a very low demand scattered throughout the area. Fifty percent of the O&D passengers in the Los Angeles region are concentrated in just 5 percent of the land area of the region. Twenty-five percent are concentrated in two percent of the area—the region right around LAX.

The squiggly line on Slide 9 overlays on that demand density, the 60-minute travel time zone for Los Angeles International Airport (LAX). It is not coincident that LAX, which serves by about 75 percent of the region's air traffic demand today, serves that because the accessibility of that airport is simply unparalleled in the region. One-third of the total regional air travelers are within 30-minutes travel time of LAX and half are within 60 minutes of that airport. Only the policy-restricted Long Beach Airport comes anywhere close to that accessibility in the region. The airports that fall in the red, green, and yellow areas are the ones where capacity would be most meaningfully added, but might be the most difficult to attain capacity as well.

Reflecting the concentration of demand, virtually all major U.S. airports are located in close proximity to the core of the urban regions that they serve. Slide 11 plots a few of the major airports and multiple airport systems. It also shows the airports in the LA system. Almost all major airports fall within 20 miles of their regional central business districts—the newer airports, Dulles and Denver, are merging out toward the 30-mile range. But, we have a very close proximity of airport to central points of demand in these regions. This tells us where the facilities are needed.

The U.S. commercial aviation system has considerable capacity except in the largest and most congested urban areas. Traffic flow management techniques tend to disperse delays away from these areas and thus hide the true magnitude of the large urban area problem. These techniques increase the perception that small airports have delay problems. General aviation (GA) seems to have capacity everywhere except at the largest commercial airports where it simply doesn't belong. However, GA serves a relatively small number of passengers and has perhaps undue influence over policy because of the large number of aircraft operations. Because they can only be located in less accessible urban fringe areas, new airports have not been a significant force in the provision of new capacity where it is most needed. In the last three decades, we have developed only three new airports, Washington Dulles International Airport, Dallas/Fort Worth International Airport, and Denver International Airport. Each was the only game in town, either with closures of the other competing local airports or severe user restrictions on other existing airports in the areas.

I would conclude that unless your community or airport name begins with a "D," you won't likely see a new commercial airport. Economic and political barriers are just too daunting. I'm not sure I can buy into the idea of superports or wayports because I think in the final analysis they don't enhance convenience.

Military airport conversion for commercial passenger use only makes sense where the site has a ready-made market and is in proximity to where there is a need for an additional airport or a new airport facility. Well-located military airfields need to be recognized as unique capacity assets and ought to be preserved for long-range needs. Certainly, it would be a big mistake to let a site like El Toro be developed for office buildings, but who needs Grissom Air Force Base in rural Indiana for anything other than growing corn?

Perhaps the greatest opportunity in base closures lies not in the re-use of the concrete but in potential re-use of the airspace. Certainly, anything that reduces or makes more flexible special use airspace would add potential capacity to terminal area airspace systems, particularly along the East and West Coasts and the southern borders of the country.

Over time, all large metropolitan areas, especially if public policy allows urban sprawl to continue unchecked, will be served by multiple airport systems. Given the difficulty of adding real airfield capacity at mature, land-locked airports, the focus of attention will shift toward increasing the number and productivity of other existing airports that are used for extensive commercial service. I think you'll see airline alliance partners electing to serve only selected airports within these systems.

Distribution of airlines, among the airports in Chicago, New York/Newark, Boston/Providence/Manchester, and San Francisco/Oakland reflect this trend.

To conveniently serve demand, mature land-locked airports in vital urban markets will have to be rebuilt. There is significant capacity locked in these facilities, which can be realized using creative planning, technological advances, and supportive government policy.

Many of the older urban airports of the country, such as Chicago's O'Hare, began life as military airfields with a triangular runway configuration driven by crosswind considerations of aircraft of that day. Today, aircraft technology has advanced to the point where crosswinds are less of a consideration but the airfields or remnants thereof still exist. I think that the introduction of regional jets reinforces the case that these airports are candidates for being rebuilt and realigned into a parallel configuration of one type or another. There are a large number of the major airports, which over time could be redeveloped with the advantages that are noted in the slide. Clearly, you can get into a situation where through reduced runway intersections, reduced runway crossings, and easier air traffic control management, that capacity increases on the order of 20 percent plus at the operations level are easily obtainable at many of these airports—not easily from an environmental standpoint, but from a concrete standpoint.

When the runway systems are reconfigured at these older airports, the terminal tends to be enhanced from a capacity standpoint as well. The advantages for moving aircraft and passengers in a reconfigured environment are very obvious. You get dual ground access points, greater gate capacity and accessibility from a taxiway standpoint, less runway crossings, and a more manageable and flexible system.

Emerging navigational technologies are providing opportunities to make airports less intrusive on surrounding communities by narrowing flight corridors, which could reduce parallel runway separation requirements, which increases capacity. It seems to me that the marketplace will adjust the demand to fit the capacity in those vital urban markets that refuse to take on the responsibility of adding capacity at their primary airports. Basically, you will see socioeconomic changes, which will reduce demand. Shippers and passengers or businesses will relocate themselves to regions that have better air service and the wisdom to deal effectively with these issues.

Wrapping up, I think there are a number of things from a policy standpoint that we could do which would help us in accomplishing added capacity in these difficult urban markets, where it is most needed. A number of regulatory and policy changes are required. I think that among the most beneficial would be:

The FAA needs to seriously consider getting away from a first-come/first-served mentality on airways that have proven to have congestion problems. We could take a page out of FHWA's book where they have a proven capacity and planning management

concept of high-occupancy vehicle (HOV) lanes and apply that policy to our airways system or to airport runways. Limited operating capacity airways and runways serving severely congested urban area airports could be designated HOV, thereby increasing passenger carrying capacity. One could have 100-seat or a 250-seat airway, or perhaps a 300-seat runway.

Selectively abandoning first-come/first-serve would also provide an effective means for meaningful management of demand in multiple airport systems. It would become possible to effectively force service from one facility to another to meet regional needs. We can't do that today. Without such ability, regional planning is a largely esoteric exercise. As an example, Southwest Airlines' operation at LAX (which is basically an O-D short- and medium-haul service) constitutes 11 percent of the passenger and aircraft activity at that airport. If this activity could be shifted to other regional airports in Los Angeles—Long Beach, Burbank, and Ontario being potential candidates—Southwest's 82,000 aircraft operations annually at LAX could be rededicated to international and long-haul service. That would cause a capacity increase, in terms of passenger carrying capability, at LAX of about 20 million passengers annually, or about 30 percent. No environmental impact statement (EIS) or environmental impact report would be required and the capacity increase would far exceed the capacity to be gained from $4 to $5 billion worth of planned improvements at that airport in the near term. Southwest might not like it. United certainly would. But, the market could be served and the capacity of the overall aviation system could be materially increased by such forced shifts of demand.

With respect to enhancement of runway area safety at major urban airports, the provisions of the National Environmental Protection Agency of 1969 (NEPA) are the single greatest impediment to expeditious completion of airport facility runway safety improvement projects. We are adding 5 to 7 years to the time to build any piece of concrete on an airfield at our major airports today. The industry should be very proactive in lobbying Congress to exempt major commercial airport runway safety improvement projects from the EIS requirements and NEPA, particularly for those airports serving more than 1 percent of the U.S. passenger market. I would include runway safety areas, clear zone actions, and relocation of existing runways and taxiway structures to achieve current design standard separations. This would do a lot to deal with increasing runway incursion problems and allow the enhancement of safety at our most busy major urban area airports.

As it did previously with the aircraft noise, the industry must develop a proactive staged source reduction program for aircraft engine emissions. As ground transport clean up, aircraft are rapidly becoming a major source of N_{ox} and other toxic pollutants. Air quality assessment of airport development projects in multi-airport regions must be done on a regional basis or meaningful development will be stopped in its tracks where it is most needed. Lastly, using technology, the industry virtually solved the aircraft noise problem at major airports over the last decade.

But the lack of reasonable land use controls is allowing shortsighted local interests to erode the gains. Local political bodies do not have the resolve to restrict incompatible development. Federal airport land use zoning controls with real teeth are required to protect the public and the industry's substantial investment.

Click here to see Jeffrey Thomas' slide presentation.

Aircraft Technology
Impact on Airport Capacity

ROBERT KELLEY-WICKEMEYER
Boeing Commercial Airplane Group

The presentation addresses the impact of aircraft technology on airport capacity from the perspective of four issues: the implications of traffic growth for airplane size and flight frequency; fuel supply considerations; the need for community noise reduction; and ways to minimize the effects of adverse weather. The two priorities are safety and how to handle traffic growth. Safety considerations include the need for precision approaches, runway conditions, aircraft ground de-icing, and runway incursions.

The size of aircraft being flown is going to be a big question in addressing traffic growth. More airlines are moving away from using the four-engine B-747 on long-haul flights in favor of twin-engine aircraft, such as the B-777. As a result of the rules allowing extended over water flights by twin-engine aircraft, the B-767 now dominates the North Atlantic market. This results from the lower cost of twin-engine operations, the introduction of point-to-point service in thinner markets, the greater comfort of wide body aircraft, and the ability to more easily match capacity and frequency to market demand. It can be anticipated that the same thing will happen in the Pacific market, as a result of an increase in the number of city pairs served and the introduction of Polar routes over Siberia.

The question of how to handle traffic growth needs to consider the situation both between airports and at airports. Between airports, increased capacity will need to be provided though the modernization of the air traffic control system through the use of advanced communications, navigation and surveillance technologies and improved air traffic management techniques. Providing increased capacity at airports will require that more runways be built or ways be found to get more passengers through the existing runways by the use of larger aircraft or increasing the operations frequency.

As traffic grows and more airlines move away from using smaller aircraft, the size of the largest aircraft will become an issue. Factors affecting the ability to increase aircraft size include the strength of runway and taxiway pavements, as well as taxiway bridges and overpasses, and limits on aircraft wingspan and length from gate considerations. How large a wingspan will be needed for a 600 passenger aircraft weighing a million pounds? What about an 800 passenger aircraft weighing 1.5 million pounds? The effect of larger wingspan on gate widths and the size of hangars can be reduced through the use of folding wings. Generally aircraft tend to be about as wide as they are long. Longer aircraft increase the depth required for gate stands, although the use of two decks can allow higher passenger loads without increasing the length of the aircraft. However, loading and unloading passengers can be a problem with two-deck aircraft.

Consideration of aircraft size needs to take airline costs into account. The objective of building an aircraft is to allow the airlines make money. Aircraft ownership costs are about half total aircraft operating costs, so changes in ownership costs have a bigger effect on airline profits than any other factor. The next most important factor is fuel cost. Operating costs can be reduced by reducing fuel burn through improved aerodynamic efficiency. Boeing has been exploring blended wing-body concepts, although there are

difficult emergency evacuation considerations. A different approach to reducing costs would involve ways to increase utilization by reducing aircraft turn times through the use of modular fuselage components that could be loaded with passengers and baggage in advance and then quickly attached to the wings, engine and cockpit.

Increasing runway utilization will require strategies to reduce the required separation between aircraft. Aircraft wake vortices are often the limiting factor. Solutions involve either eliminating the vortex, avoiding a vortex encounter, or dealing with an encounter. One concept that has been proposed makes use of the aircraft ailerons to collapse the vortex. Research efforts to better predict the location of vortices include the NASA AVOSS program and the Socrates program at San Francisco International Airport.

In the longer run, fuel supply issues may become important. There is at least an 80-year supply of conventional fuels and a wide range of alternatives. However, the infrastructure for cryogenic fuels will need to be able to handle a large volume of vented gasses and retrofitting existing aircraft for new fuels is difficult. The cost of new fuels could range from twice to five times current jet fuel, although aircraft using liquid hydrogen would be able to achieve a better fuel burn than those using conventional jet fuel on longer range flights.

The final consideration is community noise. The future Stage 4 requirements for aircraft noise certification are expected to be 8 to 10 dB below Stage 3 requirements. It is probably achievable with new aircraft, although achieving it with existing aircraft will require a lot of modification. As the engines become quieter, greater attention will have to be paid to the airframe and landing gear. Reducing the source noise will help existing flight patterns, although there may be problems with preferential runway or different wind conditions that result in communities being overflown that are not used to high levels of air traffic. Cruise noise will still be heard in remote areas.

Click here to see Robert Kelley-Wickemeyer's slide presentation.

Airport Capacity
Limits, Technology, Strategy

R. JOHN HANSMAN
Massachusetts Institute of Technology

This presentation gives a brief overview of air traffic control technology and how it impacts capacity, with a primary focus on airport systems.

When we look at the airport environment, we can consider it as a flow system where airplanes enter the system at an entry fix in the terminal airspace, follow an arrival route to the landing runway, taxi to the gate, then subsequently taxi to the departure runway, takeoff, and follow a departure route to an exit fix where they depart the system.

The runway capacity is currently the principal constraint on system capacity. Data on causes of departure delays reported by pilots for a major air carrier over a 10-month period at four airports show that about 60 percent of the delays are due to the runways not being available while other flights land or depart. In the case of this one major airline for the ten-month period, this amounts to about 350,000 minutes of delay at Dallas/Fort Worth Airport alone.

As mentioned in the previous presentation, the principal cause for the runway delays to arriving traffic are the separation requirements between aircraft. However, the current separation standards are consensus standards and not definitively supported by specific engineering analysis. We do not actually know if these are the right numbers for current technology and procedures. On the departure side, there are similar separation constraints, as well as delays due to the need to wait for aircraft crossing runways.

One can express the interaction of arrival and departure flows, and the effect of weather conditions on airport configuration, through the use of runway capacity envelopes, that show the maximum combination of arrival and departure rates that can be sustained for a given airport configuration. These rates can then be used in queuing models to study the performance of the airport as the demand and weather conditions vary over the day. In the case of Boston Logan Airport, capacity under good weather conditions exceeds even the peak traffic volume. However, when capacity drops in poor weather, the demand profile exceeds the capacity for prolonged periods and delays start to accumulate.

The banking structure of flight arrivals and departures that occurs at most hub airports is also an important factor. The gaps between the flight banks are important to allow the system to recover if the capacity of the airport reduces below the peak demand. Data is presented on gate congestion for American Airlines at Dallas/Fort Worth Airport on a day when a late afternoon thunderstorm delayed arriving flights. The data show that a complete flight bank was lost and the situation did not recover until after midnight.

This leads to the issue of the role of weather in the variation of airport capacity and the resulting delay. FAA data for 1997 show that weather is the principal cause of delay, much greater than traffic volume or other factors. Comparative data for different airports show that while delays increase with traffic volume, there are some airports that are way above the general trend. These data show that airports such as San Francisco and St.

Louis, where weather has a big effect on capacity, have much higher levels of delay for comparable traffic levels than airports such as Las Vegas or Honolulu.

There are also gate capacity limitations in the system. The dynamics of the system make gate arrival and departure times relatively unpredictable, which impact the airline management of the gates. Data on pilot reported causes of arrival delay show that the largest single cause is aircraft finding their gate still occupied. Data on gate departure times relative to schedule show that only about 13 percent of flights are ready to push back within 6 minutes of scheduled departure, and the average departure delay is about 14 minutes. So a large number of aircraft are still on the gate 15 minutes or more after their scheduled departure, which introduces a lack of predictability into the system.

Delays also arise from downstream flow constraints. These include the effect of ground stops as well as congestion of departure fixes. If a departure fix becomes blocked by thunderstorms, the airport will lose a significant amount of capacity. Controller workload can also be a constraint on the system capacity. The system is designed to restrict the flow to prevent a downstream controller from being overloaded, and there are feedback mechanisms to prevent this.

Other limitations on the system include landside constraints on how many seats can be scheduled to depart in any 15-minute period, due to roadway access capacity and the terminal passenger processing and security throughput rates. Community noise considerations may also impose capacity constraints due to the cost and difficulty of getting new runways approved and restrictions on flight paths. Minimizing runway queuing delays are an area of potential benefit by reducing air pollutant emissions as well as decreasing airline direct operating costs.

A final consideration is the trade-off between safety and capacity. Runway incursions are a growing area of concern. Increased capacity with current infrastructure implies reduced operational separations. The current system of airborne separation is extremely safe but very conservative, and a key challenge will be how to dependably predict the impact on safety of the changes required in this complex interdependent system.

Click here to see R. John Hansman’s slide presentation.

Discussion

Part I

Following the presentation on:

Airport Infrastructure: Where and What Kind of Development?

Jeffrey Thomas, Landrum and Brown

Richard Golaszewski: My name is Richard Golaszewski and I'm with GRA, Inc. I have a question for Jeff Thomas. The graphic you showed of the Los Angeles Basin, and where all the people are, tells you exactly why Southwest wants to be at LAX. It is called access time and cost. Other than by edict, how do you provide them incentives to perhaps relocate to a secondary airport where you think there is a greater social benefit?

Thomas: They have a right to operate wherever they wish and it is very hard to provide enough economic incentives. Although their operation is market-wide, I think you could serve that market from a number of the other airports in the region. Again, it would have to be out of Burbank, or Long Beach, or at Ontario.

George Blomme: George Blomme from Airport Planning and Technology Systems. Jeffrey, I was confused by one of your statements. I think I understand what you were trying to get at, but you had mentioned near the end of your talk that the aircraft noise levels have been substantially reduced, which is quite true. And, you had referred to some of the neighborhoods nearby. The inference I thought was neighborhoods that shouldn't be there, but of course, a lot of those neighborhoods have been around major airports like O'Hare and the New York and Los Angeles airports—they have been there for 30 to 40 years already. So, if you are reducing aircraft noise and yet increasing the number of aircraft at the same time, perhaps those people don't belong there in the first place. But, the reality is that they are there. I'm afraid those people, in spite of narrowing the flight corridors and everything, are really being hit with a lot of noise. Do you see any change in that coming up perhaps, or any way to further alleviate the problem?

Thomas: My point was slightly different, and I don't have the statistics with me, unfortunately. But if you take a look at the noise contours that existed before the aircraft noise reduction program at O'Hare as an example and then following that program, we have seen this major shrinking from 300,000-plus people to something in the range of 100,000 or less. The source noise reduction that caused this is now mostly over. But that is only a part of the problem because what we have also seen happen is that a large percentage of housing units that now fall within those noise-impacted areas did not exist in the 1980s. As the industry has been going through some very expensive programs to make airplanes quieter on noise impacted corridors, the communities out there are willingly allowing housing and residential uses to be built in these noise impacted areas, and we can't stop them. There isn't a great deal of cooperation between the jurisdictions and a large part of the noise problem in Chicago and elsewhere is basically units that are

being built today. I think the industry needs some sort of national type of zoning control for noise-impacted areas off of these airports.

Dorn McGrath: I'm Dorn McGrath from George Washington University. I was very interested in your comments about regional planning for airport systems. As you demonstrated, so many passengers live so close to the major airports. I wonder if there is any way to overcome what I would consider the potentially destructive political rivalries to expand one airport tortuously and very expensively, as in the case of St. Louis, Missouri, when a competitive alternative—such as Scott Air Force Base—exists in the same metropolitan area, a very short distance away, offering many more alternatives and very much better circumstances to expand without destructive displacement?

Thomas: I think the situation that exists there is testimony to the market forces of convenience. I don't think we have answers to those questions. In my experience I have seen nothing that leads me to believe that it is easy to move market demand around in a free market system. Certainly that leads to development in some very difficult circumstances. But, you don't have the tools to do that today and I think policy wise there is the need to get some help in this. We can do analyses of demand allocations in regional systems—and I've done many myself over the years—and to a large degree, without the ability to move or motivate people to use different airports or to motivate carriers to go to different locations, it is very difficult to affect any actual change. You can make all kinds of projections and they look very nice, but when it comes down to it, the passenger is going to go to the airport that has the best service and is closest, and so is the shipper.

William Fife: I am Bill Fife with Frederic R. Harris in New York. This is really a question and an observation. As some of you know, I chair a peer review group of about 100 airports in the United States and Canada and the agendas of these groups for the last 13 years have had at every single session at least one-third of the discussion on the environmental side. So, that has set a certain tone of where the problems are. It just reflects Jeff Thomas' comments about how long it takes to get things done.

So, the question to the panel is this—short of actually exempting the airports from the National Environmental Protection Act of 1969 (NEPA), what can we do to get the process moving, to have the FAA be an advocate for airports and for change, as opposed to what happens in some of the regions today? Second, an observation on noise: What I've heard from the group is that it is not just the local folk. In fact, it is typically less of those. If you look at the noise problems around Newark, it wasn't the people in the Ironbound district, who probably have more noise than any people in the rest of the world, who complained, but in fact, it was folks who live in very affluent neighborhoods, where the planes were at 30,000 feet. It was the overflight noise that generated those issues. So, I would be interested in hearing not just from the panel, but also from some of the other participants about those two issues. Thank you.

Thomas: I wish I knew the answer to that Bill. I don't have any bright ideas. I'm not suggesting that we exempt airports and capacity increases at airports from NEPA. However, I'm suggesting that certain safety-related improvements be exempt, not entire airport development. I think we have to just slide our way through the process, as difficult as that process is.

Blomme: On the NEPA requirements, aren't we seeing more and more regulations all the time, which to some of us, appear to be lengthening the amount of time it takes to get approval for airport construction projects that could help alleviate capacity concerns, to some degree?

Thomas: I don't think the process is becoming any easier. Mr. Cutler is sitting back there in the audience and can certainly talk about this process better than I can. But certainly from the experience of trying to get through it, it hasn't gotten any easier and it won't get any easier, particularly in these major urban areas. Air quality looms as a huge issue for airports in urban areas, and we have just seen the beginning of that one. That is a massive problem.

Blomme: We hear about things like green aircraft, and in fact, that is going to be one of the major discussions at the National Aviation System Planning Symposium in May. But aircraft like these that will have reduced noise and pollution will take some time to appear in the fleet and I do not think there is going to be a real quick turnover, although our friends from Boeing might feel differently. You're still unfortunately stuck with the problem of ground vehicle pollution. For people living near the airport, while I don't want to discount aircraft pollution, it is the ground vehicle pollution that matters.

Richard de Neufville: In the interest of a discussion, I would like to revisit this notion that Jeff Thomas talked about in terms of wayports and why they are a bad idea. Certainly, the idea of constructing a large new airport from scratch in the middle of nowhere is hard to accept. But if we think back a bit to the construction of Dallas/Fort Worth International Airport (DFW) about 30 to 40 years ago, Dallas was still a cow town. Compared to New York or San Francisco, and similar places, it wasn't where the need was.

Orlando, in the same way, wasn't where the need was. The need was in the major cities, for example Miami. In a certain sense, if we take that into perspective, we have been successful over the past generation at constructing facilities that have supplied major capacity. We didn't imagine, and it is still hard for people in Miami to imagine, that Orlando is going to be another gateway to Latin America, and yet various airlines are starting to use it that way. We didn't imagine for a long time that DFW was going to be the kind of place it is now. When you thought about Love Field 40 years ago, it wasn't viewed as a major airport. It was out in the middle of nowhere in many respects, aviation-wise. So, I think that properly conceived, this notion of building major capacity, not where it is currently needed but where demand will develop, as in Orlando or Denver perhaps, or DFW, is something we need to keep in mind. Just a thought.

Blomme: I would like to ask Tom Brown from the Air Transport Association—do you or your colleagues have any thoughts on what is being expressed here about developing new airports before the demand emerges?

Tom Brown: The concept of a wayport is a good one if, in fact, you accept the notion that you build capacity where there is not a need today, but will be in the future. We have two problems with this. Number one, it doesn't solve the problem where the problem exists today which is the big cities. Number two, with any of the airports that have been

built way out, with maybe the exception of Dallas back in the 60s, there was a certain level of local demand there beforehand. Certainly, Denver today gets a large percentage of its traffic from local origin-destination (O-D) demand. If there isn't that kind of demand to support these airports, then the airport itself probably isn't going to be a feasible wayport in the context that it was described, because you've got to have feeder traffic, certainly, but you've also got to have the O-D traffic to support the concessions. As Jim Wilding has found out, when we built the new terminal at National, the concession program is not nearly as successful as everybody hoped it would be because everybody runs right through the airport. You don't have people sitting there doing the things that you need to support concessions, although the terminal itself is successful.

So, you've got to have some level of traffic there generated locally in order to make a go of the airport to begin with. The other problem with wayports, of course, is you still have to have an employment base. If you don't have the employment base, you don't have the employees to man and run the airport, then you don't have a functioning airport. By definition, if you build it out in the middle of nowhere, you don't have the people to run the airport, so how are you going to make it work? If you build it where people are, you probably have built it in a relatively populated community to begin with. So, we have a lot of thoughts on this and there is a lot more that I could say. We have been through this a couple of times in the last 15 to 20 years, and we will probably go through it again.

Part 2

Following the presentations on:

Aircraft Technology: Impact on Airport Capacity

Robert Kelley-Wickemeyer, Boeing Commercial Airplane Group

Air Capacity: Limits, Technology, Strategy

R. John Hansman, Massachusetts Institute of Technology

Matthew Coogan: I'm Matthew Coogan and I've been given the job of coming up with ideas that are so outrageous that people will listen while they are eating lunch. I want you to know that one week ago, in preparing my remarks, I took out everything about the people canisters coming out of the 747 because I thought it was so outrageous that I would lose credibility entirely. In fact, I'm fascinated by your work, or your colleagues' work, and I have 100 questions about the implications of a person canister and the integration of air systems and ground systems, but I'm not going to ask all 100 questions. Let me just ask one—have you considered the possible impact of such a program on the market for westbound red-eye flights, which is to say, go into some form of sleep created either by God or by chemical and wake up in this pod and the airplane trip is scheduled at the will of the airline?

Kelley-Wickemeyer: As tempting as it might be to draw on my experiences from Berkeley, I won't go into the chemical stuff. However, there is talk about somebody, for example, going to a nice hotel in London, having dinner, going to bed in one of these

canisters, and waking up in Chicago. John Hansman hit it right on—you put your baggage in the pod; you and the pod go together so when you get to the Avis lot, say, your suitcase is right there.

Gosling: One of the difficulties with handling baggage is that it can't tell you where it wants to go, whereas if you have the people in a pod, they can call on their cell phones explaining exactly where they are.

Blomme: I don't know if you can give me an answer today or 20 years from now, but let me ask the last two speakers from an aircraft manufacturer's standpoint, or somebody who has done a lot of research on aircraft, what are the top one or two things that the aviation industry can do—the airlines, airports, everybody—to get airlines to switch to larger aircraft, rather than, as I see it, this coming age of the RJs and increased traffic? We have seen estimates of a 10 percent increase in traffic at LaGuardia Airport this coming year due to RJs, both in the press and from the Port Authority. Having once upon a time run the maintenance and operations at LaGuardia and since then having done a lot of long-range planning studies for LaGuardia, that really concerns me. What can we do as an industry to discourage this and yet serve smaller markets?

Hansman: You won't like the answer. The answer is you have to go back and re-regulate. If you look at the trend in traffic and the capacity problem, it has followed the deregulation cycle as deregulation has moved from the United States to Europe and is now moving to Asia. So, one solution is to go to some sort of regulation, but that is not very attractive.

The other alternative is to just let it happen and let the markets sort it out—those are effectively the choices. I don't think we will be able to manage our way out of the capacity problem. There is nothing that I see on the horizon that will provide enough capacity to meet Richard de Neufville's projection of a three-fold increase in traffic. So what will happen is that some resources will become more valuable. I'm not sure the best way to set up a market, whether you want to do it at the gate level, or you want to do it at the slot level, or whether you want to do it at the seat level. My guess is that those seats that are in greater demand will become more expensive, and that it will be shaken out on a market basis.

Blomme: Let me ask Robert Kelley-Wickemeyer if engine noise, as we perceive it on the ground, was eliminated—picking up on something you said at the end of your talk—what percentage of noise would remain due to airframe and unmodified landing gear as we know them now? Can you guess at that for me?

Kelley-Wickemeyer: Since it is a logarithmic scale, percentages don't really mean that much, but airframe noise would probably be dominated by how the leading edge devices are positioned on the wing and how noisy the landing gear cavity is. The landing gear would become the dominant noise source and it would require a lot of detailed changes to the airplane to affect it.

James Crites: I'm Jim Crites with DFW International Airport. One of the things that the panel mentioned on environmental issues is emissions. One of the things on the noise

side that was not discussed was overflight noise. At least at some of the environmental hearings and public hearings that I've attended, there is great concern that now we have reduced the noise levels near airports, we have a growing concern with higher frequency of overflight activity. I was wondering what the panel thought of that. Secondly, regarding emissions, I would make the observation that from a noise standpoint, I can move people. I can accommodate them and if I properly accommodate them, then the issue is technically solved. Emissions are another matter. I can't move people out of the way of emissions. In addition, local and regional authorities have a very serious issue—they have to come into attainment, and there are real, live monitors out there measuring real, live air pollutants. Therefore, they are somewhat constrained, and if you look long range severely constrained, as it relates to what they can and cannot do with regard to emissions. So, I was wondering what the panel's thoughts are on overflight and aircraft engine emissions as they relate to what we can do about them, and then secondly, how they see them as being constraints to future airport development?

Kelley-Wickemeyer: Let's start with overflight noise. The problem with overflight noise, to my way of thinking, is that you can get background noise levels that are so low that you can hear almost anything. The story is told about a fellow in the Grand Canyon observing two airplanes flying over and these are airplanes at cruise altitude. He reported that he could hear a 727 for about 7 minutes, and a 757 for about 3 minutes. But yet, these are airplanes at cruise altitude. Although we can make improvements to engine noise, I don't see a way of ever making airplanes quiet enough so that you won't be able to hear overflight noise if your background noise level is low enough.

As far as emissions are concerned, the most practical way that I see right now for reducing emissions is improving the fuel economy of airplanes—just burning less of the stuff. There might be opportunities to do 10 to 20 percent improvements in the engines, and if the design of airports will allow a further increase in wingspan, another few percent on top of that. But, as far as radical changes, we haven't invented the technology yet.

Hansman: I will just say two things. One is that with the overflight noise, you do have this problem of psychoacoustics, which essentially is when you have a person who has become hypersensitive, any airplane noise will be detectable by them. This is one of those issues that Jane Garvey was talking about earlier, which is how do we, as a society, decide we are going to value quiet and how much credibility do we give to noise concerns.

With regard to the emissions issue, I do think there are some significant savings to be had again in the way we operate the airplanes. Go out there and look at it—we spend a lot of time with airplanes sitting with their engines running on the taxiway. So, that is something I think we can do. That is the only quick one that I can see.

Thomas: We can begin to look at shifting the priorities of the way we operate the system. Today we tend, because of cost, to operate the system with a priority on arrivals. We want those aircraft down on the ground for safety and operating cost considerations. On the other hand, from an emissions standpoint, the place you don't want the aircraft is sitting on the ground idling and you try to reduce departure queues. So, we may have to begin to shift the emphasis to get the airplanes off the ground very quickly.

Hansman: This is a manifestation of the first-come, first-serve system, which is that your position in the departure queue is based to a first order on when you push back into the system. So, there are ways you can go to virtual queues where your position is established when you're ready, and there are some gate management issues that fall out of this, but I agree that this is the approach that makes the most sense.

Gosling: One comment I would add to the discussion of overflight noise is that the point is well taken that in very quiet environments, almost any aircraft overflight could be heard by some people, especially people who have particularly sensitive hearing or are sensitive to the issue from a sociological standpoint. But, I think we do have to recognize that in the terminal area, you have levels of overflight noise which may be of greater concern to a larger number of people, and we may find ourselves in a situation where some of the air traffic control technologies we are looking at in order to increase capacity will result in aircraft over flying communities only on an occasional basis, communities that don't normally have overflight activity, and therefore there may be issues that arise as a result of that.

We may find ourselves in a situation where there is a trade-off between flexibility that we need for the capacity reasons, and political assurances that have been given to certain communities that they will not be over flown. That will then, in turn, put constraints on the sorts of operational procedures that can be implemented.

James Craun: I'm Jim Craun from GKMG Consulting. Emissions has been brought up as one of the real coming problems. Winglets improved for fuel efficiency are probably the best way to reduce emissions—is there any thought from an engineering standpoint to retrofit wings with winglets?

Kelley-Wickemeyer: Yes, we have all sorts of programs looking at retrofitting wings with winglets. We are also looking at retrofitting wings with wingtip extensions. The wingtip extension is a less expensive way of getting the same or greater benefit, but it doesn't have the Detroit sex appeal that winglets have.

Hansman: Another thing I would point out is that it is my understanding that it is local emissions that are going to be the big problem—not the cruise emissions. So, winglets don't buy you very much in terms of the takeoff and landing. They really are cruise efficiency. So, the things that probably have more promise are high-lift devices that would get you up and out faster, and again better burner technologies and things like that.

Gosling: However, it is probably worth noting that while from the standpoint of airport planning, it is regional or local air quality that is the driver. There are concerns being raised from the global warming standpoint about total emissions through the whole flight cycle. We shouldn't ignore those factors as well.

Crites: One other question for you all. It was brought up early in the morning and also by the panel that we need to consider the time to market for improvements, whether they are traditional, new concrete or what have you, or new technology. Apparently there are a number of airports that are utilizing prototype systems, concept systems, getting great gain out of them, but they are going to be under development and testing for a number of

years. Other airports don't have the ability to make use of those systems because they are not certified yet. We have a lot of people trying to engineer new solutions. What does the panel see is necessary to engineer new processes, to bring proven technologies to market, whether advanced traffic management systems or whatever, to get those out and fielded in a more expeditious fashion?

Hansman: It is a good question. I will just use the Global Positioning System as an example. This is something that literally there are people out there with their hand-held units sticking them on the panels of their airplanes and using them, although they are not certified. Again, this is a personal opinion—I think that we have tended to over-specify air traffic control technology requirements. So, that imposes a delay. So, you actually have to look at what you're using today and what you're proposing and whether what you're proposing is better than what you're using today. It is my understanding that the reason why the Wide-Area Augmentation System is not yet online is that there are some hazardous failure modes that have been identified that don't fit within the criteria. So, if you take that hazardous failure mode and you compare it to what happens when your instrument landing system (ILS) receiver goes inoperable and just gives you a hazardous failure indication, you would probably not certify an ILS receiver today under the same criteria. So, it is an interesting and fundamental problem—have we over-specified our system?

I'll give you one other example. Separation standards—the problem we have with current separation standards is that they were not engineered to the level of specification that we would require today. So, we don't have the analysis to go back and look at and say we can maintain the same level of safety, because we only have this anecdotal level of safety based on our experience, which, by the way, doesn't yet meet the 10^{-9} standard because we haven't been around long enough.

Kelley-Wickemeyer: And it is because of things like if I'm successful and invent something that destroys wingtip vortices, there is a whole flock of stakeholders that have to get involved to really believe that is true—be it the Air Line Pilots Association, the air traffic control people of the FAA, or NASA. So, I've got to keep all of those people involved in the evaluation and the development of the data so that they believe that it happens. It isn't just me saying that it is so.

Richard Marchi: Dick Marchi from the Airports Council International. Assuming that we don't introduce some level of regulation to help with the delay problem that you and John Hansman talked about, have you or any of the other academics in the room done any modeling to show us the facts on the increased levels of delay, the number of delay events we might see per week, the duration, and all that sort of stuff, especially in the terminal area? I know that Russell Chew did some work in the en-route environment that has indicated what the dimensions of the problem might be. But, is there anything that has been done in the terminal area that will begin to help us figure out how you plan airports and what issues are going to arise if we get into that environment?

Hansman: There have been a number of studies that have looked at delay affects with different models. They tend to be okay as far as they go. The problem is, and again this is only my assertion, the system is so complex and interdependent that we don't really understand the interactions and what happens. So, Russ Chew was just saying when we

were talking this morning—if you have a slow-down in New York, that slow-down propagates to Chicago and then propagates to Dallas and so forth. There are these interactions that are not very well understood throughout the entire system, either through a particular airline system or through the national system. So, I don't have a lot of confidence that anybody can really predict to a high degree of accuracy system wide what is going to happen, although you can do it at a crude level.

Russell Chew: Russell Chew with American Airlines. I think as we talk about technology, and it is something John Hansman mentioned regarding collaborative decision-making, when we talk about capacity, we tend to think about the capacity of the airspace and relate that directly to the capacity of the airplanes to accommodate the passengers, the size of the airplanes. Actually, anyone going back through Chicago tonight has to be concerned—there are a number of storms hitting Chicago today. All of you would like me to manage the capacity of the airplanes so that I would page you or call you right now and tell you that I'm switching your flight from flight 123 to flight 456 so you know you have a seat through Chicago tonight and get to your destination. So, collaborative decision-making in technology and managing capacity has to be seen in the context of being able to manage the way you handle passengers through the capacity. That is why reducing the variability of capacity in weather events and things like that is very important to us, not only reducing the magnitude of the variance, but also the predictability of when it gets good again so that I can tell you when you are really going to be able to fly. That is going to get us through the next 5 or 10 years, hopefully, even with the growth we have. Even today, my average load factors are not in the 95 percentile, but in the 70 percentile. This weekend it might be in the 80s because of the weather. But that means there are still a number of seats that go unused and I can cancel flights and get people into those seats and be able to manage the capacity of the system. So, I think those are the kinds of technologies that we need right now. The kind of technologies that we are pursuing in terms of terminal capacity and eliminating delay, are not only to eliminate the magnitude of delays, but also to increase predictability of it. Arrival time management is going to be more important to us as airlines than the actual magnitude of the delay in total.

Hansman: I would say, however, that I would be nervous if your load factors were at 90 percent. There is no longer any robustness to the system so that if you do cancel a flight, I may not get to take my trip for another month, which may be a good thing.

Crites: One of the issues that was raised earlier, and it is another environmental question—local communities are very constrained. There is good promise in the use of alternative fuels for the all the ground-based emissions for the vehicles that operate in and around the airport. Now, the Department of Transportation (DOT), in their Transportation Efficiency Act of the 21st Century (TEA-21), laid out monies to help offset the premium cost for the acquisition of alternative fuel vehicles because they saw them as a way to benefit road development projects. Program funds will be put out through the metropolitan planning organization (MPO) for distribution under the Congestion Mitigation and Air Quality improvement program for local roadway projects and the private sector. In the latest Aviation Investment and Reform Act for the 21st Century (AIR-21), in light of the fact that airports are being challenged severely to reduce their

emissions at the airport, I was a little bit surprised that we didn't mimic what the DOT did in TEA-21, because if we're serious about creating new capacity at airports and you want to get through these environmental approvals, you positively have to address the environment. To that end, at least the DOT seems to have led the way with TEA-21 to provide monies to help overcome the premium cost for acquisition.

We know that the operating cost of alternate fuel vehicles is less than diesel fuel vehicles. So, it would appear to me there is an opportunity there not only with emissions but with other avenues that the FAA could help out in a similar way that DOT did to provide for some monies in the future, at least to targeted airports that are looking at strategic growth or to expand the entire system. I would be interested in the panel's thoughts on that concept.

Thomas: The problem tends to be one of aircraft and access vehicles. You can have zero equipment operating at that airport on the ground with no emissions and it won't make much difference. The huge numbers here are tons and tons and tons of pollution from aircraft jet engines and CO emissions from automobiles getting to the airport. It is good community relations to clean up the ground support equipment, but it just doesn't add up in the numbers.

Crites: Here is the distinction. While I share some of your views, the airport does have control over certain aspects of ground activity. The airport, as we have presented to our state environmental agency and have been backed by the FAA and Environmental Protection Agency, does not control aircraft operations. So, we are very strong supporters of anything that might reduce or eliminate aircraft engine emissions at both low and high altitude. But, as we go through a NEPA process and general conformity process, over that which we do control, and our region is in between a rock and a hard place, we have to reduce emissions—where do we get them from? In our region in particular, there is no place to draw them from. We don't have big industry. Obviously, we are a logical source of that. But, the point is, we would probably be capable of obtaining environmental approvals for programs much more quickly if there was a source of funding out there to help convert the 19,000 vehicles at DFW airport to alternative fuel. As you say, it would be a goodwill gesture. I also think, given that we are a magnet for transportation, that we serve as leadership for the rest of the region if we synergistically get enough alternate fuel vehicles out there through rental cars. It is a novel concept that most cars don't need to re-fuel while they are rented. So, they are taking advantage of that and they are doing quite good things both in California and Texas. But, the point is the DOT saw a need for regional MPOs to succeed in their environmental approvals. They provide funding for it and it might be appropriate to do the same on the aviation side of the house.

Randall Malin: My name is Randy Malin. I'm an FAP, which stands for former airline person, now a consultant. I've often been reminded of the old adage that you hope for the best but you should plan for the worst. I think in my 40 years in this business, we have done a lot of the former and not very much of the latter. I said to Jeff Thomas at the coffee break that I appreciated him bringing up the concept of high-occupancy vehicles in place of first-come, first-serve and I commend John Hansman for uttering the hated word "regulation." If you think of John's last slide, at the very bottom he had the word "leadership." My question is where do we look for the leadership on how we address the

worst case? Those of you who were around in 1968, the year that led to slot controls, may remember the 4-hour trips between New York and Washington with a refueling stop at Hartford, Connecticut. I don't think that is an acceptable solution. So, where can we look for leadership and perhaps a small group off to the side addressing what do we do if gridlock occurs and some of the engineering marvels that we have talked about this morning don't come in the time we want? Do we look to Congress? Certainly the events of the last month say we can't look to Congress because they said the solution was to give RJs unlimited access to LaGuardia and they also told Dulles' Jim Wilding that it is time for him to have long-haul flights at Ronald Reagan National Airport. So, that is not a good place to look. Do we look to DOT, or do we say it is a hot potato and throw it back to Congress? Do we expect the airlines to show some sense of self-interest in taking unilateral action to limit the penalty of delay? I don't think that is going to work either because history says what they will do is just pump more and more traffic in there and kind of hope that somebody else blinks first. So, where in our industry do we get the group together to address this very difficult political issue of admitting that the concept of total free entry and free access has always been a sham, from the time it was first proposed as part of deregulation? And, if and when regulation, by whatever name, has to take place, how will it be implemented?

If you take an airline's perspective right now and let's say you're head of fleet planning, how do you plan your fleet if you don't know whether or not larger airplanes may be mandated, or a hub approach may be the rule of the day? Do you just go out like the major airlines are doing and try to buy hundreds of RJs right now, when in three years they may not be acceptable at certain airports? So, where do we look for leadership?

Hansman: I'd just say two things. One is, I'm worried about the lack of multi-modal leadership. I think on the airplane side we have a notion of where to look, but I'm not sure who is responsible for multi-modal issues and I don't really see DOT doing it. I'll just give you air traffic control's perspective. If you look at the history of air traffic control, major transitions have occurred after some crisis, which is a concern. So, you now project forward and ask, what crisis would cause this to become such an issue at the national level that you would be willing to change the way you do business? It is an area of concern and I think there are some crisis modes that you can envision. I'm not sure I want to say them here, but I'll tell them outside.

Okay, I'll give you one. Geoff Gosling and I were talking about modeling the system for safety analysis. Envision if you will, a bad weather day on the West Coast with fog up and down the coast, and then an earthquake occurs that takes out one or two air traffic control centers. It is not clear to me that there is enough capacity to get all the airplanes that are in the air onto the ground before some run out of fuel. Some of you may have noticed that I forgot to mention one of the things on one of the slides I had was degraded mode operations. If you are going to increase the capacity of the system, you have to be able to get all the airplanes down under degraded operations in a safe environment. So, if you think about something like that—I agree that it is pretty far-fetched, but I think there are some gridlock scenarios where you can envision a situation where some airplane runs out of gas before they could find a runway that would take them.

Gosling: With that, I'm going to close the morning's session with the comment that the discussion this morning has demonstrated that decisions about the future development of the airport system need to be informed by a better understanding of many of the topics that we've been talking about. So, I think one of the questions that we need to think about as an industry is what is the research agenda on the airport side? We're spending a lot of money on R&D on the air traffic control side, but nowhere near as much trying to understand the system operation on the airport side. Yet, from what we have heard from the speakers this morning, that part of the problem may turn out to be as difficult and maybe more important than solving the throughput question in the en-route environment.

LUNCHEON SESSION

Airport Capacity

MATTHEW COOGAN
Consultant

Thank you, Mr. Chairman. Something pretty exciting happened to me while I was doing the historical research for this presentation. I found that 50 years ago today, that is the year 2000,—or Y2K as they called it then—50 years ago today there was a meeting in this room about the subject of airport capacity. And in that meeting they kept examining bits and pieces of technological solutions to make piecemeal improvements in the capacity of the aviation system. They had no idea, back then, that the answer to the question was institutional, and not technological.

I got a phone call from Larry Kiernan, who is 110 years old today, and he suggested an approach for a lecture on an historical basis. Larry said,

> "Look, they all know how they got here. You don't have to describe the technology of today, and all the people-pods they travel in! You don't have to describe the conditions of today because everybody knows what the system of today is, and how the old issues were solved. But, you could do an historical analysis of how the we solved problems that they perceived 50 years ago."

I've looked at this historical record, and they perceived there was a capacity problem in the national airports system. So, I'm going to talk to you about how that capacity problem went away. As you all know, we don't have it anymore, and I want to talk to you about three aspects of it. I want to share with you our conclusion that a lot of things happened over that 50-year period, but the main changes were institutional and not technological.

I think we can break up the things that happened over that 50-year period into three categories. Most important is how we changed the fundamental idea of the transportation providers, who they were, who they are, and how they make money. Second, we learned that our information technology wasn't helping and how we had to fix this. Third, we changed the physical design of major airports, but we won't talk much about that.

If you want to take one summary note and then fall asleep, the message would be that *the problems were essentially institutional in nature, and that the free market solved them*. Now, it wasn't necessarily the free market that they knew 50 years ago today. It was a rougher, meaner, more cutthroat free enterprise which hit many industries but hadn't yet hit aviation. When these cost-cutting pressures happened, the solution to the problem happened in response to those pressures.

The free market wanted to offer highly differentiated brand products to retain the loyalty of the customer. The free market wanted to drive down the cost of product delivery, no matter who got hurt—and this was a little ruthless and we have documented that. The result of those two forces, keeping separate brand identification on the one hand, but ruthlessly driving down costs, gave us the solution that we have today that works so well.

As a historian, I would like to start the story of change in 1980. Between 1980 and 1985, the American President Lines, something that used to be a steamship company, was reorganized. We refer to that period between 1980 and 1985 as the "logistics revolution." On the screen you can see some boxes representing trip segments. You could look at this slide and see columns, or you could see rows. Today we all read these lines, as rows, or horizontal lines. You're reading about a truck that picks up a product and sends it to a ship and sends it to a train, and sends it to a distribution facility. But, I'm telling you, 50 years ago or 60 years ago, it is amazing, people didn't think that way. They thought in these vertical categories called modal operations and they couldn't get out of them. It wasn't until they got out of them that they found the solution.

So, they thought of measures of modal efficiency. The CEO of the American President Lines, back in 1980, said I imagine, "I am the head of a steamship company!" and he was proud of it. This is a true story—5 years later, there was a total reorganization of the company. The President of American President Lines (and everybody else that survived) had to define themselves as *managers of an integrated service company*. They didn't describe themselves as a shipping company anymore. There is a fundamentally different way they had to learn. What is remarkable is that this company learned so early, but it was just the first.

Over the 1990s, people discovered there was more power in logistical control than there was in that other stuff—providing the capacity. So, you would sign a contract for just-in-time delivery somewhere in Kentucky; you would track and monitor the location of thousands and thousands of shipments. You would have those shipments pulled by locomotives from, for example, Burlington Northern. But it was not important who provided the modal capacity: that is something that the revolution at the American President Lines told us.

We can call the group on the left of this slide the integrated service providers. They were the new kids on the block. Relatively speaking, the modal capacity providers had become less important. Over at United Parcel Service, they understood this, and in the 90s, they put billions of dollars (not millions) into a program of tracking and control so they could monitor and track the location of all of these products. As for modal capacity, who was actually pulling the train? I think that picture shows a Santa Fe locomotive, but that is not important. It wasn't really important to the customer, or to them, who actually provides the modal capacity. The question is who had the logistic control? Who was dealing with the customer?

Well, back in 1992 there were a group of young people, including George Schoener, Larry Dahms, and Larry Kiernan. They organized a TRB Conference in December of 1992 in Irvine, California, and they introduced at the conference a man named Jack Helton. Jack Helton was Vice President of CSX/SeaLand and he gave one of the most remarkable presentations the participants had ever heard. He said that decision makers for many years believed that working alone with dedicated assets, ships, and everything, was the way to maintain a competitive advantage in the marketplace. If you wanted to control an industry, you owned it all and you ran it all. Then Jack Helton said that during the 1980s, the operating philosophy at SeaLand evolved from one of being driven by the market, competition, and costs, to one of an "obsession for the consumer."

In this example some of those vertical lines of organization now are replaced by these horizontal lines of cooperation. He was quick to point out that just that year, a path-breaking contract was signed between the CSX/SeaLand organization, and the Maersk

organization, which was their biggest competitor. The folks at SeaLand said, “for any given container, I need to serve the customer. I’m going to send that container across the Pacific and I don’t care whether it goes on a boat that is owned by CSX/SeaLand or a boat that is owned by Maersk.” The freight people called this *rationalization of capacity*. They talked about using the capacity that was out there as efficiently as possible. Of course, a key element of this was the creation of information systems, one of our three points, that manages this joint distribution and joint tracking function.

So, if we look at what happened during this period, we find that it happened all through the transportation industry. The strategy of reliance and dedicated assets, the thing you must own, part of this vertical stovepipe thing, was replaced with the strategy of shared asset utilization. Now, the joint routing and dispatching algorithm optimized effectiveness of capacity and the result was better utilization of the capacity that was already there.

Now, at about the same time, another group at TRB was studying the structure of transit organizations and they found a real interesting one in Gothenburg, Sweden. They found a situation where the transit people had been stuck in their stovepipes. There were some people running a transit service for the hospitals, some for the elderly and some with disabilities. In this town of Gothenburg, late in the 1990s, they changed it completely. They went for a program of joint dispatching and management, which designed specific services for specific customers. As to who runs the service, they said, “we don’t know who they are!—it is whoever wins the bid—a bunch of taxi companies, a bunch of van companies, but they just carry out their assignments.” All four programs go through this process of joint dispatching and management; in the revised paradigm, they used shared assets, not dedicated assets.

This slide, with this one woman sitting at her computer talking to the customer, is a picture of a transit agency. In Gothenburg, they don’t own any buses—not one. The transit agency is the unit shown in this picture—that computer, connected to a program that does the automated dispatching, and somebody who deals with the customer. They have farmed out the task of providing service, modal capacity. Now the bad news for this operator is that they also automated the process of dispatching so you don’t even have to use a telephone operator! All this happened around the year 2000—that is 50 years ago.

These are some of the building blocks that influence the transportation system we have now. The first examples were from freight; that example was from a small scale transit business. What about the large scale transit business?

London Transport has one of the largest bus operations in the world; they restructured themselves in the 1990s. They restructured themselves to deal better with the customer. They formed a logistics center that designs, tracks, and evaluates services for the customer—but guess what? London Transport doesn’t own any buses, they don’t run any buses, and they don’t provide any modal capacity. They don’t run any buses. They outsourced that stuff. So, we have found the same metaphor existing in the transit industry and in the freight industry.

Back in the very end of 1999—50 years ago—we found this quote from *The Wall Street Journal* about an organization that really did continue to believe in the exclusive use of dedicated assets. Lord knows, if you had paid for a package to go by FedEx, every one of the vehicles would have been red, white, and blue, with the word “FedEx” right on it. But, that changed in the year 2000—50 years ago. *The Wall Street Journal* wrote,

> "FDX is trying to recast itself as a major provider of the very management systems that threaten the company. …Working at their best, such systems would select the most logical, most economical type of transport—air, land or sea—for delivering packages on time. ...So now, FDX is preparing to embark on its new strategy …FDX is creating a unique system that will automatically select routes for an endless number of Cisco shipments ...It's quite possible that FDX's system will route deliveries on ships, airplanes or trucks owned by other companies, even UPS." (*The Wall Street Journal*, 1999)

Well, it is interesting to see how prophetic were Jack Helton's words, which were said in 1992. It turned out that he had predicted change in the transit industry, and even at FedEx.

So, what do we have here? We have an organization that was at its peak, making a lot of money and saying, gosh we made a mistake. Frederick Smith, the founder and conceptualizer, understood the necessity to evolve into a system of shared asset utilization:

> "It took a long time for me to get across to people…how profound I thought this was going to be and what a different set of disciplines it was going to require to be successful. We couldn't continue to conduct business as usual."

He knew he had to deal with this change to deal with a changing market and change he did.

So, we get this revised paradigm and we get it over and over. We look at SeaLand serving the just-in-time delivery to customers and we learn they don't really care whether their package goes on a SeaLand ship or on a Maersk ship. Now, we look again, 10 years later, and see that FedEx says, I don't really care whether my shipment is pulled by a train or pulled by an airplane—I want to stay competitive in the market. It happens in a suburb of Gothenburg, and it happens in one of the biggest transit agencies in the world.

So, my argument is that the world we have now in 2050 had its beginnings way back 50 years ago, at the turn of the century.

Now, I would like each of you, if you could, to be polite for the next couple of minutes. I know I'm a historian, but sometimes when I look back 50 years ago, I feel like an anthropologist. I have to explain to you how they thought. Here we have all these institutions changing to become more flexible. And now we look at how the aviation industry was operated back then. You may not believe it, but let's look at it.

I did some research in an Official Airline Guide of the year 2000. I looked at schedules from Boston to Los Angeles, and I found that a third company—Delta—decided to fly the route that had been dominated by American and United. So, at 3:00 p.m. in Boston, there is a 757 that goes out with the word "American" on it. There is also a 757 that goes out with the word "United" on it at 3:00 p.m. There is a 757 that goes out with the word "Delta" on it. They are all going the same place, essentially providing the same service. Well, what happened between their world where you got stuck on the runway, and the world we have today? It is interesting. It was the free market. It was the cutthroat free market.

Fifty years ago a bunch of new institutions had a lot of money. In this "new economy," money started moving around and pretty soon the airlines were owned by new people. Different kinds of rates of return were asked for. And there they were—these four

airlines with their highly vertical organizations. Then the lawyers and the finance guys got at it. They said, internal to the company, let's separate out the portion of the company that owns the airplanes, maintains the airplanes, and flies the airplanes. Let's create separate divisions within our corporation, but make sure that any function that deals with the customer remains with us. We will keep this loyalty that we have built up over these decades and decades. And we will see what the free market does when we ask if anybody else wants to own the modal capacity provision.

Well, that was it. It seems that the big international leasing companies, from Ireland and from Singapore, and the insurance companies said, "you mean I could get a chance to own a good percentage of the modal capacity of the national airlines system?" Immediately, they were bought up. They reconfigured themselves. This foreign money came in from all around the world and created many modal capacity providing organizations.

Then the four airline organizations restructured themselves to become the integrated service providers. One of the first was this man named Richard Branson. He wanted to provide this certain kind of customer service on trains, and he wanted to do it on airplanes, and he sold his company to Singapore for more billions than I can even think about. He had a lot of money and he helped influence these new creations. They didn't call themselves airlines—they called themselves integrated service providers. Their job was to sell you a ticket from your origin to your destination. This was defined by the customer: it could be airport-to-airport or home-to-home.

Over this decade, the belief in the use of dedicated assets was abandoned, just the same as it had been in the rest of the transportation industry. The organizations formerly known as airlines decided to outsource the task of providing modal service. This slide shows the first of the jointly operated planes. The red airline would lease the back 200 seats, and the blue airline got the middle 200 seats, and a white airline got the front 200 seats, and boy did they compete. I'll tell you, the competition was fierce. They competed with frequent flyer miles and they competed more aggressively than they had before when they were all flying on three separate 757s. The only thing that changed was the efficiency of operation.

In this presentation today we are interested in this issue of airport capacity. But, that is not what the owners of the restructured airlines were concerned with. They were concerned with paying for three landing fees, three sets of gates, three sets of ground people, and six people in three cockpits versus two in one cockpit. The drive to select with the most efficient modal service provider became stronger and stronger, and this became the mode of operation just like it had become in the freight industry.

High capacity aircraft were designed for the American domestic market. Without going into details, there was a very large company in Seattle, Washington, that was uniquely positioned to make large planes. The now familiar 767 became the workhorse of the industry, a role once played by the 737 and the 727 before that. But before the adoption of the new paradigm, this manufacturer of efficient airplanes was having trouble convincing the U.S. airlines to buy their biggest planes. Under the new system, the restructured airline company would buy 25 percent of the seats on each shared flight. With this system, they all could offer hourly flights to L.A., but with only one-quarter of the aircraft operations.

So, the implications for cost minimization were what drove it. The academics, the architects, the do-gooders like me, we didn't do it. It was the desire to minimize cost. Did

they fly a lot of planes to Chicago? Of course: for passengers who had an origin or a destination in Chicago! O'Hare became one of the great origin/destination airports of this world. It was used by people who live in and near Chicago; but when the new airline managers looked at the cost of transferring a person with the delay in Chicago, versus routing through Birmingham or Topeka, it became clear there were cheaper ways to make connections. Remember, they have leased some of the seats on the Chicago flight, but they have also leased some seats through Alabama and some through Kansas, etc. So, the managers started re-routing everybody they could away from the congested origin/destination airports—it wasn't do-gooders like me, it was private enterprise that solved that congestion problem. They owned the capacity on all the routes and set out to make the most efficient use of it.

Okay—Part 2. What was the key that they didn't see back in the year 2000? It was the importance of information systems. Basically, the new philosophy was borrowed from the internet. Do you know how your message is routed on the Internet? Actually, you don't—they don't even tell you. The routing algorithms seek to maximize the capacity and utilization of the whole grid, every piece of it.

Now, if we are to get the airline customer to make use of all logical paths, it makes sense that we have to find a way to inform the customer about those travel options. In order for the customer to select a good path, the customer has to know the range of routing options available. So in the second decade of this century, the passenger information systems for the air were merged with the passenger information systems for the ground. Information systems containing airline routes and schedules were merged with information systems describing ground transportation, known as Advanced Traveler Information Systems.

The slides describe the trip options from a town east of Los Angeles to a town west of Boston. The intermodal integrated service company can route me via any of five airports in the L.A. region and four airports in the Boston region. The integrated service provider provides high-quality ground connections for all of these airports, so I have a lot of choices for this trip. Before the integration of the information systems, though, it was impossible to find out the total trip times and costs for each of these options.

I talked to my grandchild today, a little kid about this big, and I told her about this presentation I was giving. I told her that 50 years ago, when you started to plan a trip, you were asked to specify the airport of origin and the airport of destination before you could get information about your trip options. She said, "Grandpa, that is silly! The trip planning algorithm is supposed to tell you which origin airport and which destination airport to use. How would you know before you asked the algorithm?" I quietly explained to her that they didn't understand that 50 years ago. I tired to explain that they hadn't yet merged the fundamental information about ground access services with the information about airline services. She couldn't believe me, so we dropped the subject.

So for my trip from the town east of L.A. to the town west of Boston, some information about ground travel at the metropolitan area of origin is merged with some information about flight schedules and some information about ground travel at the metropolitan area of destination.

When they married all three, that was the key. They were at least able to tell the consumer the true origin/destination times of going up to Burbank or down to Ontario or up to Manchester or down to Providence. At first, that is all it was. It was passive. All it did was tell me my options—this is how much AOL Virgin is going to charge and this is

how much Cisco Disney is going to charge and this is how much all the other companies are going to charge.

But, over time, as we got to 2020 and 2030, the problem looked serious again. So, the combined information system evolved into a capacity maximization algorithm, which is to say half of the algorithm was thinking of my needs, the customer, but the other half was concerned with the optimization of the system. The algorithm took into consideration that it is only ten minutes more to keep them away from Chicago or it is only ten minutes more to bypass areas of congestion; the capacity maximization algorithm worked to spread the demand over the full grid.

The capacity maximization algorithm had to be operated by somebody. Who ran it? Was it the FAA? Was it the do-gooder society that I'm the head of? No. It was the airlines themselves because they were the ones who benefited most from efficient operations over the system. Remember, they own some seats in the first flight, some seats in the second flight. They don't care which flight you take. It is in their interest to get the full utilization out of the grid.

So, the system tells me what my options are, from these efficient regional solutions in California to the efficient regional solutions in Boston. At first, all it did was tell me what my options were, but then it grew. It grew to actually bias the information in favor of a well-balanced network and the pricing scheme set it up.

So, here is where we are today. Larry Dahms usually comes by Cisco Disney—it gives a totally new definition to the word "Mickey Mouse Airline." Yahoo Marriott? George took that because they routed him on something called a train coming down. They don't fly New York to Washington anymore. They routed him on a train. AOL Virgin? I always use them. The other one, FedEx–Martha Stewart? I'm so mad at them, they are not even on this list anymore: the hors d'oeuvres on that airline are awful.

So, finally were there any problems? Yeah, there were some. The airports were just plain designed wrong. They had become very big, but they were never designed for quick connection from every incoming plane to every departing plane, which is essential for the concept of the totally efficient grid. Previously, your walking distance was just from one United gate to one United gate. The integrated service providers required an easy transfer between all incoming and all outgoing flights. This became know as the CUTE airport. The Common Use Terminal airport is built on the principle that we know 100 planes are coming in, we know that 100 planes are going out, and it is our obligation to interconnect all those gates in an unbiased way.

Well, the designers worked on it and every model was outmoded. Even the airports with good internal circulation (the key for this level of interconnection) were using a primitive transit technology that goes station 1, station 2, and station 3. Everybody knew by that point that the personal rapid transit technology had taken over. So, you can get on a person pod at any one gate of arrival and are taken directly to your gate of departure. I don't have to show my smartcard because it is embedded right here in my watch. They used to use paper tickets, but that was a long time ago. My smartcard is embedded in my watch, so I touch the side of the person pod and it is the person pod's job to get me directly to the desired gate. The off-line personal rapid transit system provides me with a non-stop trip between gates, using a series of one-way loops.

So, in the third decade of the century, the first CUTE airport was built on the Kansas–Nebraska border. You know the old joke, "where do you go to buy a white elephant?" It was a good joke. The answer was you go to the border of Kansas and

Nebraska because this airport was such a radical idea. But, I've done a little homework—they said the same thing about Dulles and Cincinnati and about lots of them. Over time, people accepted it.

See, the airlines had said no way can I give up on a flight to Chicago and send it to the new transfer airports—there is too much risk. But, remember that was the old system. The airlines now own one-quarter of the space on just about every flight. So, starting up this service to the new CUTE airport, they all did it together. The fundamental logic of competition changed and today we have five new transfer airports, and they are all operated as CUTE airports.

So, essentially what you see is the mature system. The mature system is really interesting. It was led by the economic interest of the integrated service providers, of Cisco–Disney, of Yahoo–Marriott, of AOL–Virgin. All they were trying to do was maximize the return on their money. But, these other guys, the modal capacity providers—Mesa Aviation Services, Midwest Aviation, Florida Gulf—they are making a profit too; and they are all working to maximize the capacity through the grid.

So, I've used up my 30 minutes. I want to conclude by saying that, yeah, part of the solution came from physical facilities. Part of the solution came from information systems so that we could at least know about our options. But most of the solutions came from institutional change and that was what was so difficult for people to see 50 years ago. It reminds me of a quote that I've already given you—it is from Frederick Smith, the man who created FedEx—he understood this nature of change and he said,

> "It took a long time for me to get across to people how profound I thought this was going to be and what a different set of disciplines it was going to require to be successful. We couldn't continue to conduct business as usual."

As a historian, now in the middle of this century, I can only look back to that period right around the turn of the century and conclude it must have been a very exciting time to be a transportation manager.

AFTERNOON SESSION

Institutional Arrangements for Airport Planning and Alternative Ways to Manage Growth

Introduction

STEPHEN KAPLAN
Cutler and Stanfield

Thank you. We have a terrific afternoon ahead and it is really a time to turn from an incredibly interesting look ahead to exactly where we are today. I thought a little bit about coming and talking to you about the fifth anniversary of the Denver International Airport, to let you know that, in fact, it can be done and it can be done successfully with blips along the way. It is a terrific project and really shows what can happen when a community, the FAA, and the surrounding communities move forward and bring the airlines along with them.

Jane Garvey deserves a lot of credit for putting this together, and I want to thank her for all of her leadership and vision. If you look at what the FAA says its role is in the capacity enhancement plan, its goal is to expand the capacity of the national airspace system so that it is ready to meet projected increases in demand. Right there, the dichotomy is struck because the FAA, on the one hand, views the system as a national system. And, on the other hand, it completely reacts to what local airports say they need to increase capacity. Whether that airport is an authority or whether it is a local proprietor like a municipality, you've got this incredible sense of the airspace as controlled by the federal government, and the airport is in another place with perhaps conflicting goals.

Jane said something really interesting this morning that I wanted to call out because she said that the airport directors should bring their constituencies together. She called on the airport directors to find the political will to increase capacity. One of the contentions that you'll hear about this afternoon is that even when the airports and the airlines and the communities have a solution, the FAA will not step up to the table and assure that solution can be realized. Let me just take 2 minutes to explain a little bit of what I mean.

All of you know that when you're doing a major expansion project, you've got to go through an environmental impact statement (EIS). You still have to go through an EIS. A lot of EISs are based on assumptions, and in the process of making decisions, there are restraints or conditions on that EIS and on that project. But, it is virtually impossible for anybody to ever enforce those conditions and after 2 or 3 years, most people forgot about them and believe they were never there. The FAA will not do much to help in that regard.

FAA's Catherine Lang, earlier when I talked to her about this, suggested we think about this as where we were with rates and charges in the mid-1990s, and that we think about ANCA coming to a conclusion. Everybody knows Stage 3 has done what it needs to do and what it was called on to do, and everybody knows that we spent the last 10 years trying to grandfather airports under ANCA so that restrictions use didn't apply. Where is Part 161? Has anybody gotten the FAA to approve a Part 161? No, because the FAA has slammed the door shut in the face of the entire aviation community and basically said, don't bring us them. Do not bring us 161s—we're not ready to approve

them. The bar is too high. Well, I think that is about to change and I hope it does change. The FAA has got to move forward.

Now, this afternoon you are going to hear from some folks who have hands-on direct experience. We're going to hear from Larry Dahms, talking about planning models. He is not here just to talk about transit. He is going to talk about regional planning models. Eliot Cutler, a partner of mine, is going to talk about environmental considerations. John Martin from San Francisco is going to expand the San Francisco case study, and really make things interesting with some ideas that they are trying to explore. Then, we are going to hear later from Kevin Neels on congestion pricing.

AFTERNOON SESSION

Planning Models

LAWRENCE DAHMS
Metropolitan Transportation Commission, San Francisco

Let me acknowledge at the outset I feel a little bit like a fish out of water here. My business is mostly surface transportation. I only dabble in what you've been talking about, so this has probably been a more interesting morning for me than any of you because most of it was new.

One of the things I've been told, even though the problems I heard about this morning are much larger in the sense, more daunting than the ones that I face, I've been advised that you shouldn't tell people about your problems because most of the people in the room don't really care about your problems, and a few of the people in the room are glad you've got them.

But, in any case, it was maybe a little heartening to find that the air system problems look to be even more daunting than ours.

What I'm going to do is just quickly tell you a little bit about the extent of experience we have had on the air side, then touch upon the influence of the Bay Conservation Development Commission (BCDC) in the San Francisco Bay Area because that has a lot more to do with expansion of capacity than anything that we do, the current status of proposals and trade-offs, and then a comment or two about what is next.

For the most part, I think you can view what I'm going to say relative to the regional context as a warm-up for what John's going to say in a minute. The guy that has the real burden, relative to capacity in the Bay area, is John Martin—thankfully not me.

We do at Metropolitan Transportation Commission (MTC) play a few roles, one of which you might call the analyst, where we have done passenger surveys and other such things to gather data relative to what to expect in terms of travel, and particularly with our three major airports—San Francisco International Airport, Oakland, and San Jose—engage in forecast and capacity analysis, noise, air quality, and access assessments. In some sense, we are viewed as being neutral to supplement our analysis, supplementing the master plans and the environmental documents that are prepared by the airports for the FAA.

Even though we rely almost entirely in the work that we do on consultants, it does require that we have some residual staff expertise within our shop. So, our aviation analysis skills are there to complement the air quality analysis skills that are normally associated with the metropolitan planning organizations (MPOs).

A second role of ours is that of facilitator. The membership of my commission and the membership of our Regional Airport Planning Committee are largely locally elected officials. By running this analysis through these organizations, it is a way to educate at least a nucleus of the locally elected officials within the communities, and certainly education is one of the vital tasks that needs to be done. That, in turn, sets the foundation for us to do things like facilitating recent workshops and oversight noise and other such auxiliary tasks.

A third thing that we take upon ourselves from time to time is advocate. Back in the days when there was a Civil Aeronautics Board (CAB), we were testifying in support of

Oakland in terms of more service being assigned to that airport. We have also recently supported the preservation of the Regional General Aviation Airport in Santa Clara County, which is helpful in relieving the stress on San Jose Airport. We even intervened legally to attempt to preserve the airfield at Hamilton Air Force Base. I'm sorry to say we lost that fight about a decade or so ago. We were instrumental in development of state legislation to create airport land use commissions as a way to try to mitigate, to some degree, the encroachment of development around airports in California. We were a major sponsor in the development of the Bay Area Rapid Transit (BART) system extension to San Francisco International Airport (SFO). So, all of those are samples of a variety of things that the commission has done in order to be an advocate in support of the business.

We are bankers when it comes to surface transportation in the region. We owe much of our own influence in the region to the fact that we are bankers. People pay a lot more attention to bankers than they do to planners. We are not bankers, nor do we have any really significant authority as it relates to the airports other than being the forum for bringing the airports together and the regional regulatory agencies together.

Let me segue then into the regional organization that does have authority, and it is the organization that John Martin clearly has a difficult role in convincing if he is to reconfigure his runways at SFO and that's the BCDC. In the mid-60s, I was in Sacramento when this was going on, but at that time, much of the Bay was in fact being filled. We even had a brand new city right in the flight path as you fly into SFO and that was Foster City. There was even talk at that time of cutting down a good piece of San Bruno Mountain, which separates San Francisco and San Mateo Counties, and filling some more of the Bay for more development with the mountain. There were three women associated with the University of California at Berkeley who didn't think this was all such a good idea. They, together with a very colorful disc jockey in San Francisco, started gathering the storm that ultimately resulted in the creation of the BCDC to put a stop to filling of the Bay. The advocates at the time had a bumper sticker that said, let's fill the Bay with Daulwood. Daulwood was the State Senator from San Mateo at the time, who was supporting the continued fill of the Bay. The disc jockey, Don Sherwood, argued that what we should do is let them fill it, put all those little houses up there, and paint the roofs blue and we will never know the Bay is gone.

In any case, it was an interesting beginning and BCDC has had significant power since. They have a very strong constituency base, the Save the Bay Association. Their first plan, the '68 Bay Plan, had some very interesting findings. The findings acknowledged that the favorite location for lots of reasons for airports was along the Bay shoreline. That is where two of the three major airports are. They acknowledged that there was an expectation of sharp increase in the demand that airport growth clearly has land demands for the auxiliary functions, that a buffer zone was clearly needed. Then they called for a regional airport system plan—a plan that would do the kinds of things that my agency has done three times since then, and most recently in 1994.

In the absence of the plan, that '68 Bay Plan by BCDC had a couple of interesting interim assumptions. One was that there would be reliever airports that would take the pressure off San Francisco and Oakland. A second was that there would be a need for a regional agency to finance the expansion at the optimum location or by default, the airport with the dollars would expand and maybe with unwarranted Bay fills from the point of BCDC.

So, moving from that background of a strong organization and its first plan, its ’68 Plan, having those kinds of findings and policies, let me move then to the current situation.

What are the plans? Our plan, the one that is adopted by the Regional Airport Planning Committee or the Regional Airport System Plan of 1994, is a reference point. San Jose has just completed some work and they are expanding their two runways to 11,000 feet and some terminal expansion. They are environmentally cleared and construction has only recently begun.

Oakland, on the other hand, has an EIR for the terminal cargo and parking expansions. The environmental impact statement (EIS), as I understand it, is with FAA at this time. They are also initiating recently an alternative runway study.

San Francisco, as I’m sure you know, is engaged in major terminal and related facilities construction, scheduled to be finished later this year, as I understand it, and they are moving in the direction for performing EIR/EIS for the runway reconfiguration.

Now, moving back to the 1994 regional plan, it did acknowledge the capacity deficiencies at all three airports. But, it singled out Oakland to reevaluate runway capacity need at the so-called Stage 3 demand level. That was the easy answer in 1994. It avoided anybody getting into too much trouble. It was easy because at that time, San Francisco disclaimed the need for additional runway capacity in the near term and it was perceived that expansion at Oakland as opposed to San Francisco would involve less Bay fill.

The San Francisco runway reconfiguration work being done right now does not exactly fit that mold, thus it is a challenge to the 1994 conclusions and therefore has prompted the work that is now underway. So, for something of a year, we have been engaged in an update of our 1994 plan and that is something that is supposed to come to a close here along about June of this year.

So far, our projections that have been done differently than when they were done in 1994, nonetheless, tend to reconfirm the analysis of 1994. That is, vibrant demand, strained supply, and a problem to reconcile the two. It also identifies the same old trade-offs—the need to serve a growing Bay-area economy and as I’m sure you know, our economy is hot-hot. With scheduled adherence and the charts revealed this morning what I experienced flying out of SFO, they are not always on time. And, the reconfiguration would likely provide some noise relief. However, there are questions about Bay fill and air quality and other environmental impacts.

So, where are we then and how and who is to decide whether San Francisco can move forward? Where does the hot potato lie? One of the things that we’ve done in our analysis is conduct what we called a sensitivity analysis of some of the other things that might be done to take a little bit of the pressure off. Would FAA’s improved air traffic control make enough of a difference? Would Congress permit some sort of slot management scheme that would make a difference? Would technology, either on the airport or the airplanes, be sufficient to make a difference? Would the Department of Defense (DOD) look kindly on facilities … being converted to commercial use? Would that make a difference? Would the governor or the state legislature and the voters of the state support high-speed rail and would that make a difference? Would scheduling of flights by the airlines make a difference? Note that all of those places—FAA, Congress, the airlines, DOD, the governors, the legislature and the voters—none of those people report to MTC. As a result, it leads to the conundrum that on the one hand, our assessment does not suggest that the sum of the above would be sufficient to take enough pressure off, not to take seriously the need for capacity expansion. So, we see ourselves likely in a situation either having the

expansion or expecting deteriorating service and not serving our growing market. Those conclusions we are comfortable making. The BCDC, even though it is a very strong organization, would just as soon not be—this may be putting words in their mouth and I have to be a little careful about that—but in any case, I don't think they want to, all by themselves, have to be held accountable for saying no Bay fill and therefore no expansion. They would like very much to have us party to that decision.

My commission so far is comfortable with the idea of indicating that the capacity increase is essential if you can solve these other problems. The main other problem, of course, is Bay fill. But, in that we are not in a position of telling the FAA, Congress, DOD, and others what to do, or what the market will be, we do not believe we are in the position to say that the new demand out to be allocated to Oakland, San Francisco, or San Jose, but instead, let these other forces play out. That is a difference that engages a fairly significant debate in the region.

So, what is next? Should our Regional Airport Planning Committee, which I didn't say earlier but I'll say now, includes the three major airports and BCDC and MTC representatives—should it decide and essentially is it sort of a front for MTC deciding—would it matter? Should San Francisco International Airport push ahead anyway? If John Martin and his troops stumbled, will the states step in? Will FAA step in or who will step in? I don't know the answer to those questions. I was pleased to see that some other people admitted that they didn't know the answer to some of the tough questions this morning. I don't either. Again, I would say this is a big warm-up act for John Martin and I'm sure he is going to give you some more positive answers than I've been able to give you so far.

REMARKS

As the MPO for the San Francisco Bay Area, MTC is responsible for the Regional Transportation Plan (RTP). A Regional Airport System Plan (RASP) constitutes one element for the RTP. The RASP is prepared and occasionally updated under the general guidance of the Regional Airport Planning Committee (RAPC) which includes representatives from the three regional airports (San Francisco, Oakland, and San Jose), general aviation, MTC, the Association of Bay Area Governments (ABAG) and the BCDC, the State Division of Aeronautics, and FAA. The RASP was last updated in 1994.

The 1994 plan has been the subject of intense review by RAPC for more than a year. RAPC intends to recommend changes to the plan this summer. Given that background, this paper briefly describes MTC's airport planning role, the special influence of BCDC, the highlights of the current RASP update and speculation regarding next steps. MTC is an analyst, a facilitator, an advocate, but it is not a banker with any ability to influence the financing of airport operations or facilities (except highway and transit access).

As an analyst, MTC conducts passenger surveys, prepares demand forecasts and capacity analyses, and examines noise, air quality, and airport access impacts. These activities, conducted in support of the RASP, are supplemental to the environmental documents that are prepared by the airports for FAA in support of airport improvement plans. While most of this work is conducted by consultants on behalf of MTC, it is essential that MTC have the staff capability required to manage these consultant contracts. The MTC facilitator role is enhanced by the membership of the RAPC. MTC,

ABAG, and BCDC representatives are almost always locally elected officials. RAPC membership is a mechanism for educating this nucleus of elected officials. The RAPC work extends beyond supervision of plan development. For example, it is currently sponsoring a series of overflight noise workshops.

When the occasion demands, MTC has been willing to assume the role of advocate. MTC supported Oakland Airport, in its petition to the CAB for additional service years ago. It has supported retention of the Reid Hill general aviation airport as a San Jose reliever when there was community pressure to close it. It intervened in court in a failed effort to preserve Hamilton Air Force Base for civil aviation when the military abandoned it. MTC sponsored and worked to pass airport land-use legislation, which requires local agencies to consider safety and aircraft noise when making land-use decisions. And MTC was a major force in the long battle to extend BART to serve the San Francisco International Airport.

MTC allocates state, federal, and regional funds to support highway and transit improvements proposed by over 150 constituent agencies. As such it may be seen as a regional banker. It does not have this power, however, to influence airport improvement decisions. It is BCDC, not MTC, that has the most influence when the hard decisions are made if airport expansion involves bay fill. Thus, the next section speaks to the role of BCDC.

Foster City is in the flight path of planes arriving at San Francisco International Airport. The new city was built on bay fill as a unit almost 50 years ago. At that time other bay front cities were extending their boundaries at the expense of the bay. Alarmed at what all this might eventually lead to, the Save the Bay Association was formed. Led by three prominent women associated with the University of California and abetted by a radio personality billing himself as the “world’s greatest disc jockey,” this team produced a constituency with enough clout to win passage of legislation creating BCDC in 1965.

The first BCDC Bay Plan adopted in 1968 took careful aim at the demands expected to be imposed by air traffic growth. The findings declare that the Bay shoreline would be the favored location for airport expansion, that airport growth entails large chunks of land, that a buffer zone is essential to safety and noise mitigation, and that as a result a regional airport system plan should be developed.

In the absence of the system plan, BCDC assumed air traffic in the San Francisco–Los Angeles market growth could be served by emerging reliever airports and that a regional airport authority would need to be created to avoid undue pressure being put on bay fill to expand existing airports (based on the ability of current operators to finance expansion). The reliever airports did not develop and a regional authority was not formed. In 32 years since the ’68 Bay Plan, BCDC has not authorized any fill for airport expansion, either.

The pressure, however, is mounting. Foggy mornings and rainy days in the Bay Area mean long delays and cancelled flights, especially into and out of SFO. The 750-foot separation between runways is insufficient in adverse weather conditions. In response, airport management is exploring runway reconfiguration alternatives, all of which would involve major bay fill construction. While San Jose Airport is expanding to provide two full-length parallel runways to 11,000 feet and Oakland is launching its own runway capacity analysis, it has been the immediate SFO problem that prompted MTC to reopen the 1994 RASP, *Conference on Airports in the 21st Century.*

Even in 1994, the RASP acknowledged capacity deficiencies at all three airports. At that time however, SFO management denied the need for runway expansion. Further, if expansion were to be envisioned, a new runway at Oakland was expected to involve less bay fill. Thus the plan focused on the need to reevaluate the need for an additional runway at Oakland when the so-called Stage 3 demand-level had been reached. Now, only 6 years later, the stage 3 level is upon us. The pending SFO runway reconfiguration idea was not envisioned in 1994 and does not match the runway expansion concept outlined in that plan. Thus the current situation challenges some parts of the 1994 conclusions.

The RAPC update is well underway. The consultant team responsible for assessing demand based their projections on a market analysis instead of the trend line analysis that supported the 1994 plan. The results, however, are not much different. The demand versus supply squeeze has been reconfirmed.

Further, the sensitivity analysis of the potential benefits to be derived from improved air traffic control, slot management, advancing technology, use of other airports, potential for high-speed rail, and more efficient airline scheduling did not identify any combination with sufficient promise to significantly alter the runway shortage conclusion.

The factors examined in the sensitivity analysis are subject to decisions by a wide variety of actions by others:

1. FAA has responsibility for improved traffic control;
2. Congress dictates the slot control parameters;
3. FAA, the airlines, and others determine when and how to apply emerging technology;
4. DOD is in charge of Travis Airport—the best long-term reliever option;
5. The governor, state legislature, and voters must all act if there is to be high-speed rail in California; and
6. Airlines determine service schedules.

MTC does not control any of these variables; we simply make assumptions about how they might impact the demand for additional runway capacity.

What happens next?

Can RAPC as advisor to MTC decide whether expansion should take place and which airport should act first? Given MTC's lack of authority, would it even matter? Should SFO management push ahead in my case, with the BCDC's concern about bay fill representing the potential brake. If there is stalemate, will the state step in?

Expand this specific Bay Area capacity question to a national scale. Does the FAA wish to empower MPOs where regional authorities do not exist, at least to a position somewhat analogous to the MPO position established by ISTEA relative to surface transportation? Would that help? Is something more needed? Will the silent hand of the market ultimately prevail?

AFTERNOON SESSION

Environmental Considerations

ELIOT CUTLER
Cutler and Stanfield

I'm going to talk today not so much about particular environmental constraints, although we can do that in the Q&A discussion session. I will simply say that they are serious and are going to get worse, and most of you in this room have not yet imagined how tough the air quality conformity problems are going to get. Instead, I'm going to talk mostly about the institutional response to the environmental constraints in this industry because I think I know something about it and I have been at it for 20 years. I'll share with you all what I think.

I want to begin my remarks today with what I believe are three central truths about planning and building airport capacity in the 21st century. The first truth is this—airports have a broader adverse impact on more people who typically do not share in the benefits of its operation or at least don't perceive that they do, than any other large public facility with the possible exception of a jail or a prison.

Second, airports are the only polluting activity of any real consequence, at least to the transportation sector, where the principle point sources of pollution, air and noise, are essentially unregulated. Finally, the air transportation system in general, and the ownership and operating responsibility for airports in particular, are thoroughly balkanized, more so than in any other transportation sector, even railroads.

Here, in our business, the means of movement are generally private. The medium through which the movement takes place is federal, and the starting and ending points, the airports, are maybe federal, maybe local, maybe state, or maybe private. Indeed there is often such widely dispersed ownership and management of airports in any given region that optimizing the use of precious existing capacity and planning new capacity in increasingly difficult and bizarre plans sometimes emerge to create a new capacity of the wrong sort or in the wrong place while nothing happens where and when new capacity is most needed. In short then, we have largely unregulated airplanes from an environmental standpoint, making a lot of noise and spewing tons of noxious emissions on thousands of people who vote for public officials. These are officials whom we hope will cooperate with the industry and the federal government to build new airports, new terminals, and new runways, even though their ability to control the impacts of the operations of these facilities on the people who vote for them and who, not incidentally, own those facilities, increasingly has been circumspect.

Is there something wrong with this picture? We continue to subscribe to the proposition, properly so, that airports should be built and owned by local governments. Yet, the steady erosion in local proprietor authority over airport operations has placed a huge premium on local control over airport location and construction. So now, the location and construction decisions have become where all the action is. They become more and more contentious and complicated and more and more difficult to make. Lead times have stretched and stretched to the farthest horizons. With those observations and general comments as a starting point, I would like to invite your attention in two

directions. First of all, to Southern California, for two reasons, both because I'm intimately familiar with it and because it is probably the single region in the country where useful, new airport capacity is at the same time most urgently needed and most difficult to get planned, approved, and built. I would like to invite your attention to the FAA's role also in Southern California and elsewhere in helping new capacity to be built because we need this agency to be something more than a potted plant.

Recall Jeff Thomas' overheads and discussion. The clarity in the Southern California picture is striking and alarming. There are three airports that are close to the airlines' customer base, that is, within an hour's drive or so, and there are two other airports that are reasonably convenient to the areas of projected future population growth. The first three are Los Angeles International Airport (LAX), Long Beach Airport, and Burbank Airport. The second two are John Wayne Airport and Ontario International Airport.

Let's take the first group first. The Long Beach Airport is not going to grow, so that leaves LAX and Burbank of the first three that I mentioned. You can see where LAX and Burbank are located and how close they are to the heavy green and orange areas where most of the people who fly live.

Of the other two airports—John Wayne and Ontario—John Wayne is capped and, not incidentally, the voters of Orange County just took El Toro, for all practical purposes, off the table. Los Angeles World Airports just completed a major terminal expansion project at Ontario, but for the time being at least, there remains in place a cap on Ontario annual operations that has been imposed by the California Resources Board. So, any growth in regional airport capacity in the 11th largest economy in the world, any growth of regional airport capacity that will be practically useful during the next couple of decades will likely only be accomplished at either Burbank or LAX. There is not a lot of new capacity that reasonably can be expected from the Burbank Airport, but as you must understand by now, in the South Coast region, everything counts. Many of you are probably familiar with the Burbank case. The existing terminal is too old, too small, and too close to the main air carrier runway.

Everyone wants to build a new terminal, and there exists one sensible location for it—a parcel located in the city of Burbank that until recently was owned by Lockheed. The Burbank-Glendale-Pasadena Airport Authority and the city of Burbank fought for years, embroiled in nearly a dozen separate lawsuits, over the conditions under which the terminal would be built, if at all.

Why so much contention over a terminal? Remember what I said about where the action is. The city of Burbank, well advised by counsel, understood the limits on both its authority as a non-proprietor jurisdiction, and just as importantly, the limits on the airport's authority as a proprietor over airport operations. For many years, particularly following the city of Burbank's decisive victories in litigation, where its exercise of land-use regulatory authority over the terminal had been challenged, the future of the Burbank terminal project was in doubt. It wasn't clear that Burbank would contribute any new capacity to the region.

Then, following months and months of negotiations in which the FAA and the carriers chose not to participate, the city and the Airport Authority reached agreement on a framework arrangement for a new terminal. As one might have expected under the circumstances, neither the carriers nor the FAA was particularly pleased with all of the provisions of this complicated set of arrangements, especially those elements that conditioned terminal expansion increments on curfews and other airport performance

criteria. More to my ultimate point, which I will elaborate upon later, some FAA lawyers bent over backwards to find reasons to condemn the Burbank framework, gymnastically defining meanings intended by Congress and not apparent to anyone else, such as a new preemption policy and a PFC statute where it had never been identified before. So, a bookie now would probably put long odds on the construction of a new Burbank terminal. The city of Burbank and the Airport Authority are trying to build new capacity at Burbank, but no one else seems to want to make it happen, especially FAA lawyers.

Turning to LAX, the only other option in this region and obviously by far the bigger option, the issues at LAX are bigger, more complicated, and eventually may become even more contentious. LAWA, what we call Los Angeles World Airports, will soon announce the details of its $10 to $12 billion plan to modernize and add new capacity to LAX and to improve access to the airport. That plan faces two types of challenges. On the first front, a group of cities and other jurisdictions, some neighbors of LAX and others distant but impacted by airplane overflights, have called for a regional solution that freely translated from their perspective means little or no new capacity at LAX. Their vision calls for little-used airports like Palmdale, apparent ephemera like El Toro, and a high-speed rail line now in the early planning stage, to serve the millions of tons of additional freight and 70 to 80 odd million additional annual passengers who won't be served by LAX, Burbank, Long Beach, Ontario, and John Wayne, in the 2005 to 2015 period. This fight is being principally waged at the Southern California Association of Governments right now. It will ultimately be waged at the NEPA context.

The second front is not fully matured, but only because the draft environmental impact statement (EIS) and environmental impact report (EIR) for the LAX project has not yet been published.

When it hits the streets later this year, we anticipate that widespread attacks will focus on noise, air pollution, and other adverse project impacts. Remember that this project is being attempted in what may be the single most environmentally constrained region in the United States.

In order to get it built, LAWA may need to take some creative and unusual steps in order, for example, to accomplish sufficient mitigation under California law, to achieve an affirmative conformity to termination under Section 176 of the Clean Air Act, and to comply with the executive order on environmental justice. Further, a key part of this project is to improve access to the airport and to reduce traffic and air emissions impacts on neighboring communities by building a new ring road and a new freeway that will run parallel to the I-405 for several miles. Neither the carriers nor the FAA has signed off on any of this because a detailed plan has not yet been presented to them, but there will be issues that will not easily be resolved, particularly if the FAA assumes that same posture that we have observed in other projects.

Now, I doubt there is a person in this room who would find promise in the Southern California circumstances that I've just described. But, you should get used to them because they are typical of the circumstances we will face all over the country during the next several decades.

How should the FAA respond? Generally speaking, I think the agency has three options. There are always three options in government. First, the FAA could plod ahead on the same path it is on now. Of course, it was largely set, as Steve suggested, with the enactment of ANCA about a decade ago, in reaction to the industry's fear that the system would fall prey to a patchwork quilt of local regulations on airport operations and access.

This was the false front statute—false front meaning the Part 161 process that Steve described as the closed window, and also can be described as false front—there is nothing there.

If the FAA stays on this path, only divine providence will deliver a functioning national system with enough airport capacity to meet demand in the 2010–2025 period. My daughter is a freshman at Brown University and I worked on the T.F. Green Airport years ago. Those were my only connections with either divinity or Providence. So, I am ill-equipped to discuss this option further and I won't.

The federalization of the entire national airport system would be the second option. I won't discuss this option either, since it would require just as much or more divine intervention as Option 1 and, to boot, would require from the Congress a remarkable policy turnabout, a major financial commitment and, surprising to me, an amount of political will. Moreover, it would be a bad idea. So, that leaves only the third option.

You may think this construct a simple-minded rhetorical device, but I do believe this is in fact the only workable option, and I know that the approach I'm about to describe succeeded in Denver in building the only major new airport in a generation or two is an approach worth considering. This third option is for the FAA to empower local governments in a manner consistent with the principal and the stated congressional and FAA policy that local governments are responsible for building, owning, and operating airports. The governing strategic principal of this partnership approach would be the notion that a local solution that increases system capacity is acceptable even as part of a patchwork quilt, if it does not unduly impede the function of the national system. This principal would put a premium on case-by-case decision-making and would require focussed attention from FAA policy officials.

Under this approach, for example, the FAA would encourage airport proprietor jurisdictions to make intergovernmental agreements with neighboring jurisdictions. These agreements would provide, with FAA cooperation, satisfactory assurances of permanence with respect to such issues as noise levels, flight tracks, hours of operation, and the like, so that the neighbor jurisdictions would have a satisfactory basis for local land-use planning. FAA policymakers in this approach would pay little attention to agency lawyers who claim, with no identifiable basis, that a proprietor is preempted from promising other jurisdictions that it will do, or refrain from doing, something the proprietor has authority to do or to refrain from doing on its own. What else would an activist, policy-driven FAA do? It would push hard and publicly for the regulation of aircraft emissions and for the early development of cleaner engines so that the Clean Air Act conformity requirement would pose a lesser threat to the expansion of airports in major metropolitan areas. It would take a serious new look at how noise is measured, or Stage 3 compliance, and how adverse noise impacts are determined, with the goal of identifying methods that will make the agency a more credible authority among those who live with noise itself. And, it would promote the unified ownership, or at least the cooperative management, of logical airport systems in metropolitan areas so that the use of existing capacity and the development of new capacity can more easily be optimized for an entire region.

After 20 years of airport lawyering, I have learned that the essential foundation or the resolution of airport conflicts is the willingness of the airport proprietor and the impacted neighboring communities to undertake mutual obligations in order to achieve shared environmental and economic goals. I have also learned, particularly in the Burbank case, that

these good intentions, even when they finally emerge on both sides out of the long and contentious dispute, are not, by themselves, enough.

The federal government's dominant role in airport transportation, and particularly its pre-emptive jurisdiction over aircraft in flight, makes it virtually impossible for the airport proprietor alone to provide to a neighboring community assurances of certainty and permanence that are sufficient to induce reciprocal actions by the neighboring communities to control, for example, the growth of incompatible land uses on the airport's periphery. Why else should they?

I used to believe the FAA's reluctance to endorse or to provide these assurances, in concert with local proprietors, and the agency's dogged refusal to participate meaningfully in local negotiations was the product of a conscious, though ill conceived, policy development process. I don't think so anymore. No rational policy development exercise conducted in the face of a dwindling set of realistic alternatives for the expansion of the nation's airport infrastructure would adopt and implement a policy that time and time again frustrates and impedes the local resolution of airport disputes. I'm now persuaded that the lawyers at the FAA, sometime after the enactment of ANCA, basically commandeered the bridge and have been making FAA policy by default. It is hard to come up with any other explanation for policies that on the one hand impose upon local authorities the responsibility for doubling airport capacity in this region, and on the other hand, deny those local jurisdictions the tools to get the job done.

I don't think we can afford much more of this schizophrenia. The circumstances in Southern California are dire. Southern California, ladies and gentlemen, is only the leading edge as it is in so many other things for the rest of us. The economic consequences of failing to develop new capacity will be extraordinarily serious for this region and for the entire country. The FAA, to put it bluntly, has been whistling past the graveyard, allowing lawyers with no public accountability or policy-making responsibility to hog-tie this region's and the nation's air transportation future. Sure, the noise and air quality issues are serious and complicated, but they are not going to go away. They are only going to get worse. The air quality issue itself is going to get much, much more difficult.

So, the problems I think we face are not the rules and regulations themselves. The problems I think we all face are the gross failures of this agency's response to those issues and the constraints they impose on increasing airport and system capacity. The FAA needs to understand that it can no longer indulge itself in the luxury of non-engagement, nor in the fiction that the system and our national goals are well served by a uniformly and flexible approach to local, institutional, political, and financial needs.

Having said all that, I want to thank the agency for permitting me to come to their garden party. However, in my own defense, I will say that most of the people at the FAA from Jane Garvey on down, many of them have heard me say all this in private. So, I'm not too bashful about saying it in public. I don't think I've overstated the stakes and I don't think I've overstated the problem. If you want to discuss the particulars of any of it or the environmental issues at the foundation, I would be happy to do it later on. Thank you very much.

AFTERNOON SESSION

Economic Management of Capacity

JOHN MARTIN
San Francisco International Airport

Thank you to FAA and TRB for the invitation to speak today and to participate in this valuable conference. It has been really interesting for me to hear the presentations and share in exchanging ideas.

This is a 750-foot centerline-to-centerline separation. So, in good weather, we can do simultaneous landings and an arrival rate of 60 per hour. As soon as we have cloud cover below 3,400 feet, our capacity is cut in half—single-file landings and 30 or less arrivals per hour. Most hours of the day, we have 45 to 50 scheduled landings. That is why we frequently have 2- and 3-hour delays for arriving aircraft. The solution is the ultimate runway configuration that MTC's Larry Dahms referred to earlier. There would still be four runways - no increase in the number of runways, but adequate separation to allow parallel landings and takeoffs in almost any weather condition.

But, in the near term, I can't wait as Airport Director for the reconfigured runways. I've got to act today to try to give some nature of relief to our customers, to the passengers, and to San Francisco and the Bay Area community. It is my job to provide the facilities to serve the economy and certainly, when passengers are experiencing 2- to 3-hour delays, and some days 4- to 5-hour delays, it is an unacceptable situation, even for a short-term period of 4 to 6 years.

So, with this in mind, last year we hired Charles River Associates and the John F. Brown Company to conduct a detailed study to, in effect, determine the anatomy of weather-related delays at San Francisco International Airport (SFO) and weather-related cancellations. The objective was to identify specific interim relief measures.

Some of those measures include PRM and SELYA. That is a precision runway monitoring system with an offset instrument approach and landing procedure. That is already underway and I give great thanks to the FAA, which has helped us to accelerate that, and we expect to have that in place, using airport funds, but with the FAA managing the project, by mid-2001. The airlines, and in particular United, have also been very cooperative in getting this into place very quickly.

The next relief measure we are looking at is a Part 161 rulemaking and we are now formally proceeding in completing the studies to petition the FAA for rulemaking. It is my preference not to end up having to put rules into place. I would rather see that we continue to work with the airlines and that the airlines voluntarily make changes to give us more relief in the short-term on delays and cancellations. But, we are prepared to move forward with rulemaking to require the airlines to use larger aircraft in certainly very heavily served markets, which are heavily served with small aircraft. Part of the rulemaking will also be to consider longer ground times for turn-around aircraft, particularly aircraft serving shorter haul markets.

The third interim relief measure that we are working on, again in close cooperation with the FAA and the airlines, although we need even more cooperation from the airlines, is for accurate and timely information to be provided to passengers on flight cancellations and delays. There is tremendous frustration in San Francisco by residents who are not

given advance notice on bad weather days of cancellations. They typical pattern is to show up an hour or 45 minutes before flight time, and only then when they arrive at the airport are they told that their flight is canceled.

As I stated, SFO consistently ranks among the worst in terms of percent of flights arriving within 15 minutes of schedule. This shows our ranking over a 6-year period—always near the bottom. The impact of the delays is very significant. We conducted extensive surveys of business and non-business travelers; 54 percent of business travelers and 29 percent of non-business travelers reported missed and late arrivals for important appointments traveling through SFO. The problem is even more severe for the principal commuter carrier, which is United Express. United Express is now the only commuter carrier operating at our airport. Forty-nine percent of these passengers reported missing connecting flights; and 19 percent reported that they had to cancel a proposed trip because the delay and cancellations.

As I indicated, the primary source of our problem is the closely spaced parallel runways, and we frequently do go down to that reduced capacity operation. One-third of the time in 1998 we were at 50 percent or less of capacity—that is 30 arrivals per hour.

In 1999, one-quarter of the time we were at 50 percent or less of capacity. That small reduction from 33 to 25 percent of the time reflects somewhat better weather in 1999, together with some measures undertaken by the FAA and by United to give some relief to the delay problem.

This graphic shows a percentage of time we are at different arrival acceptance rates. Look at the last column—1999—to see the arrival and the percent of the time we were at different arrival acceptance rates.

This graphic shows the demand and the number of scheduled passenger flights. As you can see, on good weather days, for the 60 per hour arrival capacity, we have no problem meeting the demand, even though there are short peaks where we go above the demand without significant impacts on flight operations. But, going down to 30 per hour, there is no way we can meet demand, especially if the flights are full and the airlines are unable to cancel the flights, in which case flights arrive 4 to 5 hours late at 2 or 3 a.m.

As shown here, we have two types of bad weather days at SFO. We have the bad weather morning days in which the cloud cover typically clears by 10 or 11 a.m., sometimes noon. This occurred 113 times in 1998. Bad weather all day, more typically in stormy conditions, occurred on 75 days. You can see the minutes of delay for both types of weather conditions. Certainly, as you would expect, there are much longer delays when we have bad weather all day.

The burden of the weather delays—this is a real interesting aspect that came out of the study—the burden really falls disproportionately on flights originating with the west FAA 6W region. Those flights are much more likely to be canceled than flights originating elsewhere. Flights originating on the East Coast are more likely to be delayed, and more likely to experience delays that are longer in duration. The burden is made heavier by both the FAA flow control policies and their ground delay program, which is focussed on the West Coast flights, as well as operational decisions made by the air carriers at the airport, and I'll get into that in a little bit more detail in a second.

This graphic shows the cancellations by day for the various types of weather conditions. As you can see, we get about a doubling in the number of west region flights cancelled on bad morning weather days, but very little change on non-west region flights in terms of

cancellations. If we go to bad weather all day, you see a very large number of cancellations for the west region, and still a fairly small number for the non-west region flights.

Again, a different way of looking at it is the flight delay in minutes for west region flights and the non-west region flights. On a bad morning weather day, the delay is about 50 percent longer for the west region flights, but when we go to bad weather all day, the percent delay is almost twice as long for the west region flights. So, it is a very disproportionate burden on those travelers who are traveling on the West Coast.

There is a lot of airport capacity that is used and is used disproportionately by airline flight scheduling of small aircraft to a few cities. This shows the number of round trips or departures by a single carrier—the single carrier being United or United Shuttle or United Express. All of these cities are served by either 737s or Brazilia—a 30-seat propeller aircraft.

Looking at four cities—Eureka, Fresno, Monterey, and Sacramento—those four cities are all served strictly by 30-seat aircraft. They account for 10 percent of all flights and 2 percent of passengers. That is a lot of capacity eaten up by very small aircraft. All commuter cities taken together account for 18 percent of our flights and 3 percent of the passengers.

The FAA and the airlines do work to manage the delay problem and I think the steps they take are appropriate and have definitely had some positive impacts. The FAA uses a collaborative decision-making (CDM) process in which they work with the carriers at 4 a.m. San Francisco time to evaluate weather conditions. At that time, the carriers make decisions on cancellations that they are going to make to help manage their flights, given the capacity that is going to be available. United is the most active participant in that CDM process.

Even with that process though, generally passengers are not notified in advance of the cancellations. This is a particular issue, for me as director, in trying to improve customer service and provide better information to the passengers. As I indicated, delays run into hours. Typically on a bad-weather all-day condition, there will be 2.5- to 3-hour delays for Los Angeles passengers. If it is a very busy day like last Sunday, we may have delays of up to 4 hours. Occasionally, when United has a 747 available, they will use it to help clean out the backlog and run a 747 between San Francisco and Los Angeles.

There are benefits to this ad hoc cancellation program. It definitely reduces the aircraft demand so that, in effect, it serves to minimize or reduce the delays that would otherwise occur. So, the delays, even at 2.5 to 3 hours, would be worse if the airlines were not canceling some of the flights and consolidating passengers on fewer flights.

We also, as a result of this program, have more ground delays of any major U.S. airport. Let me explain further. Ground delay is when the FAA holds a plane on the ground before it departs for SFO. The reason they do this is they hold the plane until they know there is going to be a slot available for the arrival. It is an effective tool. It is much safer, much more efficient to keep the plane on the ground until they know there is going to be a slot available rather than having a plane circle over the Bay. But we have had more ground delay program (GDP) days than any other airport. In the last 3 years, SFO had 494 GDPs compared to Newark, which is a number two with 205.

As an example of how this GDP is managed and the CDM process—on December 13, 1998, United canceled 33 SFO-bound flights because of weather conditions. This did work to reduce the projected SFO arrival demand so that it dropped to below 30. There were still some delays that day, but the FAA didn't have to implement the GDP. United reported that it generated net savings as well of approximately $200,000. United does use

a revenue model to help them determine which are the best flights to cancel and how they can best accommodate the passengers from those canceled flights on other United flights.

So, generally the management process helped to reduce delays, but we still have major delays and the cancellations do limit the FAA GDP in the 6W region.

Actions we're taking to increase the acceptance of capacity—any technology that we think can help, we are evaluating and trying to put in place as quickly as possible. The PRM and SELYA system, we think, we will give us that 10- to 15-percent reduction in delay once it is installed. It is difficult to estimate the delay reduction benefits because we still have to see how the controllers are going to accept the new procedure. It will also be very dependent on what the actual cloud ceiling levels are and there is also a big question of pilot acceptance. We expect initially the pilots will use the procedure, but that it will take time for them to become more comfortable to where we can realize greater benefits from the PRM/SELYA. One of the key issues of the pilots on that is the wake turbulence separation issue, and we have done a lot of modeling and testing using the SELYA approach.

We believe the use of larger aircraft can yield significant delay reductions particularly in those heavily traveled commuter markets and in the San Francisco/Los Angeles market. Even with the larger aircraft, there will be some level of airline delay management. But taken together, the use of larger aircraft would still provide the same number of seats with the airline management program, but would produce much greater delay reductions.

This graphic shows the actual minutes of delays under different scenarios. The first column is daily delays if all the scheduled flights were flown. Looking at the next column, daily delays with the actual cancellations, you can see that there is a great benefit to the program that the airlines have put into place. A little greater delay reduction can be expected if our program for the airlines to use larger aircraft is in some form adopted. But taken together with the airline cancellation management program, only 33 percent of today's cancellations would actually have to be made. Concurrently, we reduce the delays down to 60 to 100 minutes. Again, this doesn't solve the problem entirely—not even close. We still need runway reconfiguration.

Peak-hour pricing certainly appears attractive, but we are prohibited by the airport lease and use agreement from imposing peak-hour pricing. We have asked the airlines to use larger aircraft voluntarily and we delayed, for some period of time, announcing our intention to go forward with the Part 161 rulemaking, because we thought we might see some changes from the airlines. But, we haven't seen those changes. One of the concerns they have is back filling—that if they use larger aircraft, a new carrier comes in with a smaller aircraft and undercuts the market.

The rulemaking we're proposing would level the playing field and would address that backfill concern. It would be temporary because we would only need these measures until the runways are reconfigured, and because we are focussing on only a limited number of markets, it would limit our intrusion into the airlines' scheduling.

Propagated delay—propagated delay is a fairly unique problem to San Francisco that occurs on arrivals-to-arrivals, particularly on United's shuttle. United's shuttle uses an aircraft that may go back and forth between San Francisco and Los Angeles or San Francisco and Portland three or four times a day. When that aircraft begins in the morning in Los Angeles to San Francisco, it might be delayed by weather for an hour. Once it loses that hour, given the tight time sequencing that United's shuttle has programmed in for the day, it is hard for them to make the time up. So, it departs San

Francisco late for Los Angeles. Then returning from Los Angeles, even though the weather may have cleared in San Francisco, by the time the plane is returning back from Los Angeles, passengers are told there is a weather delay in San Francisco and the flight is going to be 45 minutes late going out of Los Angeles. So, that is the propagated delay that I refer to. It gets worse and worse depending on how long it takes on those days when the cloud cover does clear. So, if it is not until 1 p.m. that the cloud cover clears, it is almost the whole day that aircraft is going to be delayed—which means until 9 or 10 p.m.

It truly is a scheduling phenomenon—not a weather phenomenon. It is weather-related, but the airlines have so tightly sequenced the airline scheduling that they no longer have the flexibility. If you go back to 1993, we didn't see this problem because the airlines had 40-minute turn times in San Francisco. They dropped that down to 20 minutes. They have increased the turn times, but they have scheduled 30 minutes, and I appreciate the efforts by United to provide more flexibility in that respect. It is what I might call the "Southwesternization" of airline scheduling—everybody is trying to match the tight Southwestern turn times—it doesn't work in San Francisco. It may work at other airports.

A particular problem for United's shuttle and United Express, as I said, is that typically these flights are under 1 hour, sometimes less than 30 minutes. You can see here the affects of the propagated delays. You look at the last column that shows propagated delay minutes for United's shuttle and Express, and you can see propagated delays are virtually entirely with the shuttle and United Express.

Weather-related propagated delay accounts for 15 percent of all United shuttle delays and 13 percent of all United Express delays. Adding that 10 minutes back in, and going to 40-minute turn times, would reduce delays by 32 percent for the week studied, with a 50-percent reduction in delays for the bad morning weather days. So, 32 percent for bad weather all day, and 50 percent reduction for the bad morning weather day.

Turning now to passenger information—we conducted a number of surveys and focus group interviews with our passengers and clearly one of the most frustrating things to a passenger is the lack of information. Sometimes we find that the information on the flight information displays from the airlines don't match the information provided when you call in on the phone—two different sets of information. Generally, phoning for information seems to be more accurate.

We are working to try to get better information, working with the FAA and working with the airlines, to get better information.

One of the things we're undertaking is to post all the airline's flight information on our website. United is taking the lead in cooperating with us on this effort. We will set it up on our website so that you can be notified on your pager or phone if there is any change in your flight status. So, as a passenger you no longer have to keep calling in. You can be notified by that means.

In summary, actions that the airport intends to take are insulation of a PTRM/ SELYA by mid-2001, being done on a very accelerated basis. We are undertaking the Part 161 rulemaking for the use of larger aircraft and longer ground times. Again, I would rather work with the carriers cooperatively and find agreements so that we can deal with the delay problem and cancellation problem without having to formally end up in rulemaking.

Finally, in the interim, more accurate and timely information on cancellations and delay; making sure that all passengers, regardless of their frequent flyer status, have the same level of information and the same accuracy of information.

Finally, ultimately we need runway reconfiguration. I'm convinced despite needing the approval of 31 different regulatory agencies, we can achieve that. If I can make one short pitch for our runway program, I think we can get it because we've committed ourselves to an environmental win. We have committed that we must reduce noise to all communities and we can do that by moving more flights over the Bay. We can produce net environmental gains to San Francisco Bay itself by restoring up to 20,000 acres of land that is now in salt production, against 1,300 acres. I'm convinced that we can, despite all of those obstacles, obtain approval on the runway program.

Thank you for your attention.

AFTERNOON SESSION

Congestion Pricing and the Economic Regulation of Airports

KEVIN NEELS
Charles River Associates

To start off, I'll confirm what you probably all suspect, which is that I earn my living primarily as an economist and not as an audio-visual set-up person, although I was happy to help out when asked. I am going to be reporting today on some work I did in collaboration with Shomik Raj Mehndiratta and Harry Foster, both of whom work with me in Charles River Associate's (CRA's) Boston office. Shomik is here today, but Harry wisely decided to take a break from trying to solve the problems of the country's aviation system and instead to enjoy a well-earned vacation. However, he sends his regards.

I'm going to talk today about congestion pricing. I'm going to try and go beyond the relatively simple presentations of this notion that you tend to see in papers by economists and try and think about what would it really mean if we tried to use pricing as a way to manage the capacity of the air transportation system in a more sensible way. I think, as I'll show, there are a number of problems that we run into that deserve some careful thought and hopefully I'll give you all something to think about before you leave today.

First, let me talk a little bit about—congestion pricing, and I will also say too, being the last speaker of the day, that I'll accept the challenge of trying to deal with everyone's impatience and schedules and try and go through this very quickly so we have time to talk.

First, let me talk a little bit about the realities of congestion, just to set up the discussion. There is an operational element to it. Obviously we get congestion when demand exceeds the limited capacity of the facility. The minding constraint can be on the airfield, on approaches, or on a number of different points. But when the demand exceeds capacity, you get a queue building up. As aircraft have to work their way through the queue, they experience delay and the queue really imposes delay on all of the users of the airport at that point in time.

One thing this means is that congestion, and it is good to keep this in mind, congestion is necessarily a transient phenomenon. If you had demand exceeding capacity throughout the day, you would have an ever-increasing queue and you would never have an opportunity to work it off. So, congestion is something that has to happen in a limited period and eventually after the peak, when the weather clears, as John said in San Francisco or perhaps even into the evening, you work off the queue and things return to some sort of an equilibrium.

There are economic realities associated with congestion that have been well explored in a lot of theoretical studies of congestion pricing. In times of congestion, each additional user who shows up imposes a cost on everyone else. Every additional user lengthens the queue and increases the time it takes for everyone in the queue to work their way through it. These users, however, perceive and respond only to their own delays. You don't have to worry about the costs you're imposing on everyone else. You just worry about your own costs. So, what we have is a classic problem of economic externalities. There are costs that go outside of the calculus of the private decision-makers and so they tend to ignore them. So, they wind up scheduling more demand for the system than it can really accommodate.

It's important to recognize that there are significant differences in the kind of congestion that U.S. airports incur. I think we can divide it into two broad categories. The first is scheduled congestion. This comes when you look at the schedule and you see that it provides for the arrival and departure of more flights at a particular time window than the facility can really handle. If you think back to the charts that John had in his presentation, you showed peaks where the schedule demand exceeded the capacity of the airport, even under ideal conditions. Now, in the case of San Francisco, as was pointed out, those peaks are surrounded by slack times and so they don't cause continuous operational problems. As you have more and more scheduled demand above the processing capacity of the facility, however, you get more and more severe problems.

This comes up often in connection with the a.m.–p.m. peak. If you have a business destination, people want to arrive at the beginning of the day, and they want to depart at the end of the day. So, you have a big bunching of the schedule at this time. It can also happen in connection with hub-connecting banks. When you have a hubbing air carrier scheduling connecting banks at an airport, this necessarily means bringing a lot of aircraft in at about the same time and moving them out. So, you can get scheduling delay there. However, as SFO's John Martin's presentation made clear, there are also important non-scheduled congestion and associated delays. A lot of times what happens is you experience transient disruptions to the system. John Martin described eloquently what happens at San Francisco when weather reduces the arrival rate that the facility can handle. When you have these transient shortfalls in capacity, suddenly you have a tremendous amount of congestion that can build up in a relatively short period of time.

He also described the phenomenon of propagated delay, when an aircraft is delayed at one point of its daily itinerary and never really gets a chance to make it up through the rest of the day. John Martin had said this was a uniquely San Francisco International Airport (SFO) problem, but I think we can see it spreading as more and more carriers try to emulate the scheduling practices of Southwest in an effort to increase aircraft utilization and get costs down to a level that allows them to compete more effectively.

These different types of congestion have very different implications for the applicability of congestion pricing. If we look at the a.m. peak-period congestion, this is related to the time of day preferences as I said—people want to get to the airport at the beginning of the day and to depart at the end of the day. These time-of-day preferences are stable and predictable. People know this is going to happen, and this really represents the classic congestion-pricing scenario. If there is a problem that can be dealt with through pricing, this is probably the one that is most susceptible to a pricing solution. The realities are that decisions are made well in advance, schedules are set well before the delay occurs. You can post a set of landing fees or charges at the airports that airlines can take into account in making scheduling decisions, and they can act upon it in a sensible way. There is enough time to make decisions and to encourage behavior that would reduce delay. It can encourage carriers to shift departures to off-peak times. Maybe instead of leaving right at 6 a.m., leave at 6:30 a.m. if that gets you around the edge of the peak period. It can encourage substitution to larger aircraft. It may encourage some flights to just stop, if in fact they don't generate sufficient revenue to pay the charges that are being imposed. So, this is probably the situation, which lends itself most readily to a pricing solution.

If we look at the other form of congestion, hub-related congestion, it is also susceptible to a pricing solution, although it presents a few special problems. As I

described before, this is related to the mechanics of connecting banks. You have a hubbing carrier who wants to create opportunities for passengers coming in on many flights to connect with many outbound flights. Hub economies require peaking, although there is some flexibility in the time of day when the banks are scheduled. This is not the typical congestion-pricing scenario that people talk about. The behavioral response that carriers can mount is a little bit more complex. In order to have a hub, you need to have a large number of arrivals and departures coordinated to occur within a relatively short period of time. Because of the economics of hubbing, the hubbing airline may have relatively little choice, with regard either to the number of aircraft to bring in, or the size of the aircraft. The size of the aircraft will be dictated by how many passengers are making the connection and the fact is that there are economies of scope in a hubbing operation. So, as you reduce the number of spokes coming in, you reduce the economies associated with the whole operational mode.

It is possible to spread out the length of the bank, but this increases passenger transfer and travel times. Already, when you're making a connection, you're imposing some circuitry and some connecting time on the passenger, and if you stretch out the connecting bank, you increase the surcharge and make the connecting flights somewhat less competitive.

It is also important to note here that in this form of congestion, the hubbing carrier incurs really the high congestion costs, and in some ways internalizes it. In a situation where you have a hubbing carrier scheduling connecting banks of flights, it actually accounts for a majority of the operations taking place in that window. So, in a sense, that addresses some of the concerns about externalities that I cited before. Additional flights impose delay on all the flights that take place at that time, but it is really the hubbing carrier that has to worry about it. So, one could argue that these scenarios have a greater tendency toward self-regulation than the a.m.–p.m. peak. But still, because you're talking about scheduled congestion, about congestion that occurs in advance at the time when schedules are set, you have a lot of time to make decisions and for carriers to react in a sensible way to whatever prices airports decide to impose.

When you get to unscheduled congestion, you really have a different sort of situation. Inclement weather causes some of the most serious short-term congestion presently. This congestion is very important in terms of the impact it has on carriers and on passengers, but it can be short term, and by its nature, it is unpredictable. You don't necessarily know at the beginning of a given day or given week what the weather is going to be or what kind of problems might arise over the course of the day. This means traditional congestion pricing might be inappropriate. At the time congestion arises, a lot of the serious decisions have already been made. Schedules have been set. Aircraft have departed earlier in the day. At the time the congestion arises, they may be in the air or scattered at various points throughout the national air transportation system. So, you don't have as many possibilities for dealing sensibly with the congestion. It conjures up, frankly, some humorous or frightening images. You can envision a pilot sitting out on the edge of the airfield with a plane full of sweaty and disgruntled passengers who finally gets notice from the tower that we've been given clearance by central flow control and are presently accepting bids for the first position for departure. You also have to think about the logistics of using pricing in real-time in a setting like this. Are you going to have harried air traffic controllers trying to accept bids or are you going to have airline

management making a lot of real-time decisions about how much this might be worth? It might be workable, although it would take a lot of effort to really make it happen.

It is possible to think about a solution that would be set in advance, in the form of a contingent protocol, much like some of the protocols that are in place now and that John alluded to. You could envision a system where in advance of the congestion, carriers purchase priority positions and have the opportunity, once congestion arises, to take their priority flights and move them forward. You can envision something like this working, but if you think about it, it has fairly substantial implications for all sorts of aspects of how the air transportation system works. You would have some flights, presumably, which would have priority access that would be more expensive because airlines would have to pay for that priority access and would have to be promoted as such at the time passengers are sold tickets. So, it wouldn't be quite like the recent situation where you have a high-fare business passenger sitting next to a leisure traveler who purchases tickets several weeks in advance at a much lower price. You would actually have to promote whole flights differently. Also, it would require a good deal of cooperation among airlines and other "actors" scattered throughout the system because the congestion wouldn't necessarily be experienced at one point. The affected aircraft could be in the air or on the ground at other facilities and you would need to really provide the priority that such a system would require, and would necessitate cooperation among all of these different "actors."

Also, when you think about situations like this, you're talking about congestion that arises as a result of a short-term disruption. None of the kind of prioritization that you might do is necessarily going to eliminate the congestion. At best, you will be managing the congestion more sensibly and not necessarily reducing it. So, this component of congestion, which is much of what SFO is wrestling with now, is just not nearly as susceptible to a pricing solution as some of the other forms that we talked about.

Now, there is also an issue that comes up when you think about congestion pricing, and that is the issue of pricing behavior of airports and the regulation of that behavior. Here, I think when you talk about congestion pricing, you are talking about a fundamental departure in how we run airports. Currently, prices must be set to equate revenues to costs. Most airports are operated as public entities and that is the requirement that is imposed on them. Even with this requirement, as everyone here knows, there have been major arguments over which costs you include, which costs you exclude, what revenue you include when you set that equation, and all of these have been the subject of major controversy between airports and airport users in multiple locations and multiple instances around the country. Nonetheless, we have this requirement in place now, and it really anchors the current pricing structure for airport services. This is still how we set prices.

Now, when you talk about congestion pricing, this changes. Prices that equate supply and demand are not necessarily those that equate revenue and costs. When you move toward congestion pricing, you are opening the door to cutting that tie that has really been the anchor for the pricing of airport services. And you need to think then about what kind of a world you're getting into. Airport operators, or whoever else sets prices, under this system would enjoy new freedoms. This is a fundamental shift to paradigm. Now, when you think about giving airports greater pricing freedom, as an economist one of the questions I ask is what kind of competition do they face and how would that competition place constraints on their ability to set prices? Now, if you think about this, it is clear there is competition. As MIT's Richard de Neufville said this morning, you have

specialization of airports and you have a certain amount of sorting out of different types of traffic in multi-airport systems. It is clear when you think about it that airports do compete for non-local traffic. There is hub traffic, the connecting traffic I described earlier, which in some sense is footloose. It could, in principle, take place at a number of locations around the country and we have certainly seen instances where hubs have been set up and where hubs have been shut down. In a very short period of time, Piedmont set up its first operation at Baltimore–Washington International, and Continental has largely pulled out of Denver. You see that hubs are born and hubs die, and so there is competition between airports for traffic of that sort. There is also an increasing amount of competition for gateway traffic—transfers between domestic flights and international flights. As you have more and more point-to-point service, you have more and more competition between alternative gateways for this traffic.

However, the competition for local traffic is very limited. For some movements, surface transportation is a possibility, largely if the distances are relatively short and in a few cases, if there are high-speed ground alternatives as in the northeast corridor. But, for the long haul, there really isn't much of an option, unless there are alternative regional airports, and we have heard a lot about that today. But, in quantitative terms, how important is that competition?

Now, in anti-trust proceedings, there is a standard measure of market concentration, which is known as the Herfendahl Index. This is a bit of anti-trust, so let me just describe what I mean by it. The Herfendahl Index describes the degree of concentration in a particular market. You compute it by taking the market shares, in percentage point terms of every participant in the market, squaring them and adding them up. So, if you have 100 providers, each with a 1 percent market share, you would have a Herfendahl Index of 100. If you had one provider with 100 percent market share, you would have a Herfendahl Index of 10,000, which is as bad as it gets. Now, the Department of Justice (DOJ) and the Federal Trade Commission (FTC) have published merger guidelines that talk about the Herfendahl Index as a tool for analyzing the effects of mergers. In fact, there has been a lot of research that has shown that the Herfendahl Index, associated with a wide variety of markets in a wide variety of locations and points in time, has a pretty strong relationship to how high the prices are that you see in those markets. There are, in fact, particular numerical values that are set in the DOJ and FTC merger guidelines. What this chart here shows is the Herfendahl Index for the 20 largest airports. The best case is New York, with several major airports. Then you come to Washington, again with several major airports. The next one down is San Francisco, where we heard there is SFO, Oakland, and San Jose. You then get to Los Angeles, which we heard quite a bit about, and so on it continues. I think after Los Angeles we have Miami, Florida, Boston, Massachusetts, etc. By the time you get to Pittsburgh, Pennsylvania, here, you have one airport really providing all of the local service for a metropolitan area.

To put this in some perspective, New York is what the DOJ and FTC merger guidelines would characterize as a highly concentrated market. If you were to come in with a merger proposal and it would have the effect of raising concentration to the level we see in the best case, there is a good chance that the regulatory authorities would laugh hysterically and throw you out onto the street saying this is something they would never approve. So, the best case we start with here is a highly concentrated market, and it goes on from there.

This suggests, just from this very simple anti-trust analysis, that if you give airports pricing freedom, you can expect that they would use the freedom to set prices wherever they saw fit, and get away with it.

Now, how would you deal with this? How would you constrain the behavior of airports in this situation? You may be able to combine our current regulatory system with a little bit more freedom by expanding the concept of revenue neutrality. Here, what you want to do is start setting different prices for different types of use under the constraint that you're still keeping revenues equal overall to cost. There are a number of possibilities. You might have a differential in the fee between large aircraft and small aircraft. There is a differential now, but maybe you want to tilt it a little bit. You can have peak/off-peak differentials. You may also have set fees in such a way that they are higher at the primary airport than at the secondary airport. This could encourage the development of service at currently underutilized facilities.

When you think about this, you start to run into some institutional issues. If you're talking about using revenue generated at the primary airport, and using it essentially to pay-down the landing fees at a secondary airport, you have to ask are the relevant airports run by the same entity. Otherwise, what kind of conduit do you have? How do you transfer the money across? If they do, does that common ownership exacerbate the market power problem? There is some competition between different airports within a metropolitan area, and if they are all owned by the same entity, then are you really going to have the secondary airport trying to take business away from the primary airport? Also, you may run into a situation in which in order to maintain revenue neutrality, you have to set negative prices. In other words, you would pay people to land at certain kinds of airports. Now, that may be workable, but you could start to think about some funny kinds of behavior responses you would get to that. Service is set up just to take advantage of the negative feeds.

So, although this may be a helpful way to marry the current concepts of price regulation with a greater flexibility that would be needed under congestion pricing, it may not do the job. It may be that the prices that equilibrate supply and demand really require that you set fees well in excess of costs, in which case you could generate substantial revenue surpluses. When that happens, you could have some airports that could just simply become fountains of extra revenue. Also something for you to consider, in the absence of slot controls, is what kind of fees would it take to equilibrate supply and demand at LaGuardia Airport? They might generate a lot of money. The surplus revenues could create incentives to expand capacity, but we have heard a lot all day today about all the many barriers that inhibit expansion of capacity at airports. So, even if there are economic incentives created by all this surplus revenue, are people really going to be in a position to act upon them?

Then you also need to consider what kind of private or public entity can be trusted to manage such a pricing system? Currently, our airports are operated by public entities and their officials are answerable to elected officials and they have a concern about running the airport in a way that is consistent with their notions of the public interest. But the structural analysis, the fact that you have providers of services in a highly concentrated market, means that if they wanted to raise prices, they probably could. Even in the case of public operation and control, you could be constrained by the concept that public officials have as to what constitutes the public interest. It may well be that this revenue could be put to good use on some other projects around the airport or projects that are tangentially

related to airport operation, or maybe that are just related to other important social needs that could be funded.

So, the anti-trust concerns, and the question of how do you constrain pricing behavior, arise either under public or private ownership of the airports. You still need to think about how do you give freedom to set congestion-based prices and still deal with the market power problems that may result.

So, in conclusion I would say that to summarize what we've said here, there are many forms of congestion that may not be easily susceptible to traditional pricing solutions. It is also clear, I think, that adoption of congestion prices would fundamentally alter the regulatory environment within which airports operate. If we want to do that, we need to be ready to consider those fundamental changes and to devise an alternative regulatory scheme to deal with the problems of market power and high fees and charges that we would be likely to encounter under such a system.

Thank you.

Discussion

Rich Golaszewski: Rich Golaszewski from GRA. I have a question for Kevin Neels. I was always taught that when scarcity exists, there is an economic profit or an extra return that exists in the market and it is simply a matter of who gets it. So, if the airports aren't going to price to capture the rent, do you have any speculation on where it is going?

Kevin Neels: I think some of it is being dissipated in congestion. When you have over-scheduling, you have a lot of extra costs that all users of the airports generate and that is just a dead-weight loss to society. In some cases, and certainly in the cases of the slot-controlled airports, we've tried to limit the congestion by limiting the number of people who can use the airport. I think in those situations we've essentially allocated the rents to the slot owners.

Beyond that, I think they are probably being passed out in an inefficient form to the current users of the airport who essentially get to use the capacity that is there for less than its full economic cost. If you allow the airports to collect the rents, then the operators of very valuable facilities with limited capacity would be in a position to collect a lot of money because of their control of those facilities. Then it is up to us to say what they should be allowed to do with it. I think that is one of the regulatory questions that we need to address.

Stephen Kaplan: Let me ask John Martin a question. John, earlier you were billed as going to drop a bombshell on everyone by talking about this Part 161 study at SFO. Your demeanor did not reflect a bombshell but maybe the message did. Do you believe in your conversations with the FAA that you will find any receptivity to that? You talked about the runway reconfiguration or new runways as an environmental win–win. Do you envision doing a Part 161 study to assure the community that those environmental considerations will be permanent?

John Martin: A couple things. First, I think that the anticipation of what I had to say was probably partly based on the press release I saw from United Airlines that came out yesterday. I think the airlines probably consider my announcement a bombshell, even though my approach is still to try and work cooperatively with them. That is where I hope we will end up. Regarding the Part 161 process—the FAA, I think, is going to be reasonable. I have no reason to believe they are going to stop us cold in our tracks from proceeding with this study. I'm optimistic we will be able to move forward with the study and they will fairly consider the results of that study and anything that may come out of it. There may be new ideas yet that come out of it.

With respect to the runway reconfiguration, I'm not expecting it will need a Part 161. In conjunction with that, I certainly expect that a part of the environmental documents will show the changes in the flight procedures that will be established and will document the noise impacts from those shifts.

Kaplan: What assurance will the community have that those flight procedures will be maintained?

Martin: I think the actual changes in flight procedures become incorporated as a part of our environmental documents. The FAA, along with the San Francisco City Planning Commission, is one of the lead agencies. The flight procedures will be formally adopted by the San Francisco City Council.

Kaplan: Eliot Cutler, you're shaking your head. Would you like to respond?

Eliot Cutler: One of the problems that a lot of airports have had, are continuing to have, and will have more frequently with the agency is that when you make these agreements with other local jurisdictions, no matter whether the agency considers them to be preemptive or not, if those agreements involve certain measures that are within the exclusive province of the federal agency, the FAA historically has taken the position that it will not provide to the other communities, either directly or through the proprietor, permanent assurances that those particular mitigating procedures, be they flight tracks or something else, will be adhered to for *x* or *y* or *z* years. Now, Steve Kaplan and I licked that problem in Denver by making certain agreements between the city and county of Denver and Adams County, in which the city and county of Denver guaranteed to Adams County and the cities in Adams County, certain levels of performance standards. Even though the drivers of those impacts were decisions that the FAA was subsequently going to have to make, Denver was basically going to be the guarantor of the FAA's behavior. It has, generally speaking, worked out pretty well. Yes, there is a lawsuit that Adams County won for about $5 million, but most of the noise violations that had been identified early on were fixed by the FAA because Denver was at risk for far more than that $5 million.

The problem is when you get into a situation where the city of X and the city of Y want to make a deal, and the city of Y says, that's all right, we'll go along with this if you can promise us that we can depend upon what you're saying, and what you're representing in terms of the way this airport is going to be operated for the next 20 years. We need to be able to depend on it so that we can plan the way our land is used and we can put housing where it belongs and put other uses where they belong.

The first city, the proprietor, looks to the FAA because after all, the proprietor doesn't control the way the airport is operated over a 20-year period. It doesn't control where the airplanes fly. The FAA says, sorry, we cannot make the commitment, but if we ever want to make a change, we are required by National Environmental Protection Act of 1969 (NEPA) to do another environmental impact statement (EIS). Well, the first city says, the hell with that. That doesn't do us any good. It doesn't put us in the position of being able to make intelligent planning decisions. It doesn't give us anything that we can rely on. This is a huge problem. It has been a problem in virtually every airport community dispute in which I've been associated, which are scores of them, on both sides. I think there is some residual resentment or concern over what happened in Denver among the carriers and the agency. I don't think that the agency or the carriers want those sorts of assurances to be provided, but I think that in the absence of those assurances being provided, we are not going to have the kinds of agreements necessary in order to really produce new capacity.

Dorn McGrath: I'm Dorn McGrath of George Washington University. The third most rapidly growing urban county in the United States is Loudoun County, Virginia, right near here. One-half of Dulles International Airport, one of the big 3Ds that were

mentioned earlier, lies in Loudoun County. There are 30,000 dwelling units in the pipeline approved by Loudoun County and there are two runways in the approved budget for Dulles. My question is, what can the FAA do constructively to help prevent this inevitable clash? I assume now we are in a saddle or in a moment of complacency with respect to noise exposure and air quality emissions. But, I would predict that before long, we are going to see push come to shove in that area.

Jim Wilding: I'm Jim Wilding, president of the Metropolitan Washington Airports Authority here in the Washington, D.C., area. Dorn McGrath makes a good point, but I think probably chose the wrong example. The fact of the matter is that we've worked with Loudoun County, Virginia—three-quarters of Dulles actually lies within Loudoun County—to work out what I would suspect is the most rigorous, most protective local noise abatement program in the United States. Above 65 DNL no homes are built; from 60 to 65 DNL homes are built only if they are insulated and only if the owner of the home gives us a navigation easement, and only if there is extensive disclosure. Even beyond 60 DNL for 1 mile there is extensive disclosure. So, I would put that up against anybody else's program in the United States in terms of filtering out people living in those residential communities who really are sensitive to what they are moving into.

Kaplan: Did you purchase any residential development rights so that people would, in essence, be prohibited from building homes, but could still build commercial or industrial, or was that just done through zoning?

Wilding: It was done just through zoning and, frankly, it took advantage of the fact that there was a real estate depression that left a lot of that land in the hands of banks who didn't want to own it. And the price of our cooperation to move it back out of their hands was the program I just described. So, it is a little unique in that sense.

Cutler: What happens when the tide changes in Loudoun County, if it ever changes, and considerable pressure is brought to bear on the Board of Supervisors and the Planning Board to change the zoning to permit residential uses where under your agreement or understanding, they are not permitted? Do you have an agreement with Loudoun County that is enforceable that prevents them from doing that? I would be interested in that.

Wilding: To the extent that part of the current program is actually working the navigation easements into the deeds on those properties, it is beyond the reach of any future political body. To the extent that there is an agreement with the current political structure that there will be no residential noise levels above 65 DNL, that could change.

Cutler: It sounds to me that they have basically accomplished with the navigation easements the same thing they accomplished with the purchase of the land around Denver.

Kaplan: It is also an interesting example for those of you who have lived in the Washington, D.C., area or spent any time here. I worked on Capitol Hill in the mid-1970s when Dulles was really far out and was just a dream. Airports are economic engines and it doesn't take very long, when it is all said and done, before there is build up all around them. They will build whatever they can build. In fact, we represent a developer who

owned property at the edge of a runway in Westchester County, New York, who was encouraged by the village to build housing so the airport could not expand anymore. It was a planned defensive strategy because the county owned the airport. That is the other thing that is amazing—what the marketplace will foster.

George W. Blomme: Were these people in Greenwich, Connecticut, or in Westchester County, New York?

Kaplan: Westchester County. They were across the road from Greenwich and they were right at the end of the runway. The airport had that property on its Airport Layout Plan as a purchase for 10 years and never bought it and didn't have the political desire to condemn it and buy it.

Jim Crites: I am Jim Crites with Dallas/Fort Worth Airport. Just a comment for Kevin Neels with regard to peak-period pricing. This is something the airlines currently do in their yield management programs, as you pointed out. At least in the case of San Francisco, the airlines have all really based their programs on VFR conditions and cannot provide sufficient seats to accommodate the customers during the IFR times. As to the proactive efforts of San Francisco, I really applaud SFO's John Martin for all that he has done there to try to promote rationalization. Studies to date show that 50 to 60 percent of the delays will be accommodated by some of the initiatives that are being considered. But, if we were to implement peak-period pricing—like I said, it has already been done by the air carriers to their advantage—the airports would be seen as the bad guy for tacking on even more cost to what the passengers already incur during the peak periods. This is just a comment and I would like to have your opinion: might it not be beneficial to provide information to the public on what impact delay has? I'm sure John Martin has probably done a very big public relations campaign to inform the customers what is going on at SFO. I'm not certain the airports should be in the position of trying to control something like pricing of flights, seeing it from a customer's viewpoint.

Neels: Well, I understand what you're saying certainly, although as I was listening to your remarks, I was thinking about my own experience trying to get from here back to Boston on many stormy nights where I was wandering around the airport for hours and thinking, I might pay a little bit more, if I really knew I could get back. I think some people are concerned about pricing, but people are frankly concerned about delay. Part of that concern is the unpredictability of it, but part of it too is just the lost time. I think, as you point out, the airlines already have higher prices in the peak period that reflect people's desire to fly in those periods. The question then would be, incrementally, how much more would people be willing to pay to fly in those periods reliably. I think to some extent, it might be the airports being perceived as the bad guy, but to some extent too, people would really like a more reliable product. If it could be presented as such, I think there would be somewhat more willingness to pay. Now, how much would be enough to change scheduling behavior and things like that are critical questions.

Crites: What you pointed out earlier was the differential between IFR and VFR capacity, which causes a lot of that unpredictability and then weather delays elsewhere which, once

again, is out of everyone's control. I'm not sure that if it is out of your control, and the price goes up, what we gain.

Randy Malin: Randy Malin and this question is for Kevin Neels. As one who scheduled major airlines for many years, I've heard congestion pricing recommendations from many people. I have two questions—one, has it ever been tried anywhere in the world, and two, has anybody done any real research, either with the consumer or with the airlines, as to whether behavior would change? The best of my recollection, landing fees normally account for about 2 percent of the operating cost of an airplane. Every time I looked at this, I could never figure out how high it would have to get before I would reschedule an airplane. It just had to be an astronomical number, plus I think the people who are flying at the a.m. or p.m. peaks are, in fact, non-discretionary travelers, who are the most time sensitive and least price sensitive. The airlines jack prices up all the time by 10 percent and it doesn't seem to affect demand at all. So, it is a wonderful idea—I've just never figured out how it could work.

Neels: You raise a good point and I'll see your comment and raise you one. One of the responses that people long for in response to congestion pricing is a switch toward larger aircraft. If you think about it, just think about the economics of having a seat on a smaller aircraft versus a larger aircraft. There are already tremendous incentives to use larger aircraft. Just on a seat-mile cost basis, they are much less expensive. If that isn't enough to encourage people to schedule larger aircraft, how much more are you going to load on through landing fees to really change that calculus? It does lead me to a certain skepticism that says you might really have to have pretty high prices to make a change. That being said, the nature of congestion is such that you may not have to move a lot of traffic to make a big difference. It may be that the core schedule isn't going to move or change that much, but buried within that time are some flights that perhaps could be diverted, given the right incentives. Maybe it is private aircraft or maybe it is some smaller aircraft or isolated flights that are not part of a major carrier schedule. There may be just enough traffic that could be shifted away to provide some real relief. It may not be the core schedule is going to change that much, but a little bit around the edges could make a big difference. I think that is somewhat of an empirical question. I know some people have looked at that and have expressed more optimism than you or I might be inclined to hear today, but I certainly understand what you're saying.

Richard de Neufville: Could I add to that? In one sense, the congestion pricing differential has been a tremendous success as you have already seen. If you think about the discussion 20 years ago about whether people would fly at 6 a.m. in the morning to go to places and do things. The fact is these shoulders have broadened tremendously not because they have added on the pricing, but because we've told people if you want to go to Florida for your vacation, take your kids at 6 a.m. at a cheap fare and people fill up the aircraft. So, we may not be able to use pricing as a tool to hit those peaks, but we have managed to increase the capacity of airports tremendously in terms of people throughput and operations over the year, by in effect completely changing the pattern of the peaks.

Kaplan: Let me ask MTC's Larry Dahms a question, since I don't want him to get off here completely scot free, about regionalization and changing the way FAA works on

airport planning at the local airport proprietor level. You talked a little bit about the Bay Area and your view and I guess there are two things going on. One is that there are some smaller regional airports that are growing and that want traffic, such as the airports around Boston, like Manchester and Providence. Then there are other general aviation (GA) airports that don't want passenger traffic but the FAA says they have to take it if they have received any federal funds. We represented an airport in the Denver area, Centennial Airport, where the FAA said, they received runway money, so they have to take passenger traffic even though the community is doing everything it can to not have scheduled commercial service. In the Bay Area, how does shifting GA traffic away from San Francisco International Airport (SFO) or Oakland factor in the planning?

Lawrence Dahms: I think SFO's John Martin could probably answer the question better than I. In Oakland, there is a lot of GA airport traffic because they have essentially a separate airport for GA. I don't have the feeling that GA is really that big of a problem, but I would defer to John on that.

Martin: We have seen a decrease over the last 15 years in GA. We are down to essentially only corporate aircraft and this is for two reasons. First, we now fully recover costs for each landing, so we have a minimum landing fee of about $60 for private airplanes. Second, we only have 11 acres available for the GA operators, so there simply aren't enough parking spaces available. Certainly keeping the GA airports in operation in the Bay Area is very important to us.

Kaplan: You don't have a problem where you're trying to achieve efficiencies at your primary airports by moving GA out of the traffic flow and into another airport?

Martin: We are down to only corporate traffic and we think it is important that we be able to handle that executive-level traffic, which is 3 percent of our traffic.

Cutler: I think the GA traffic 20 years ago used to be a very serious problem for a lot of airports. I think that today's analogy is the Brazilias and the RJ's. You still have the same kind of problem. It has just ratcheted up the scale a little bit. It is in that area where intuitively I happen to think that differential pricing would have an impact. It may not have an impact as Randy Malin pointed out, on a 767 as a large percentage of its operating cost, but you get a healthy enough bump in a landing fee on a Brazilia and you're going to have an impact. You have to have an impact on the economics. If you do get the Brazilia out of the stream, you've accomplished something significant if it is replaced with a substantially bigger aircraft.

Kaplan: Is that one of your goals in your effort to shift to larger aircraft at SFO? Did you consider some type of pricing?

Martin: We have tried. We can't charge above cost. We get whatever we can for commuters. We would like to get $200 to $300 per GA or commuter aircraft to make a difference. But, we would have to differentiate between those communities that need the essential air service and those communities that have 16 flights a day, such as to Sacramento.

Neels: I think you touch on one of the points I discussed which is that when you're living with the requirement that revenues equal costs, you have to think about how widely that circle is drawn. If it is drawn around each aircraft type, then it can be kind of tough if all you are tracking are the monetary costs and not the delay or congestion costs. If you drew the circle more widely, you would at least have a little bit more flexibility as to the difference between essential and non-essential services, to some extent. I don't know whether the market would sort that out. I would think that if the market did, it would probably do so by raising the fares that the communities receiving essential air service were forced to pay. I'm not sure we would be willing to live with that, but that is one of many political questions that congestion pricing raises.

Geoffrey Gosling: I'm struck by an element of this debate that hasn't been mentioned yet and that is that particularly at San Francisco, and indeed at most hubs, the majority of the traffic is operated by a single airline. When we talk at SFO about the commuter carriers that are coming in from the Central Valley communities, or the cancellations of the West Coast shuttle flights, these are all United or United Express flights. So, as far as delays to other flights, United is doing it to itself. United has made a corporate decision how to operate, and presumably these people aren't ignorant about the consequences of what happens during bad weather. If they have made a conscious corporate decision to continue operating these turbo prop flights into the airport and to continue to schedule their West Coast high-frequency shuttle flights using 737 equipment rather than 757 equipment, presumably they are doing this because in their overall scheme of things, this is their most profitable strategy. If it wasn't, why would they be doing it? They would be doing something different. It seems to me that we may be making a big mistake here looking at the congestion and considering that this is an airport problem, when in fact it seems to me this is purely a commercial decision that has been made by a given carrier who is having to trade off, within its own decision-making, costs that are incurred by different parts of its operation and the revenues that go with that. So, I would be interested in the reaction of the panelists.

Neels: I have one comment on that, and I may steal some of John Martin's thunder on this. Yes it is true that if you take the San Francisco example, United is the author of the problem and the victim of the problem to a very large extent. John had mentioned this issue of back filling. If United schedules one extra flight, it may know that it is going to cause more delays and more trouble when the weather is bad and it will take that into account. But on the other hand, if you have another carrier wanting to come in and with a limited amount of service try to compete as best it can against the major presence that United has there, that carrier is going to come in with the one flight right in the peak period. All the problems it causes will be problems that are imposed on United and that it doesn't have to worry about. So, the entrant carrier does not face the externality problem.

Gosling: Isn't that the nature of competition?

Neels: Well, it is a little bit different than competition in that it is not just the new entrant carrier stealing passengers from United. But, it is a new entrant carrier imposing delay costs on United's whole schedule and not having to deal with it. That is the externality problem that it has not dealt with there. If United were to back off, that would create

openings for other carriers to come in. Anticipation of that by United may be part of the explanation. But, I will defer to John Martin to add his insights.

Martin: I do worry about the back filling. A couple of years ago, we had a commuter airline enter the Sacramento market with a 12-seat aircraft trying to undercut United. I worry we could see RJs between San Francisco and Los Angeles with a new entrant. So, it is a concern. It is interesting that SFO is one of United's most profitable cities on its entire network. So, they are making a good commercial decision, even though they are facing these delay costs as well. Part of the things that should be factored in, as well, are the union agreements. United does operate under union agreements on the shuttle that they can operate only 737 flights. They have a restriction on the number of RJs that can operate nationally. As a result, United operates not a single RJ in the San Francisco market. They focus those in Dulles, Denver, and Chicago.

Mark Hansen: I'm Mark Hansen from the University of California at Berkeley. I have a comment for Kevin Neels and a question for Eliot Cutler. Kevin spoke of the tremendous economies of scale in aircraft size. It turns out that a lot of those economies of scale are actually captured by the pilots so that pilots are paid a lot more if they fly larger aircraft. That really dissipates a lot of the incentives in terms of a cost advantage that the airline has.

For Mr. Cutler, first of all, I was glad to hear you were in Bangor, Maine. It seemed to me from your presentation that the situation in Los Angeles is something worthy of Stephen King in terms of the nature of what is going on there. One aspect of the problem that occurs in both Los Angeles and the Bay Area is that you have these rich counties like Orange County south of Los Angeles, which have elected to use other counties' airports or other communities' airports. I just wonder if the freedom you would like to give to airports in general to manage their resources would also extend to some way of systematically discriminating or limiting access to their facilities by people in counties that behave in that manner?

Cutler: I tend to think the market is going to take care of that problem in the sense that when I said the voters of Orange County had taken El Toro off the table for all practical purposes, I think that is true, at least for the foreseeable future. I think it is going to be very difficult politically, in Orange County, to get a two-thirds vote, which is what will be required for an airport at El Toro or any other large public facility. The largest growth in demand for air transportation in the Los Angeles area is in Orange County. If you look down the next 20 to 25 years at the five-county region, and you weigh the expected growth, Orange County dwarfs everything. If Jeff Thomas is still here, he may even have the numbers. That is going to spill over into roadway congestion. It is going to be miserable. Orange County's John Wayne Airport isn't going to get any bigger. It is going to make getting to LAX, particularly for folks who live in the southern county, very, very difficult. So, I suspect over time the pressures are going to change a little bit and there may be a facility built in Orange County.

Maybe I've spent too much time in Washington or too much time in the federal government, who knows why—I don't trust the federal government to make decisions for counties like Orange County or anybody else about whether or not they have to develop a facility like El Toro airport. What I do know is that when the biggest provider of airport capacity in the Los Angeles region, which is Los Angeles World Airports, which owns

LAX, Ontario, Palmdale, and Van Nuys, steps up to the plate and says, we're the biggest provider, we're responsible, we're going to do what is necessary in any rational regional solution for this area, I want to be sure, both as their lawyer and a citizen and a traveler, that the federal agency with responsibility here is going to make it possible for LAX to undertake the kinds of agreements and mitigation measures and so forth, that are going to be necessary to get this capacity in the system. For that matter, I want to be sure they are going to enable agreements between the city of Burbank and the Burbank/Glendale/ Pasadena Passenger Airport Authority instead of shooting them down.

It is remarkable to me that the federal agency that ought to have the greatest concern over long-term capacity issues doesn't behave in a way that is at least obviously intended to build that capacity or have that capacity built. I don't want to go around penalizing rich folks who don't want airports in their back yard. I've represented a lot of them after all. But, I really think the focus ought to be on enabling and empowering jurisdictions that do want to step up to the plate and build capacity.

Paul McKnight: It is a privilege to ask the last question of the day. I am Paul McKnight of the John F. Brown Company. I'm seeking a ray of hope here and I would like to address this question to consultant Matthew Coogan since he is the only one in the group that has the benefit of 50 years of hindsight. I would like to know how the outcome of all of this, as you look back 50 years from now, worked out with respect to this trend that we're seeing today toward smaller aircraft. We are seeing a general move to more flights by smaller airplanes. This idea of the integrated service provider and the modal operator—how did they work out the problem with this move we saw happening 50 years ago toward an increased number of regional jets running around? How did that unfold in this vision of things?

Coogan: There are only two possible answers, and I've left my omniscient viewpoint and I'm back here right now. The only two that I can think of are an acknowledgment of the legitimacy of some form of slotting. I am served by an airport called West Lebanon, New Hampshire. Right now it is very difficult for me to get a flight, and in fact I can't, into LaGuardia, because there is not a slot available. I actually prefer that to what I think is about to happen under the strange law that something like 400 of these little planes are supposed to be given slots at once. I think that absurd. If this happens, I will never get in and out of LaGuardia without long delays and, as a citizen, I would rather have the slotting system.

I'm changing personalities here for just a second—in some situations there has to be some reactivation of that function if you're trying to optimize a situation. For LaGuardia, it only makes sense that there are a certain number of slots there. As traffic at Orange County's John Wayne Airport is growing with gigantic growth for one runway, that airport is an obvious one too. One-half of the equation has to be government intervention and the reimposition of some kind of regulation—just a small amount—of slotting. The second is the logical self-interest of the corporations who would like to haul lots and lots of people out of airports like John Wayne Airport. The airlines have to be convinced to go with the larger planes in order to accomplish that.

Somebody has to say the large plane gets some priority over the small plane. So, the answer is some government role married with the logical self-interest of corporations.

Concluding Remarks

RICHARD DE NEUFVILLE
Massachusetts Institute of Technology

I gather I'm not obliged to keep everyone here another 15 minutes, so I won't. What struck me today about this discussion is that there was very little talk about actual construction. We've certainly come a long way in the last 40 years from where we used to address such things in terms of construction solutions to everything. What we have talked a lot about here today referred to largely operational and institutional changes. Of course, we will need more construction and there will be more construction. But, I think an interesting take-away is how much, in one way or another, we have talked about institutional changes and how the airlines might respond to different pricing policies, and how we might manage expectations on the part of the travelers. Hence we're focusing on the way we perceive and operate the system.

I certainly feel most encouraged because I think that there are a lot of opportunities if we reconfigure the way we think about the problem collectively—institutions, individuals, and so forth.

Let me give you one small example. Objectively, the delays are far worse between Boston and Washington than they were 30 years ago in terms of the actual delays, number of operations, and so forth. Conceptually, however, my planes are always on time, by the magic that John Martin suggested, namely they build more slack in the schedule. My scheduled time used to be an hour to come to Washington 30 years ago. Now it is an hour and a half. My plane is delayed more, but I'm happy. So, part of that is the way we configure things and think things through in a different way.

For me, I think this is very encouraging. I've learned a lot from listening to everybody. I hope you've enjoyed it. Thank you very much for the opportunity.

Speaker Introductions

GEORGE W. BLOMME

Aviation Planning and Technology Systems
Conference Moderator

George Blomme has an aviation career that has spanned 30 years, in diverse managerial jobs supervising the LaGuardia airport maintenance crew; marketing air cargo development in France and elsewhere for John F. Kennedy International Airport; developing and enhancing technology programs to foster greater efficiency, safety, and more effective management control at airports; and progressing regional and system planning for multi-airport systems.

For the past 4 years, George has been president of Aviation Planning and Technology Systems Consulting. George places special emphasis on plan review, and introducing technology-based efficiencies, safety measures, and improved management control.

George has lectured on airport system planning and development, and practicable technology advancements for airports, at Oxford University (England), University of California, and State University of New York.

George has been an active member of TRB for 20 years, serving in various leadership capacities. He also is a contributing review editor to the monthly ITE Journal for the Institute of Transportation Engineers.

MATTHEW COOGAN
Consultant

Matt Coogan is currently a consultant in transportation. He specializes in the application of intermodal and multi-modal planning techniques. He is a nationally recognized expert in the application of statewide and metropolitan planning principles, regulations, and procedures, and specializes in the deployment of new transportation technology and the implementation of these procedures. He graduated from Harvard College, and later served as a Fellow in Advanced Environmental Studies at Harvard Graduate School of Design. He has been a frequent lecturer at Harvard and MIT and Boston University. Between 1970 and 1972, he helped establish and served on the Boston Transportation Planning Review, the first major multi-modal transportation study in the United States. Between 1983 and 1991, Mr. Coogan served as Undersecretary of Transportation for the Commonwealth of Massachusetts and as Project Director of the now famous Central Artery Tunnel Project. He was smart—he got out in time. It is going to be a great project—just forget about the cost. He was appointed by the National Academy of Sciences to both the Committee on High Speed Ground Transportation and the Committee to Critique the National Maglev Initiative. He has lectured on transportation issues throughout the United States and in Europe and Asia. He has been featured in Engineering News Record, *The New York Times*, *The Wall Street Journal*, and *The Washington Post*, and has appeared on the *NBC Today Show*, *CBS News*, and National Public Radio. He is also a Founding Member of the Board of Directors of the International Air Rail Organization based in Heathrow Airport in London. For the Transit Cooperative Research Program (TCRP), he is a principal investigator for the study, "Improving Public Transportation Access to Large Airports." Mr. Coogan is currently serving as consultant to TCRP in a study for the future of public transit services entitled "New Paradigms for Public Transportation Organizations." For the I-95 corridor Intelligent Transportation System (ITS) Coalition, Mr. Coogan is currently working on the development of a multicase passenger information system for all public modes, and is developing a program to integrate ITS-based data into the management of operations and planning.

ELIOT CUTLER

Cutler and Stanfield

Eliot Cutler is a Partner at Cutler and Stanfield. He began his public career as a legislative assistant for Ed Muskie. He was Associate Director at the Office of Management and Budget (OMB) for natural resources, energy, and science. He really began his career leading communities concerned about airport expansions and has now crossed over to where he is also representing airports like LAX and O'Hare in their efforts to determine their futures and try and move forward. As you listen to Eliot, one of the things that is useful to think about, because we continue to hear there are no silver bullets and there are no easy answers, is what kind of trade-offs would airports and airlines be willing to make, for example, to get triple simultaneous instrument flight rules in a runway system? Or what kind of trade-offs are we going to have to make in order to get capacity, whether it is at Minneapolis, Seattle, San Diego, Los Angeles, or O'Hare, where there are homes literally built up all around the airports. Eliot has been doing this for a long time. He is a graduate of Harvard College and Georgetown Law School.

LAWRENCE DAHMS
Metropolitan Transportation Commission, San Francisco

Larry Dahms is Executive Director of the Metropolitan Transportation Commission in the San Francisco Bay Area. He serves a 19-member governing board, which represents nine counties and 100 cities in the region. He has had many responsibilities and developed strong political capabilities over the years. In his previous positions, he has been employed by the Army Corps of Engineers and Caltrans. He has been a California legislative analyst and a consultant at Arthur D. Little, Chairman of the Board of Directors of the Eno Foundation for Transportation, Inc., a past chairman of TRB and he currently services on the Executive Committee. He is a graduate of San Diego State University with a Bachelor of Science degree in Civil Engineering, and a Master of Business Administration from Sacramento State University.

RICHARD DE NEUFVILLE

Massachusetts Institute of Technology

Richard de Neufville is Professor of Engineering Systems and of Civil and Environmental Engineering at the Massachusetts Institute of Technology (MIT). From 1975 to 2000, he served as the Founding Chairman of the MIT Technology and Policy Program. That is a graduate course of about 150 students that has prepared future leaders in technology policy. Professor de Neufville regularly teaches dynamics, strategic planning and engineering, and management programs in Europe, Latin America, and Asia, in addition to the United States. He is also the author of four major textbooks. For this work, he and his team have received several awards for excellence in teaching and two annual awards for "The most significant contributions to MIT education."

Professor de Neufville's technical interests are focused on airport planning and design. He is the author of "Airport Systems Planning," which many in the industry use regularly as a reference, and is writing a new text on this subject in collaboration with Amaedeo Odoni, also at MIT.

He has consulted on many international projects, most recently the design of the Kuala Lumpur and Bangkok airports, strategic planning for the Miami, Florida, and Sydney, Australia, airports, and the privatization of airports in Mexico and Australia.

JANE F. GARVEY
Federal Aviation Administration

Jane F. Garvey, the 14th Administrator of the Federal Aviation Administration (FAA) was sworn in August 4, 1997. She is the first Administrator confirmed by the Senate to a 5-year term. With an outstanding career in public service and extensive administrative experience, Garvey brings to the FAA a strong commitment to ensure the world's safest skies become even safer.

As Administrator, Garvey manages a 49,000-person agency with worldwide impact and presence in promoting aviation safety and security. The FAA regulates and oversees aviation safety and security, conducts cutting edge research and development, and operates the world's largest air traffic control system.

Administrator Garvey initiated *Safer Skies*, the U.S. aviation community's safety agenda, which focuses the agency's resources on taking the actions that safety data and analysis indicate can make the biggest difference in lowering the accident rate. She led the successful transition of the FAA's air traffic control system to January 1, 2000, with no disruptions to service. In addition, the FAA provided world leadership on Y2K transition. Under Administrator Garvey's leadership the FAA is moving forward on its phased plan to modernize the air traffic control system and has, for the first time, achieved government and industry consensus on how to proceed. To bring immediate modernization benefits, she initiated the Free Flight Phase 1 program under which the FAA reached consensus with the aviation community to deploy five specific technologies by the end of 2002.

Prior to being named FAA Administrator, Garvey was Acting Administrator of the Federal Highway Administration (FHWA). She served as Deputy Administrator of FHWA from April 1993 until February 1997. FHWA, also an agency of the U.S. Department of Transportation, has an annual budget of $20 billion and works in partnership with the states to maintain the safety and efficiency of the nation's roads and bridges. A creative leader at FHWA, Garvey chaired FHWA's Innovative Financing Initiative, which resulted in more than $4 billion in transportation investment in more than 30 states—projects that in many cases would not have otherwise been built.

Before joining FHWA, Garvey served as director of Logan International Airport, one of the nation's busiest aviation facilities. From 1988 to 1991, she was Commissioner of the Massachusetts Department of Public Works. Before that, Garvey was Associate Commissioner in the Massachusetts Department of Public Works, where she directed construction activities and developed environmental initiatives.

Garvey holds degrees from Mount Saint Mary College and Mount Holyoke College. She has participated in the Fellowship Program for Public Leaders at Harvard University.

GEOFFREY GOSLING

University of California at Berkeley
Conference Moderator

Geoffrey Gosling is an Assistant Research Engineer at the Institute of Transportation Studies at the University of California, Berkeley. He is also a member of the Research Staff of the National Center of Excellence for Aviation Operations Research. As such, he is responsible for the management and conduct of air transportation research and development of the Institute's air transportation research program. His recent research has addressed aviation safety and security, airport ground access, measuring aviation system performance, and forecasting requirements for aviation system planning.

He has a Ph.D. in Transportation Engineering from the University of California at Berkeley and has taught in the transportation program at Berkeley for about the last 20 years. He has also helped organize and teach university extension courses on airport systems planning and design, airport ground transportation, aviation security, and intermodal planning. He is a member of several professional committees and currently chairs a TRB Committee on Airport System Planning.

He has also served as a consultant and expert witness in various areas of airport planning and airline operations, for a variety of airports, government agencies, and other clients, and has performed several technical assistance missions for the International Civilian Aviation Organization.

R. JOHN HANSMAN
Massachusetts Institute of Technology

John Hansman is currently Professor in the Department of Aeronautics and Astronautics at Massachusetts Institute of Technology, where he heads the Human and Automation Division. He is also Director of the International Center for Air Transportation and of the Aeronautics Systems Lab. He teaches courses on human supervisory control of automated systems, air traffic control, spacecraft and aircraft sensors and instrumentation, and has produced an 8-tape educational video series on measurement. He holds five U.S. patents, has authored over 150 technical publications, and conducts research in several areas related to flight vehicle operations and safety. His current research activities focus on advanced cockpit information systems, including flight management systems, air/ground data link, advanced alerting systems, and flight crew situational awareness. He has received a number of awards from the American Institute of Aeronautics and Astronautics and other industry organizations, and has served as an Advisor to the Congressional Aeronautics Advisory Committee and the FAA Research and Development Advisory Committee. He also has over 4,500 hours of piloting command time on various types of airplanes.

STEPHEN KAPLAN

Cutler and Stanfield
Conference Moderator

Stephen Kaplan currently works as a partner for the legal firm Cutler and Stanfield in Denver. His primary focus is on aviation and transportation law and related financial and environmental land use and development issues. Mr. Kaplan represents public and private entities involved with airport development and improvements, large infrastructure projects, private development, and federal policy and regulatory matters. From 1993 to 1995, Mr. Kaplan served as the General Counsel of the United States Department of Transportation (USDOT). In the area of international aviation, Mr. Kaplan negotiated the open skies agreement with Canada and also negotiated bilateral issues with the Japanese and the United Kingdom. He is actively involved in the creation of the "nine-country open skies initiative" in Europe, and assisted in the development of the administration's international aviation policy. On airport issues, Mr. Kaplan was directly involved in rates and charges and revenue diversion in the legislative policy and regulatory areas. He helped prepare the United States government's amicus position in the Kemp County litigation before the Supreme Court, and also worked closely with the FAA on new funding structures for increasing airport capacity. Mr. Kaplan also spent considerable time on the implementation of the Intermodal Surface Transportation Efficiency Act of 1991 and related planning and environmental matters, aviation safety, and regulatory reform.

Mr. Kaplan served as City Attorney for Denver from 1983 to 1990, and there he was actively involved in all aspects of the efforts to plan and finance the new Denver International Airport. He negotiated agreements with the Denver Broncos and the Denver Nuggets, and the design and build contract for the Colorado Convention Center and retail development projects in Denver. He was directly involved in Denver's efforts to secure a major league baseball team and build a new stadium, in addition to being counsel to the Denver law firm of Avis, Graham and Stubbs. Mr. Kaplan also served as a legislative assistant for Congressman James R. Jones from 1973 to 1976.

Mr. Kaplan is a graduate of Harvard University and Harvard Law School. He has received a number of awards and honors, including an exceptional service award from the USDOT, presented by the secretary of transportation in 1995; the extraordinary achievement award from the FAA, presented by the administrator and deputy administrator of FAA in 1995; and the outstanding leadership award, Airports Council International in 1996; and finally, Vice Chairman of the National Civil Aviation Review Commission in 1997.

ROBERT KELLEY-WICKEMEYER
Boeing Commercial Airplane Group

Robert Kelley-Wickemeyer works for the Boeing Company, where he is the Chief Engineer for Aerodynamics, Propulsion, and Noise Research for the Boeing Commercial Airplane Group. He graduated from the University of California at Berkeley in 1966 with a Bachelor of Science degree in Mechanical Engineering, and in 1967 a Master or Science degree in Aeronautical Engineering. He first joined the Boeing Company in 1962 in a work-study program working on supersonic wind tunnels, the Saturn 5 guidance and control system, and the minuteman missile program. Upon graduation, he joined the 747-product development group as an expert in high lift aerodynamics. He has been responsible for the design of the second generation CF-6, JT9D, and RB211, for the 747, as well as for the aerodynamic design and certification of the 757SP and 757-200 aircraft. Later assignments included Chief Engineer for Testing, Certification, and Performance for Boeing Commercial Airplane's single aisle program, as well as Chief Engineer for Technology and Certification for the 600 passenger new large airplane program, as well as a brief time in the military airplane division.

In his current assignment, he is responsible for the development of technologies that will increase the capacity of airports by increasing the number of take-offs and landings. This may be accomplished by inducing the trailing vortex structure to decay more rapidly. He is also leading the development of technologies that will increase airplane performance, decrease acquisition costs, as well as enable the investigation of mobile configurations to increase overall system utilization.

JOHN MARTIN

San Francisco International Airport

John Martin has been employed at San Francisco International Airport (SFO) since 1981 and he has been the Executive Director since 1995. This airport for which he is responsible is the fifth largest airport in the United States based upon passenger traffic. It has the largest airport construction program in the United States presently underway, and is nearing completion of a $3 billion construction program. As Executive Director, he is facing one of the most difficult airport situations in the country, that will require incredible creativity.

KEVIN NEELS
Charles River Associates

Kevin Neels is Vice President of the consulting firm of Charles River Associates, where he directs that firm's transportation practice. He has conducted research and consulting on problems of transportation economics for over 25 years. He has dealt with issues relating to transit, transit design, transportation project financing, service design pricing, and management and transportation policy. His principal focus, however, has been on aviation issues and especially issues related to airline competition. He has prepared and delivered expert testimony in a number of major airline anti-trust proceedings. He has prepared submissions in connection with regulatory proceedings by the U.S. Department of Transportation, Federal Energy Regulatory Commission, and the U.S. Postal Rate Commission. Prior to joining Charles River Associates, he served on the research staffs of the Moran Corporation and the Urban Institute. He holds a Ph.D. in Regional Economics from Cornell University.

JEFFREY THOMAS

Landrum and Brown

Jeffrey Thomas has served as the Chief Executive Officer of Landrum and Brown since 1976 and has been the majority owner of the firm since 1984. Landrum and Brown is an industry leader in providing facilities, operations, and strategic planning services to owners and operators of airports, and in particular to high-capacity airports. He also has been a founding partner of Airports and Aviation Professionals, an organization that provides support to the airlines in implementing major airport capital programs. Over the last 30 years, Mr. Thomas has performed as the lead professional on airport master planning engagements for several of the busiest, most site-constrained hub gateways in the U.S. His extensive experience at Chicago and Los Angeles has afforded him insight into the strategic role and demand characteristics of airports and multi-airport systems.

APPENDIX

Prospects for the Future

RICHARD DE NEUFVILLE
Massachusetts Institute of Technology

SUMMARY

This paper explores the long-term prospects for airport development into the 21st century, particularly for the United States. It tries to identify both key issues and the range of probable outcomes. It draws on knowledge of the past, analysis of the future prospects, and an appreciation of the limits to extrapolation. It concludes with recommendations for the way that airport systems should be planned in the future.

The paper assumes that three main drivers will impel the future of airports:

1. Growth in traffic. This will lead most obviously to larger, busier airports. It will also lead to diversification and specialization. As metropolitan areas grow, multiple metropolitan airport systems will become standard. Individual airports will in parallel increasingly serve niche markets for leisure travel or cargo traffic.
2. Globalization. Airlines will merge within the major global trading blocks, as they have in North America and are in the European Union, and will join global alliances. In parallel, airports will become associated with international airport management and operating companies. These trends will jointly change the demand and the provision of airport services.
3. Commercialization. Airport operations and management will become increasingly commercial and less political. The staff will, in the context of worldwide companies managing airport facilities, receive more sustained professional training and become more efficient.

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

The scenarios focus on three main elements:

1. The levels of traffic—passengers, cargo, and aircraft;
2. The infrastructure provided to accommodate these loads; and
3. The management style for these facilities.

Traffic

Future levels of traffic are perhaps most questionable. While many Americans rarely fly and the domestic market is far from saturated, there are many reasons to think that the rate of growth of U.S. domestic traffic may continue its long-term decline. As seemingly

small differences in assumptions about the rate of growth lead over a generation to enormous differences in totals, we must be very tentative about future levels of traffic. For example, by 2025 the number of enplaned passengers in the United States could be two or three times the current 600 million a year.

The composition of the total traffic is in any case likely to be significantly different from what it is today. The international components could be larger and more pervasive. This could be propelled by two factors: the growth in the number of foreign visitors as the rest of the world catches up to the United States in terms of air travel, and improvements in aircraft range that facilitate long-distance travel. In this context, we can anticipate that more international traffic will go directly to inland cities that have not had international service. It is also possible that cargo traffic will expand dramatically as companies reorganize their distribution systems around electronic commerce.

Infrastructure

Two new kinds of airports may become more important. We may witness the further development of brand new massive airports with sets of very long parallel runways, located well outside traditional city limits. They would be on the model of Atlanta, Dallas/Fort Worth, Denver International, Orlando, and Washington/Dulles in the United States, and of Athens, Kuala Lumpur, Paris, and the new Seoul airports. They would serve as centerpieces of new economic areas or as transfer hubs.

We may also see the further development of specialized airports, serving niches of cargo or passenger traffic. Current examples of this phenomenon in the United States are Louisville as a cargo center and Dallas/Love as a base for Southwest as a low-fare airline. In particular we may expect a proliferation of multi-airport systems serving metropolitan regions, in which each airport tends to serve a particular market or type of service.

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

Organization of Airport Business

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

Over time, we may expect that airports will less and less be run as municipal departments or local authorities, and increasingly as franchises to commercial companies

operating under policies set by local political structures. This evolution could, through economies of scale, create substantial efficiencies and improvements in service.

BACKGROUND

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

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

Growth in Aviation Passengers and Cargo

Growth in aviation passengers and cargo is an outstanding characteristic of the last 50 years. Long-term, over good and bad years in this period, passenger traffic has increased by an average of about 7 percent a year in the United States and 8 percent worldwide. This means that the amount of air travel has been doubling within every 10 years. This level has been generally continuing worldwide. Recently, however, this long-term overall growth rate has dropped in the United States, where it is now about 4 percent a year, which implies that traffic doubles about every 15 to 20 years. The net effect may be interpreted as almost linear total growth over the last three decades (Figure 1).

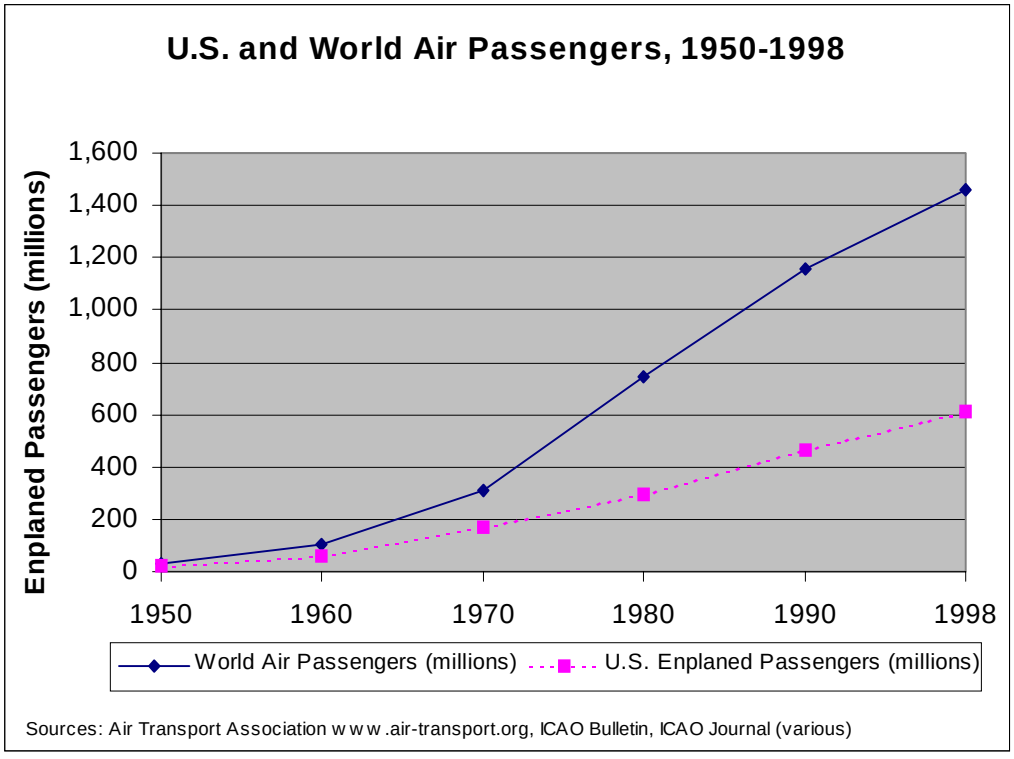

FIGURE 1 Rapid steady growth in airline traffic worldwide over the past 50 years.

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

Aviation Companies as Global Enterprises

Aviation companies are becoming global enterprises. Airlines traditionally have had specific national characters although they provided international service. American Airlines, British Airways, and Air France for example were each clearly based in their home countries and represented their nationalities proudly. Now however, airlines are developing international characteristics and submerging their nationalities. For example, Northwest and KLM work together to present a single image, so that the U.S. customer can feel comfortable with an American style of service, while the Dutch customer can similarly expect a familiar treatment.

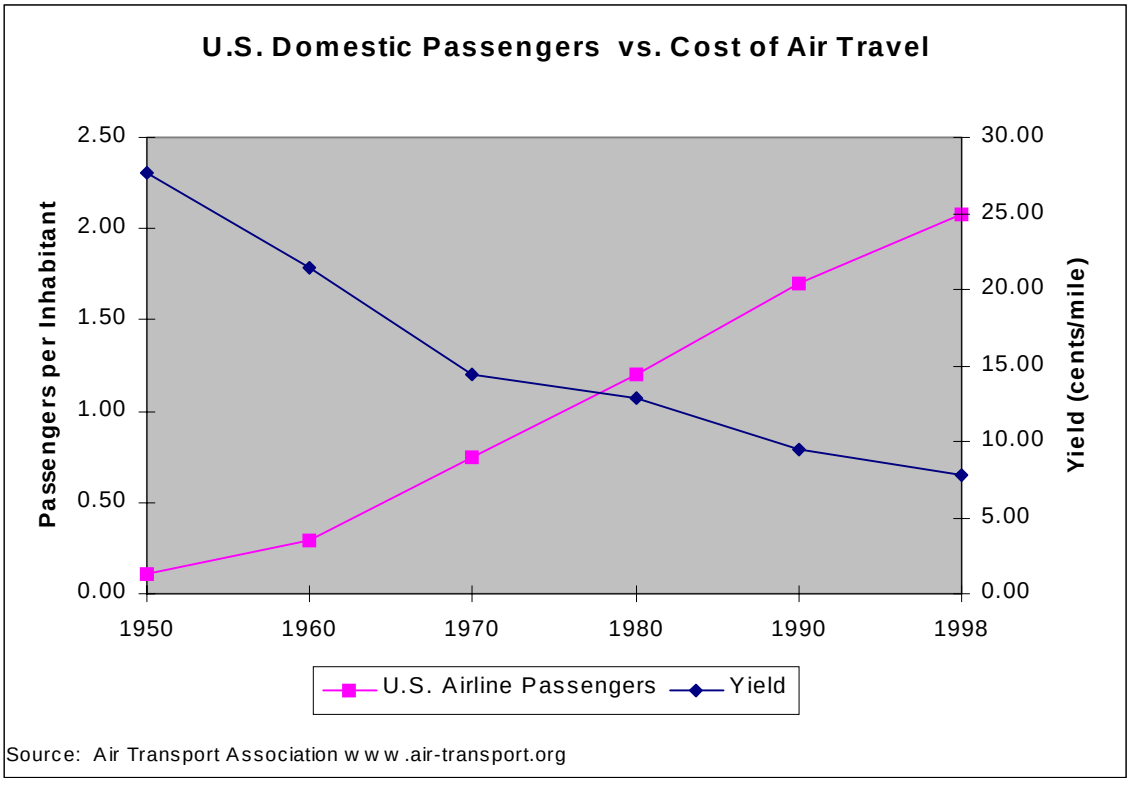

FIGURE 2 Rise in traffic has mirrored decrease in overall costs of air travel.

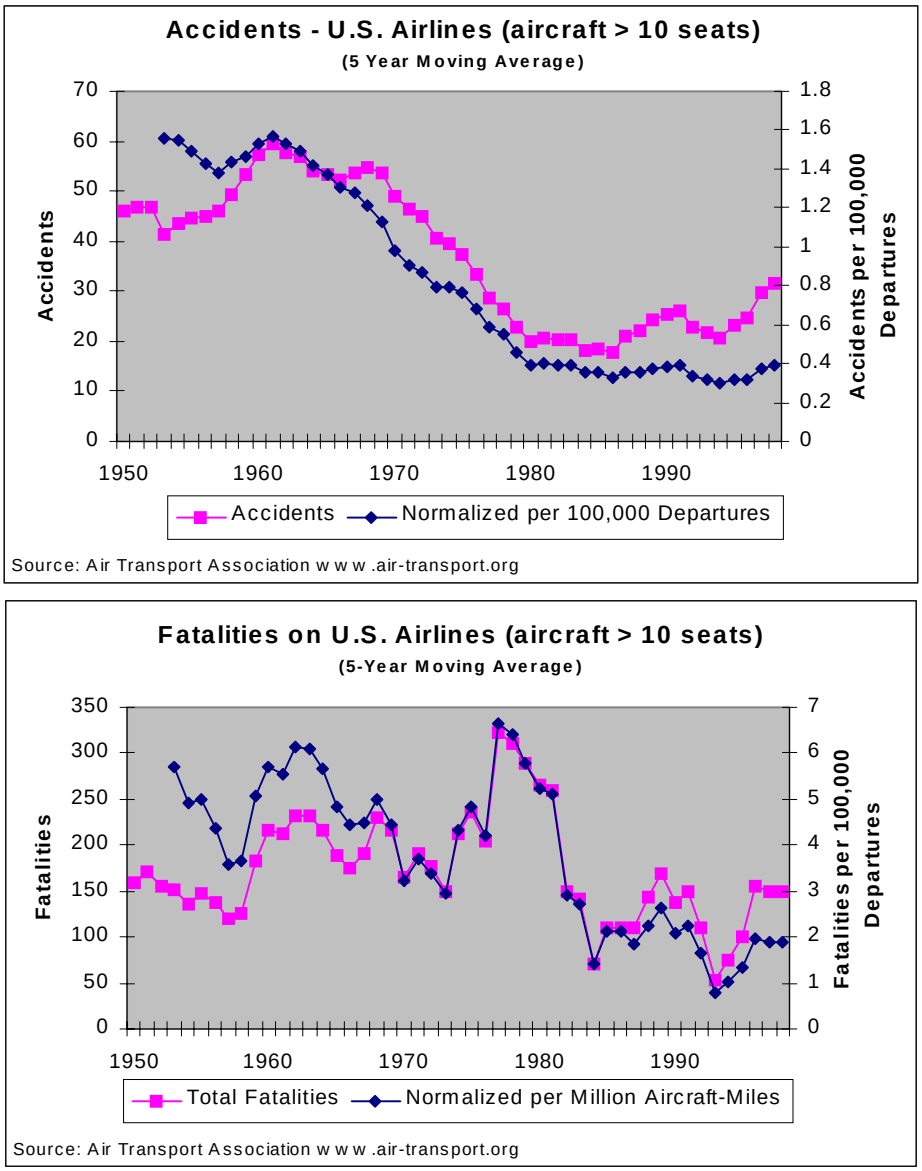

FIGURE 3 Accidents and deaths per trip have dropped by a factor of 2 to 3.

The global airline partnerships now being formed express this trend. The Star and Oneworld alliances for example each link national airlines into global networks whose stated aim is to provide coherent services to passengers as if they were using one airline. These are leading to patterns of ownership (for example between U.S. and Latin American airlines). They are also being matched by the emergence of transnational European airlines formed through mergers across borders, for example between KLM and Alitalia, and between Swissair, Sabena (Belgium), and TAP (Portugal). These transnational European airlines are naturally being integrated into the global alliances. Thus KLM/Alitalia is associated with Northwest/Continental, and British/DeutscheBA/UTA is allied with American and its partners.

Airports are similarly losing their local character and becoming international. We are seeing the development of global “airport chains” similar to “hotel chains.” International

companies are increasingly taking over the operations of portions of these properties, and delivering their own brand of services. As in the hotel business, the management arrangements are sometimes based on long-term contracts (as when BAA from England operates Indianapolis airport), and sometimes on ownership (as when SEA from Milan owns the Argentine airports along with Ogden Aviation and Argentine partners). These international companies may be based on

- Particular airports (such as Amsterdam, London, Milan, or Montreal to name a few of these airport entrepreneurs),
- Operating companies (Ogden Aviation or Westfield, a real estate operator from Australia with major U.S. holdings), or
- Especially constituted investment companies (such as TBI from England, which has bought the U.S.-based Airports Group International and is contracting with Orlando/Sanford airport).

Airport Capacity Increases

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

What is truly remarkable, however, is the increased traffic now routinely carried by a given runway, compared to twenty or more years ago. Many airports now serve 50 to 100 percent more operations a year than their “Practical Annual Capacity”, as estimated by planners in the 1970s. Actual operations now routinely can be as much as 90 percent above what planners imagined were upper limits (Table 2).

TABLE 1 Rapid Growth of New Hubs and Secondary Airports

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

SOURCE: FAA/DOT ACAIS Database, FAA Statistical Handbook of Aviation.

TABLE 2 Example of U.S. Airports That Operate Well Above Their Practical Annual Capacity (PANCAP) Without the Benefit of Additional Runways That Would Change That Figure

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

[1] Source: FAA, Office of Aviation Policy and Plans. *Airfields and Airspace Capacity Delay Policy Analysis*, FAA-APO-81-14 NTIS, Springfield, Va., 1981.
[2] Source: *ICAO Digest of Statistics, Airport Traffic*, 1990, 1997.

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

- Airport operations now routinely extend from 6 a.m. to past midnight, a sharp contrast to the situation of a generation ago when aviation planners seriously debated whether travelers would ever use inconvenient times early in the morning or late at night. As deregulation demonstrated, travelers do fly at odd hours when the price is right.
- Bigger aircraft, operating with higher load factors associated with flexible pricing practices that airlines use to fill more seats, increase the volume of traffic off a runway.
- Improved spacing and sequencing of aircraft into airports has reduced the variability in landing times, and increased the number of operations it is possible to accommodate.
- Air traffic controllers in the United States now have learned to use existing runways more efficiently, for example when they control landings on intersecting runways.
- The institution of slot controls that, especially on a worldwide basis, limit the access of smaller aircraft (either directly or indirectly by making the slot too valuable to be wasted on a few passengers) and thus raise the number of passengers served by runways.

Further improvements are in the works based on current technical advances:

- Global Positioning Systems (GPS) based on satellites that define aircraft positions much more accurately and thus improve sequencing and capacity; and
- Close Parallel Runways that could be certified for independent use, thanks to better positioning of the aircraft, and thus increase the capacity at a number of existing airports.

Environmental Issues

Environmental issues will increasingly define the design and implementation of airport systems. They have already been important factors limiting and defining the operation and expansion of airports. The debates about new runways for Boston, San Francisco, and Seattle illustrate this phenomenon. Yet these controversies have been situated in the context in which overall noise levels have generally been steadily decreasing. In recent years the increases in the factors increasing noise (the number and size of the aircraft) were counterbalanced by the introduction of quieter aircraft (stage 2 and stage 3). While the number of enplanements tripled between 1975 and 1998, the population exposed to high noise levels around airports reportedly fell by a factor of 10 from 7 to about 0.6 million in the same period.

In the future however there are few immediate prospects for quieter aircraft, so that aircraft noise and pollution are bound to increase exponentially. Moreover, aircraft at crowded airports will increasingly fly early in the morning and late at night, times that are bound to disturb airport neighborhoods that themselves are likely to become more populated. These factors are making airport planning even more difficult.

Environmental issues will soon begin to affect airline routes and traffic. Already, in Europe in particular, there are pressures for more stringent standards for the total amount of noise that airports may allow. As constraints affect individual airports, airlines will significantly place new traffic at airports with available capacity or fewer constraints. Within metropolitan areas, airlines will favor uncongested airports. Thus around Miami airlines have diverted significant traffic to Miami/Fort Lauderdale in preference to Miami/International. Likewise around Boston, Providence airport has grown by about 4 million passengers a year over the last few years, while traffic at the main airport, Boston/Logan, has been steady (see Table 3).

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

TABLE 3 Independent Growth of Secondary Airports—Boston Example

Airport	Enplanements, Millions (in years)			Growth %
	1996	1997	1998	
Boston/Logan	12.2	12.5	13.2	8
Providence	1.2	2.0	2.5	108

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

Development of Multiple, Competing Airports

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

The amount of traffic at each airport in a metropolitan multiple airport system depends on a complex competitive struggle. Airports try to attract airlines to encourage passengers, and to attract passengers to help attract airlines. The airlines meanwhile are looking for their best deals, and routinely play off airports against each other. The results are typically counter-intuitive to those who have not studied the situation. (For full descriptions see de Neufville, 1991, 1994, 1995, and 1997.)

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

It is thus no longer possible to predict the traffic at a particular airport as a function of measurable facts such as the attractiveness, population, and economic activity of its city or region. The traffic at an airport results from complex competitive behaviors of airlines and other airports. As these are constantly changing, so are the levels of traffic at specific airports. Airport traffic has thus become volatile (Barber, 1986; Barber and de Neufville, 1991). Furthermore, airlines themselves can and do move major bases of operations. American Airlines did so around 1980; Delta moved major portions of its hub operations from Dallas/Fort Worth to Cincinnati in the late 1990s; and US Air shifted international operations from Baltimore/Washington to Philadelphia (Figure 4).

PROSPECTS FOR LONG-TERM FORECASTS

"The forecast is always wrong" is a good rule of thumb. The fact is, as repeatedly documented by numerous sources, that what actually happens typically is quite different from what was anticipated (see for example: U.S. Congress, 1982). This is because all kinds of events disrupt the trends that led to the forecasts. For example:

- The Asian economic crash of 1997 severely depressed traffic throughout Asia; and

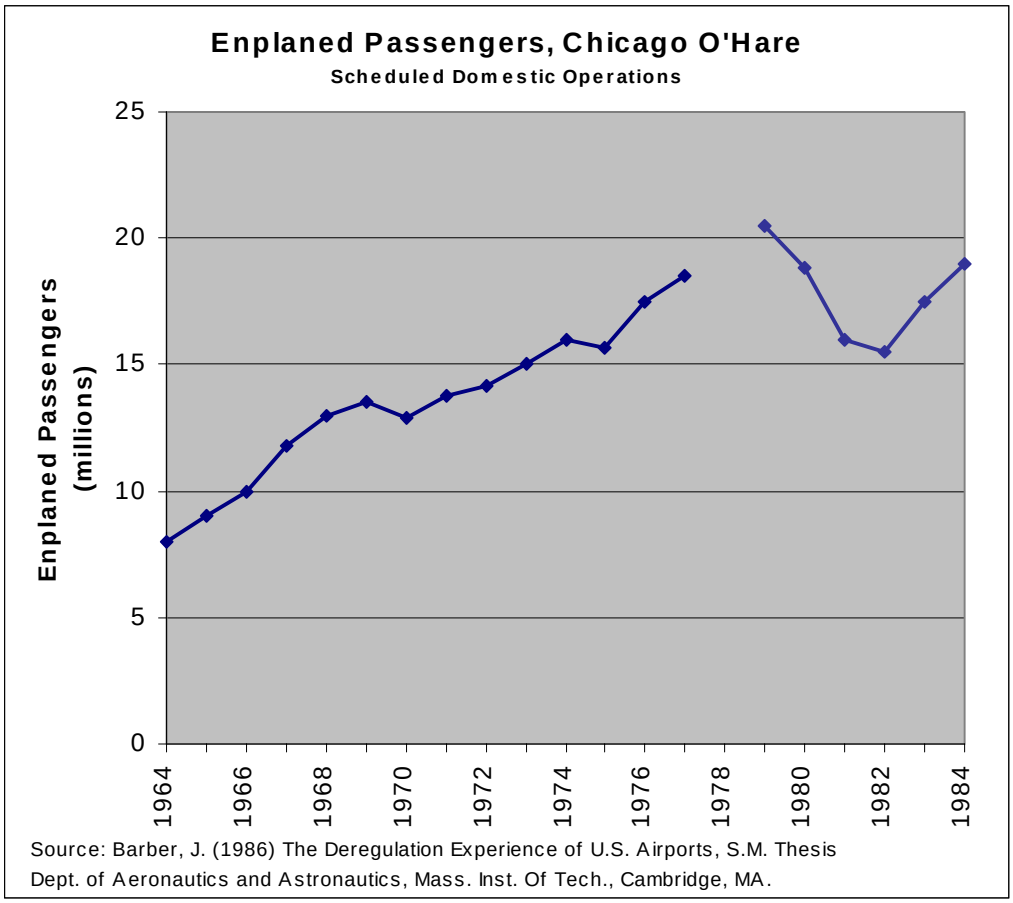

FIGURE 4 Example of increased volatility of traffic in current, deregulated environment traffic at Chicago/O'Hare before and after 1978.

- Economic deregulation of the airlines led to significant shifts of airline traffic, such as American Airlines' move to Dallas/Fort Worth, which disrupted traffic at both Chicago/O'Hare and Dallas/Fort Worth.

Predictions are most obviously wrong on the numbers, on the levels of traffic that can immediately be compared to forecasts. This is easy to see by comparing records of previous forecasts with actual results. Ten-year forecasts are easily off by ± 30 percent as Figure 5 illustrates. Longer-term predictions will naturally be even more inaccurate.

Surprisingly to many, aviation forecasts have become less accurate in recent years. This is contrary to the expectation that methodological and analytic improvements would have improved the results. The theoretical developments might indeed have improved predictions if the basic situation for aviation had not changed drastically. Before 1978, the year when the United States no longer regulated airline fares and routes, aviation traffic was fairly regular and easily predictable by simple means. Since that year however, airlines can and have changed fares and routes drastically on short notice, greatly increasing volatility in aviation and thus making it far more difficult to anticipate correctly (Barber, 1986; Barber and de Neufville, 1991). The net result is that aviation forecasts have become less reliable. The U.S. Office of Technology Assessment documented this phenomenon in its analysis of FAA forecasts (U.S. Congress, 1982).

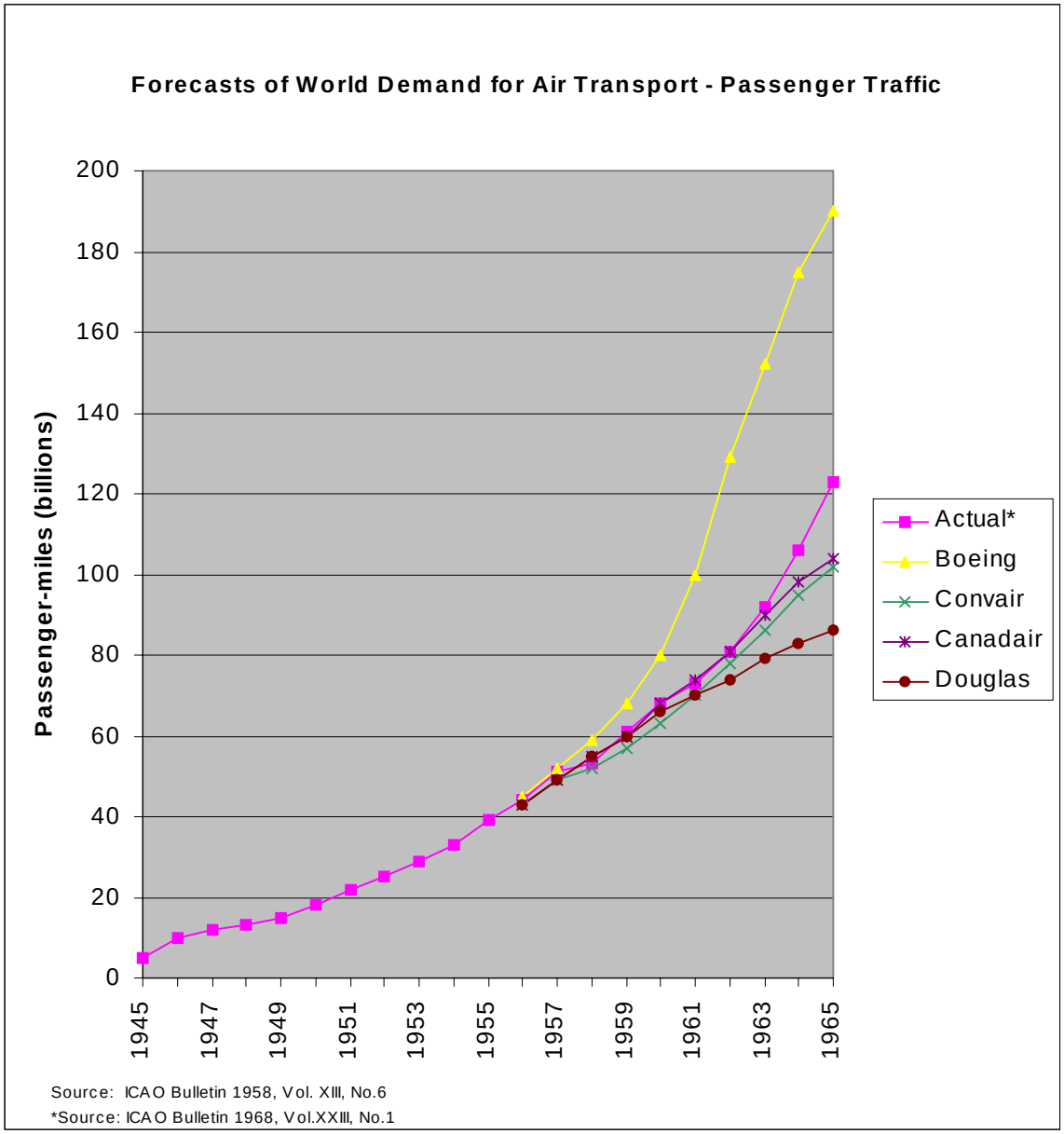

FIGURE 5 Ten-year forecasts are easily off by ±30 percent.

Forecasts are particularly likely to be inaccurate in anticipating how overall totals of traffic break down into separate categories. Statistically, this is a fact. The reality is that extreme growth rates, up and down, in sub-categories compensate for each other leading to a more predictable total. This phenomenon has been painfully visible recently in the recent fluctuations in international traffic at U.S. airports. Both at Chicago/O'Hare and at Baltimore/Washington large international terminals are in financial trouble because the actual traffic at these facilities is lower than the forecasts—at a time when international traffic is booming. At Chicago, the problem is that foreign airlines associated with global alliances use the gates of their U.S. partners for departures, thus leaving the International terminal underused. Baltimore/Washington suffers from the fact that US Air decided,

presumably as a response to United Airlines' aggressive entry into the Washington market, to shift many of its international flights to Philadelphia.

Future types of aircraft are easily misjudged. Forecasts have been quite wrong about the technologies that will be used [such as the Super Sonic Aircraft (SST) or the New Large Aircraft (NLA), Super Jumbos], and the infrastructure needed to support them. New Large Aircraft (NLA) of 500 passengers or more have been repeatedly forecast since the 1980s and before. Yet none are yet in sight and thus will not be flying until after 2005 at least. Likewise, experts used to believe that supersonic aircraft would be common. For example:

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

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

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

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

"Ideally, of course, a landing field should contain a circle, or perhaps some other figure such as a triangle, capable of containing, in the eight primary compass directions, the longest required runways…" (page 14)

"…at present, in view of the tendency toward larger planes, the runways should properly be planned with an ultimate length of from 3500 to 5000 feet" (page 8).

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

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

FUTURE TRAFFIC

Future levels of traffic are perhaps most questionable. As small differences in assumptions cumulate to enormous differences in consequences 25 years or more from now, we must be very tentative about future levels of traffic. For example, slight

deviations from the current long-term growth rate of 4 percent a year in enplaned passengers lead to substantially different forecasts. The discrepancy between a 5 percent and a 3 percent annual rate of growth compounded over 25 years is about 140 percent or ±70 percent of the starting amount. Just as a 10-year forecast may be off by ±30 percent, as Figure 5 illustrates, a 25-year forecast may easily be off by much more, for example by the about ±70 percent indicated by the difference between a 4 percent compound rate of growth and ±1 percent. Any assessment of long-range forecasts should be placed in a broad range of possibilities.

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

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

- Worldwide privatization of aviation, and increased attention to costs;
- Economic deregulation of the airlines, accompanied by competition;
- The consequent competitive restraint on wages;
- Historically low fuel prices (when adjusted for inflation);
- The introduction of yield management systems that raise overall revenues; and
- Larger, more efficient aircraft, driven by two engines (instead of three or four) with fewer pilots.

These trends may slow down or stop.

Some trends may reverse. Fuel prices for example might rise considerably, as they did 20 years ago. Also, there may come a time when business travel becomes replaced by inexpensive video-conferencing or other communications. We are not that far from the time when routine meetings will in fact be able to be held via communications instead of physical displacement. There is ample reason to think that the rate of growth of U.S. domestic traffic might continue its long-term decline—even while registering substantial overall increases in the total number since the lower rates of growth will apply to the existing large market.

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

Overall, it would be reasonable to assume that by 2025 the level of traffic could be two or even three times higher than today. For example, the number of enplaned

passengers in the United States in 2025 could be in the range of 1500 million a year, plus or minus 500 million, compared to the current 600 million a year. We should thus prepare for substantial growth (by planning and land acquisition), but not necessarily commit to building the facilities for the largest possible levels.

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

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

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

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

Cargo traffic may expand dramatically as companies reorganize their distribution systems around electronic commerce. Already, in a development that is not widely perceived, the integrated package carriers such as UPS and FedEx are among the largest airlines in the world in terms of aircraft operated. Their financial strength is staggering compared to the passenger carriers. The market capitalization of FedEx is nearly half again as much as that of American or Southwest, the next most highly valued airlines in the United States. The market capitalization of UPS, with its massive ground operations, is nearly 10 times larger than those two passenger airlines (Table 4)! As suppliers substitute web sites for brick and mortar stores, and direct shipments to

TABLE 4 Relative Financial Strength of Major U.S. Airlines

Airline Company	Symbol	Market Capitalization Billions of Dollars
United Parcel Service	UPS	66.1
Fedex	FDX	10.4
American	AMR	7.8
Southwest	LUV	7.8
Delta	DAL	6.1
United	UAL	2.8
Continental	CAL	1.8
US Air	U	1.4
Alaska	ALK	0.7
TWA	TWA	0.2

SOURCE: yahoo.com.financial, Feb. 15, 2000.

customers for warehouses and in-store inventories, the growth of the integrated cargo carriers may be very rapid. It is entirely possible that this traffic may be a driving force for future airport developments.

FUTURE AIRPORT DESIGNS

We may be at a cusp when significant changes may become widespread in airport design. Long-term developments may be gaining enough salience so that future planners might look back on the coming years as a period of major change in airport design. These changes may affect both the airside and landside of the airport; that is, the length, orientation, and spacing of the runways, and the configuration and functions of the airport passenger buildings.

The ever-increasing economic significance of air transportation, which makes everyone concerned more anxious to take care of airport facilities and run them as businesses, will drive many of these changes. As of 1998, about one-quarter to a third of American imports and exports, as well as about 6 percent of domestic production by value were shipped by air. Furthermore, every major airport expansion is accompanied by estimates of the economic benefits, as required either by the FAA or by private lenders subscribing to airport bonds. These financial imperatives will certainly have a major effect on future airport systems planning and design.

Airside

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

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

The new class of airports with long parallel runways is also generally located far from population centers. In this sense they are environmentally friendly in contrast to the older international gateways, such as Los Angeles/International, New York/Kennedy, or San Francisco/International. The airports in this class can therefore be expected to have

TABLE 5 Length of Longest Runway of Various U.S. and International Airports

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

SOURCES: U.S. Airports, FAA Office of System Capacity, www.asc.faa.gov.
Osaka/Kansai, Kansai International Airport Co., Ltd., www.kiac.co.jp/english/estab/estab2.htm
Munich, www.munich-airport.de/english/daten/fs_zahl.htm.
Kuala Lumpur, www.kliab.com.my/project/klia/airport/primary_data.html.
Paris/de Gaulle, www.landings.com.
Athens/Spata, *Engineering News-Record*, 8/16/99
Seoul/Inchon, Chamber of Commerce and Industry http://icci.asiansources.com/INCHON/INFRAS.HTM

extended operating hours, if necessary, and to permit airlines to operate transcontinental flights outside of the traditional windows imposed by curfews at either end of the flight.

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

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

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

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

Airports serving Southwest, the predominant low-fare carrier in the United States, illustrate the kind of cheap fare airport that may become more prevalent in the future. These start with Dallas/Love Field as the original base for Southwest and proceed to specialized airports in metropolitan regions, such as Providence in the Boston region and Fort Lauderdale in the Miami region. A complementary cluster of airports serving international cheap fare or charter airlines may also emerge, either independently or as subsidiaries of these airlines. Already in the United States two airports are candidates for this function: Orlando/Sanford and New York/Stewart. Such specialized airports may proliferate over the next 25 years.

Landside

Airport passenger buildings should also be quite different over the next generation. Three major changes are underway that may rearrange the types of facilities and the allocation of spaces in passenger buildings:

- Electronic ticketing will eliminate or at least disperse much of the work done in departure halls, and make them obsolete;
- More aggressive use of airports as shopping malls may enlarge and reconfigure the design of spaces both before and beyond security;
- Changes in patterns of use will force designers to build more flexibility into airport buildings.

So far, architects have not incorporated the implications of the “digital revolution” into the design of airport buildings. Electronic ticketing, seat assignment, and check-in that can be done both beforehand and elsewhere throughout the building by machines similar to ATMs will eliminate much of the work airlines now do at the traditional check-in. Similarly, preclearance of arriving passengers, as the U.S. Customs already does experimentally with some passengers and countries, will also accelerate traffic flows and reduce the per-passenger need for counters, personnel, and space. Much the same will apply to cargo, of course.

Massive departure halls with hundreds of counters and extensive queues are becoming obsolete in the information age. Even though several large departure halls are

now under construction in North America, for example at San Francisco/International and New York/Kennedy, such cavernous spaces may soon be stricken from the list of facilities needed at airports. They may be replaced with numerous remote check-in facilities distributed around the airport or remotely on the feeder system into the airport (as is now done in Switzerland and Japan, for example).

The increased attention paid to effective use of airports as shopping malls will certainly change the traditional concepts of space requirements in airport passenger buildings. More aggressive marketing may well increase the amount of space desired for shops both before and beyond security clearance. At the very least, experienced designers of commercial spaces will become key partners in the design and insist on specific features. The overall implications for airports are unclear however. The current push for more commercial space may be counterbalanced by objections to the way it obstructs easy movement of passengers and by the development of e-commerce. How much merchandise will overloaded passengers want to buy at an airport and carry, when they can shop internationally from the Internet and have their purchases delivered?

These two trends underline the third, that is the industry's constantly changing ideas about how much space should be allocated to specific uses—such as check-in stores, but also particularly to international and domestic services. Recent experience indicates that designers and owners frequently misjudge the amount of space needed for specific functions and have had to reconfigure these spaces. To deal with this phenomenon, designers will have to build much more flexibility into their designs. Specifically, for example, it will be desirable to design more facilities as "swing gates" or "swing spaces" that can respond to varying demands on short notice (Belin, 2000; Belin and de Neufville, 2000).

The future of baggage handling may also be quite different from what it is today. This considerable expense quite possibly will become less of a function for airlines and airports. People increasingly prefer to handle their own luggage using wheeled suitcases. They thus by-pass the delays associated with check-in and reclaim facilities. (This phenomenon has already upset designers' assumptions: one of the difficulties of the Hong Kong/Chep Lap Kok airport is that carpets cover vast areas of the passenger buildings, making it difficult for travelers to pull their suitcases!) As integrated cargo services expand their services, it is possible that they might handle suitcases, delivering them directly between home and hotels in distant cities. This kind of service has existed for a long time in Japan, and could conceivably be expanded. The consequent revolution in assumptions about the design of airport passenger buildings would be enormous. According to members of the U.S. Air Transport Association, the design figure for the number of checked bags/passenger is now about 1.4, lower than the 1.5 that has been traditional in the United States.

Access to airports will certainly change toward more intensive use of collective forms of transport. This will be motivated both by economies of scale in handling passengers and by environmental pressures to reduce the level of pollutants associated with airports. Rail rapid transit, express bus systems, and networks of airport limousine services arranged integrally with flights will almost certainly expand from their current level of use. To the extent that they do, these services will reconfigure much of the conventional layout of airports as room has to be made for bus and railroad stations, and to accommodate the relatively inflexible paths of tracked vehicles.

Complementarily, various forms of tracked collective service will be used to move passengers between the several landside elements of the airport. The people movers,

monorails, horizontal elevators, and moving sidewalks now being retrofitted into existing airports will certainly be a standard part of design repertory for future facilities. They will permit the dispersal of terminal and other passenger services (such as car rental agencies and garages) across the airport away from the central terminal area to less crowded and otherwise more convenient areas. Midfield passenger buildings and remote check-in facilities would be a normal feature of this phenomenon.

Overall, good design for the airside should build considerable flexibility into the design of landside facilities. Space should be flexible to accommodate the varieties of traffic (international, domestic, terminating, and transfer), the uncertain industrial organization of the airlines and their partners, the changing desires for commercial space, and the future ranges of possibilities for airport access. Flexibility may be the greatest challenge for landside design in the 21st century.

FUTURE ORGANIZATION OF THE INDUSTRY

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

Clustering of Airlines at Airports

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

Which airlines are in a group is unlikely to remain fixed for quite some time. At present these groups are each expanding their members. Some airlines are shifting their allegiances too. (For example, Canadian merged with Air Canada and thus shifted from American's Oneworld to United's Star alliance.) It is consequently difficult for anyone to know how large the group will be that wants to share any location. This fact provides an additional important reason to design airport passenger buildings flexibly to accommodate a range of uses and users.

The development of international carrier groups will render obsolete the distinction between "international" and "domestic" airport passenger buildings. Most of the significant international airlines are already part of airline groups and will not want to be processed in distinct buildings separate from the domestic facilities used by their partners. Airlines providing both international and domestic service with the same type of

aircraft will moreover not wish either to transfer their aircraft from one building to another or to have distinct operations and crew centers. They will insist on being able to use a common facility so that they can maximize their efficiency. This reality is a major challenge to new international terminal buildings, which are doubly incompatible with passenger buildings that must cater both to domestic/international passengers and to transfers within a group of airlines. It is entirely possible that the prospective new international terminal buildings at New York/Kennedy and San Francisco/International will have to be reconfigured soon after they open—if not before.

Global Rationalization of Airport Management

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

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

- Major airport groups already contract to run airport operations overall—BAA for example is under contract with Indianapolis (as well as with Naples, Italy; Melbourne, Australia, and other places);
- Specialist developers have taken over the operations of specific portions of airports, for example Westfield operates the shops in one of the passenger buildings at Boston/Logan, and at many other airports in the United States, and BAA operates the Pittsburgh airport shopping mall and similar facilities worldwide; and
- Leading companies take over the entire management of special types of services, as Standard Parking has for parking services at Chicago/O'Hare.

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

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

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

Planning Processes

Planning processes for major airport projects may change substantially, given the changed operational and institutional environment. Today, public authorities at individual airports sponsor projects and submit them to the Federal Aviation Administration for approval and funding. In the future, the situation may well be different:

- The driving sponsors for projects may be global airport companies that want to make the operations more efficient;
- The sponsors, operating over a set of airports and acting in coordination with airline groups, may well take a system view of the economic and operational priorities;
- Metropolitan regions, increasingly served by several airports each catering to different types of traffic, will insist on a broader view of proposed developments; and
- The environmental interests, sustained by a likely rise in aircraft noise over urban areas, will likewise support a broader view of the alternatives regionally and indeed nationally.

We can thus anticipate the possibility of a systems view of planning for new projects. It may be more regional, as metropolitan stakeholders attempt to define sequences of projects that make sense commercially, environmentally, and politically. It may be national, as global airlines and airport companies try to identify and develop the projects that will best improve their integrated system of operations.

Airport planning might also become more cooperative. As the number of airlines and airport companies coalesce, they may each recognize a long-term stake in coherent collaborative planning, and establish working relationships to resolve their differences and move ahead. Such relationships have developed elsewhere. For example, the auto industry and their unions have for a long time established relatively harmonious ways to bridge their substantial differences and to proceed for their collective good.

Such changes could help the air transportation and airport industry. A systematically strategic, cooperative approach to national airport planning could lead to better decisions, achieved more smoothly than today. It almost certainly would be an improvement over the current sporadic, uncoordinated pattern for major developments.

Such changes would not come easily. They are certainly not assured. They would require substantial long-term institutional developments. They are worthy goals that merit effort today.

CONCLUSION

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

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

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