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## FORUM

*Denver International Airport: Lessons Learned*

C. Daniel Prather

*“The airport planner, who is required to anticipate conditions 10 to 15 years in the future, must often resort to guesswork” (322).*

Researching the evolution of Denver International Airport was more than simply a project of interest. These three authors recognize the continuing growth in aviation demand and the need for expanding facilities to accommodate this demand. Indeed, this book was designed to assist major cities worldwide as they are forced to cope with this need for additional supply in airport facilities. In sum, “the need to build new airports and expand existing ones will continue to press communities to address many of the same difficult questions that Denver faced” (ix). In this sense, this book is a resource for all airport managers and professors confronting the increasing aviation demands of the next millennium.

Chapter one, entitled “The world’s largest airport,” points out that Denver International Airport (DIA) is the largest segment of real estate in the world solely dedicated to commercial aviation. Prior to developing this 52 square mile facility, however, six alternate sites were evaluated. This chapter details the political struggle among municipal officials, airport officials, and citizens during consideration of alternative sites. After many campaigns both pro and con, an election was held on May 16, 1989, which resulted in a 63 percent victory for the new airport. Although this vote was not legally required, City of Denver Mayor Pena decided he “could not deny citizens the right to vote on the largest public works project in the city’s history” (16). Construction began on September 28, 1989, with the airport finally opening February 28, 1995. The entire project was finalized at \$3.5 billion over budget.

Chapter two, “Three hubs to one: the folly of forecasting in the dynamic airline industry,” attempts to answer questions such as (1) how are forecasts of passenger demand generated? (2) why are these so erroneous? (3) how have recent policy changes, such as airline deregulation, affected airport development? and (4) given the shortcomings of existing forecasting practices, what kind of planning process is the most effective? Specifically, the chapter points out that issues such as deregulation, globalization, capacity, and delay have

made the practice of aviation forecasting a spotty effort at best. This however, should be no surprise to students of statistical forecasting methods. The numbers produced are only as accurate as the variables considered, and because of this, predicting the future, whether involving the stock market or airline passengers, is a complex endeavor.

This is not to say that these inaccurate forecasts must simply be accepted, however. In fact, these inaccurate forecasts at Denver proved “wildly optimistic” (xii). In the late 1980s, the FAA projected that Denver would ultimately see 55 million passengers by 1995; the actual number was less than 31 million. This, of course, played a role into how large the new airport needed to be, and in fact, if a new airport was even necessary.

Completing chapter two is the first in a series of “lessons learned.” These points are presented at the end of each remaining chapter to drive home points that should be learned from DIA’s experiences. Some of the lessons learned from this chapter include (1) not relying exclusively on aviation forecasts; they will nearly always be wrong, (2) not overlooking alternative methods of resolving capacity problems, and (3) fully considering the role of airlines in any further forecasting exercises.

Chapter three, “The politics of DIA’s development,” discusses an issue that is present in all public agencies.

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Specifically, the following questions are addressed: (1) How effective are existing mechanisms for public participation in the planning process? (2) What responsibility do the media, elected officials, and planners have to ensure that the public is accurately informed about the issues? and (3) How does a city secure cooperation with other relevant organizations in airport development or expansion?

In answering these questions, this chapter presents a case-by-case analysis of each of the following actors involved in the process: elected officials, local businesspeople, the citizenry, and various interest groups. Regarding public participation, the authors list four levels at which public participation can take place: (1) "tokenism" in which power resides with elected officials, (2) "consultation," which allows citizens the opportunity to comment via public hearings, surveys, and advisory committees; however, officials still make the decisions, (3) "reconciliatory" in which there is a strong two-way flow of information between the decision-makers, the public, and various community-based groups; however, the governmental agency retains the decision-making power, and (4) the "participatory" model in which power is shared by the public and the government. This last model allows the public to participate in the actual decision-making process at the policy level.

Some lessons learned include: (1) citizen education and participation is essential from the outset if public support is to be long-lived and democratic values respected, (2) the media must remain an independent source of reliable, unbiased information about major infrastructure issues facing their community, (3) local proponents or opponents must be unified, well-financed, and possess politically astute leadership, and (4) opponents of airport expansion can play a trump card with the threat of environmental opposition. Regarding the second lesson, the authors candidly stated "had [the media] been more vigilant as the public's watchdog, the project would likely have been implemented far more successfully than it was" (134).

Chapter four specifically analyzes the economic impact of airports. Indeed, airports have been recognized as possibly the single most important piece of infrastructure cities and nations can build to improve their chances of success in global economic competition. However, the authors quickly argue that "the economic impact argument alone cannot be used as the principal justification for building new airports" (140). In discussing the impact of these projects, a historical review of

Denver is performed dating back to its founding in 1858. Current impacts are also discussed, such as the estimate that one in every ten jobs Colorado-wide is airport-related. The chapter also discusses competing airports, such as Colorado Springs and their hub airline, Western Pacific. In addition, local land-use impacts are evaluated, such as the one main entrance into DIA, Pena Boulevard. Further, the authors state "what now is open farmland or rangeland is expected to become the site of billions of dollars in residential and commercial development over the next 10 to 20 years" (171). Lessons learned include (1) airports are not a panacea for lagging economic development, (2) land-use planning around airports should be coordinated and consistent among affected jurisdictions, and (3) insurmountable barriers to residential development should be placed near airports.

Chapter five, "Financing the field of dreams," is perhaps reminiscent of familiar megaprojects in the past. Whether an airport, or a dream, this project had to be financed. This chapter discusses methods by which both international and U.S. airports are financed. Indeed, the International Air Transport Association (IATA) and the International Civil Aviation Organization (ICAO) estimate that, worldwide, \$250 billion will be spent for airports between now and 2010 (183). Due to the magnitude of these projects and the continued declining federal funding, this chapter is of importance to many in the industry today.

The chapter begins by discussing the financing process at airports worldwide. Bonds (both revenue and general obligation), underwriters, rating agencies, and privatization are a few of the concepts discussed in the first section of this chapter. The next section looks specifically at DIA's case. DIA was financed with approximately \$3.5 billion in bond sales, along with federal funds, monies from the disposition of Stapleton, a capital fund, 1985 project account, PFCs, and a civil aviation fuel tax. With this substantial amount of bonds outstanding, debt service expense for DIA climbed to \$344.5 million per year. This, even though revenues were projected at \$431.8 million in 1995. It is obvious, therefore, that bonds make up a large portion of DIA's financing base and even more of their annual expenses.

The next section of chapter five discusses the politics of underwriting. Denver received the dubious honor of earning the lowest grade ever assigned to the bonds of a major U.S. airport. This was due in part to continued opening delays, escalating change orders, and the infamous automated

baggage system. Speaking of the volatility of the airport itself, and thus the bonds' behavior, one analyst noted, "if you don't like volatility, you don't like these bonds" (212). Because of this volatility, complaints and lawsuits have resulted, one (Rabinowitz v. City of Denver et al. 1995) charging that ". . . [official DIA bond statements] failed to fully and adequately disclose the risks associated with investing in the Bonds" (214). These problems led the city auditor to remark, "I never dreamed that when the airport was completed that we would exchange construction workers for lawyers" (215).

Another clear example of the politics associated with bond underwriting, appears when MarkAir, a bankrupt air carrier, requested a five-year, \$30 million loan from the city prior to commencing operations in Denver. Upon hearing this, Moody's told Denver that if it approved this loan to MarkAir, the ratings on DIA's bonds would be dropped to junk bond status. This threat was sufficient to bring negotiations to a halt even though the traveling public of Colorado might have benefited from a more competitive airline environment at DIA.

Lessons learned from this chapter appear to be common knowledge. They are as follows: (1) honesty is the best policy, (2) act ethically, (3) subject bond underwriters to the same competitive bidding process as other city contractors, and (4) keep the community fully informed of all financial developments.

Chapter six evaluates the site selection process. This, as all airport managers know, is one of the most difficult decisions concerning new airport development. Complex factors involved in this process include environmental constraints, noise, compatible land use, distance from city center, and ground access. Regarding distance from city center, it should be noted that newer airports are always being built farther away from the city simply due to the lack of available land near the city. On that note, Denver is 24 miles from downtown. Stapleton was a mere 7 miles.

This chapter also discusses the Environmental Impact Statement (EIS) process. Noted environmental impacts produced by airports include noise, air quality, water quality, impacts on wildlife, and social impacts such as relocation of households. Interestingly enough, even though DIA was built far way from the downtown, and on relatively vacant rangeland, 277 noise complaints were registered during the first week of DIA's operation. By December 2, 1995, DIA had received a total 66,742 noise complaints, compared with

only 431 at Stapleton during all of 1994. Several reasons for this astounding number are (1) that some residential areas were actually within the 65Ldn contour even though original projections indicated they would not be, (2) the final EIS was based on six runways, rather than the five that were built, and (3) each household making complaints is averaging nearly 20 calls. In fact, ten families account for one-fourth of all complaints (259).

Lessons learned in chapter six address several aspects of the site selection process. They include locating the airport to minimize adverse noise impacts, developing and implementing noise mitigation procedures in consultation with affected publics, monitoring the validity of the noise impact forecasts, incorporating multi-modal ground access into the terminal airport, developing a comprehensive intermodal and multi-modal transportation hub, air quality impact being considered for an entire region, and site selection processes that are open to the public.

The next chapter, chapter seven, discusses airport layout, design, and technologies. This third phase of an airport's master plan is broken down into four components: (1) airport layout (2) land use, (3) terminal area, and (4) airport access. The chapter begins by discussing the effects of airline deregulation on airport layout. Regarding DIA's master plan, it calls for 12 runways surrounding four (or five) center-field 60-gate air side terminal buildings linked to a landside terminal building (with five modules at full build out) by a 5100-foot underground train. When ultimately built out (sometime after the year 2020), DIA's capacity would be 110 million passengers (compared with about 31 million in 1995) and 1.23 million operations annually. This, the text notes, is more capacity than any other airport in the world (291).

Some interesting points about DIA include the following: (1) to flatten the site of DIA, about 110 million cubic yards of earth were moved, which is about one-third the amount moved to build the Panama Canal; (2) the FAA reconfigured 240,000 square miles of navigable airspace to accommodate the flight paths of the new airport; (3) even with high density altitude, Asia will be within reach from Denver once the new 16,000 foot runway is built; (4) the 327-foot FAA control tower is the tallest in the world; (5) no runways intersect; and (6) DIA is one of only four airports in the U.S. with an advanced airport lighting system. Technologies discussed include the radar, communications system, people movers, baggage system, security, and those technologies implemented to combat snow

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and ice problems.

One situation that results in problems and complaints at DIA is the fact that even though United Airlines utilizes DIA as a hub airport, the airport itself sees Origin and Destination traffic of 58 percent, with connecting traffic of 42 percent. Therefore, this airport is being forced to accommodate both O&D and transfer passengers. This, as one can imagine, is difficult to accomplish. For these reasons, the following conflicts have been noted: (1) baggage claim level is accessible only to public transport and not private autos, (2) to get from the parking garage to the drop-off or pick-up levels, or vice versa, automobiles must drive three miles around to return to the terminal area, (3) the public accessed the airport during the first year without the convenience of a gas station on the 12-mile Pena Boulevard, (4) with only two lanes in each direction, Pena Boulevard can become quite congested, and (5) no snow fences were originally built to protect the boulevard from blowing snow. The chapter continues by discussing several technological problems encountered during the first year of DIA's operation and how similar problems are being handled at other new airports throughout the world.

In addition, this chapter delves into the many technological breakthroughs attempted at DIA. As a result of this, many lessons were learned: (1) acquire as much land as possible at the outset, (2) design the airfield first, (3) decisions made to enhance hubbing efficiency may compromise O&D convenience, (4) design terminals and concourses in modular form, with sufficient reserved space to allow future expansion, (5) get the principal airline tenants and the national government involved early in the design process, (6) incorporate security concerns into airport planning and design early, (7) locate the airport to minimize adverse noise impacts, (8) incorporate mass transit into the terminal design, (9) adopt a proven technology for critical systems (keep it simple, stupid), and (10) set aside ample time to test-run the technology.

Chapter eight focuses on the architecture and aesthetics of the airport. First, the white multi-peaked roof is the initial impression one has when driving to the airport. This design has been praised by some, such as "... [the fabric peaks] create a mood of excitement and adventure that is inseparable from travel but virtually absent from modern airports" (361), and criticized by others, such as "... [it looks like] a circus tent draped over a big hedgehog"

(361). The terminal itself covers 3.5 million square feet – the equivalent of 35 football fields. The parking garages were "mercifully tucked below the roof line as not to obstruct the view from the west side of the departure level" (372). From the main observation deck however, the view of most of the mountains (with the exception of Pike's Peak) is obstructed by a highway viaduct leading up to the top level. And the latter, according to one critic, is "unforgivable" (373).

Due to a demand by Continental Airlines' Frank Lorenzo, the main terminal and Concourse "A" are connected by the only bridge crossing an active airport taxiway in the world. In addition, Denver decided to incorporate artwork into the terminal to showcase local artists and the surrounding region. Although the authors note that beauty is in the eye of the beholder, one critic found only "[f]ive truly first-rate pieces from a budget of more than \$7 million" (380). Prior to the conclusion of this chapter, the authors also focus on architecture and aesthetics of other major international airports. Some lessons learned from this chapter include: (1) art should be incorporated into the budget, (2) the art should reflect the unique cultural heritage and natural beauty of the region served by the airport, and (3) tasteful art should be selected by art experts, with the public then choosing from a group of finalists.

Chapter nine, "How did a \$1.5 billion airport become a \$5.3 billion airport?", summarizes the many difficulties encountered in building DIA, which resulted in substantial delays and massive cost overruns. The authors quickly point out that Denver is similar to megaproject peers in that megaprojects cost, on average, 90 to 150 percent more than their original estimates. Along these lines, the authors present a conceptual model of cost growth that defines four basic factors: (1) cost-estimating errors, (2) faulty project execution, (3) changes in project, and (4) changes in project macro-environment. Regarding cost, in comparative terms, Stapleton cost less than \$6 per passenger, whereas DIA cost over \$18 per passenger. This led then Colorado governor Roy Romer to declare, "Had somebody told me that the per-passenger cost was going to be \$18, I would not have supported the airport . . . They went Cadillac" (410).

Regarding the routing of 12-mile Pena Boulevard, the reason it is shaped as an inverted "L" rather than a straight diagonal line is a mystery. In fact, if a modest two miles had been shaved off the driving distance, auto emissions would have been reduced by more than one million kilograms of carbon

monoxide annually, thus saving two million gallons of gasoline per year (413).

Faulty project execution resulted from the fast-track approach. The City teamed with Greiner/Morrison Knudsen, a joint venture, to coordinate and ensure the quality of 61 design contracts, 134 construction contractors, and more than 2,000 subcontractors (417). This led one auditor to state "that DIA is a project out of control and without leadership" (418).

Regarding design changes, the dominant hub carriers at Stapleton, at first, had no support for a new airport that may give rise to a new, competitive hub airline. However, once they agreed, they demanded – and received – significant and expensive design changes. Mayor Webb, who was eager to finish the new airport, readily acceded to their demands. As a result, Continental's changes added \$200 million to DIA's costs, while United added \$600 million. Continental, in the meantime, fell into Chapter 11 bankruptcy. Ultimately, the City realized that Continental would occupy only 3 or 4 gates of a 20 gate concourse that had been built specifically for it. Page 430 of the text presents a very sobering chart displaying the amount of change orders as opening day drew closer. The most expensive, issued in March 1994, was a change order in the amount of \$535 million.

The next section in this chapter discusses the "baggage system from hell." Indeed, with the exception of this system, the airport may have opened one year earlier. Although many know of the problems with this system, many don't know that United actually demanded it; therefore, it was not in the original specifications for the airport. There were two conditions for this project which successful bidders had to adhere to: (1) the system had to be complete in 26 months and (2) it had to move 1,000 bags per minute. Two bids were submitted and both were rejected due to bulky equipment and untimely project completion. The City then turned to BAE Automated Systems, Inc., which agreed to complete the system in two years, provided it had unlimited access to the facility. However, delays resulted due to the City's failure to allow primary and expeditious access to BAE. Desperate to open the airport, the City signed away its rights to sue BAE for producing a dysfunctional baggage system by the scheduled opening date. Further, another company was commissioned to build a backup system comprised of conveyor belts and natural gas-fueled tugs and carts. In all, the City spent nearly \$300 million for baggage handling for an airport with fewer than 90 gates.

The next section candidly discusses problems with the management at DIA. From the governor on down, it seems that very few escape the authors' criticism. With section headings such as "Imprudent cost-cutting," "Ethics: Greed, cronyism, and revolving doors," and "Send lawyers, guns, and money," it is obvious that many unethical practices were commonplace at DIA and the City. Nonetheless, the unavoidable problems probably produce empathy by some in the industry. Indeed, "DIA was planned for three major hub airlines (United, Continental, and Frontier), built for two (United and Continental), and is occupied by only one (United)" (455).

Many lessons were also learned in chapter nine. Some of these include: (1) make every effort to get the principal tenants on board early in the planning and design process to minimize scope and design changes, (2) resist major scope changes after construction has begun, and if they must be made, amend the timetable for opening the airport accordingly, (3) install backup systems, (4) depoliticize the contracting process, and (5) promulgate a vigorous regime of ethical regulation and enforce it.

Chapter ten, "Airport planning theory in perspective," focuses on implications for those interested specifically in airport projects and generally in megaproject planning and decision-making. This chapter begins by presenting various theories decision-making that have been advanced in the past. The authors point out that "at best, the rational comprehensive model represents *only* an ideal form of how planning and decision-making is supposed to occur" (472). The authors then delve into the character of Denver's airport planning process. From problem conceptualization to project implementation, all five stages of this process are analyzed. The chapter then moves into a more thorough discussion of these processes and models. In sum, the authors suggest that the planning of airports and other megaprojects be approached from a paradigm that recognizes the great uncertainties that are inherent in such endeavors. In their words, "one must be prepared to deal with the totally unexpected" (485). Lessons learned from this chapter include the following: (1) efficiency should not be defined in narrow economic terms, (2) develop mechanisms to promote community consensus on critical choices, (3) develop arrangements to force careful public discussions of the project's assumptions, (4) develop a new approach to airport planning that recognizes the importance of maintaining

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flexibility throughout the process, and (5) promote the development of organizations that are prepared and equipped to deal with risks and uncertainties.

The final chapter of this book, entitled "What have we learned?", presents many facts which all airport planners and managers should review. In answering the question, "Why did DIA cost so much?", the following points are presented: (1) Mayor Pena's decision to break the airport into a large number of small contracts, (2) the excessive time consumed between the decision to build and the land acquisition, (3) Mayor Pena's decision to sign numerable contracts on the eve of his departure to put the project beyond the "point of no return," (4) Mayor Webb's capitulation to the airlines' belated demands for massive scope changes, (5) Webb's decision to expand the automated baggage system beyond United's Concourse B to cover all three concourses, (6) Webb's focus on securing contracts for his friends and supporters, rather than focusing on more crucial airport issues, and (7) the failure of the federal government to provide adequate oversight (500-01).

Turning to the fact that no new major airports (prior to DIA) have been built in the U.S. in two decades, the authors attempt to explain how Denver was able to do it. They outline three major factors: (1) growth impetus, which grew out of the desire to reinvigorate the local economy in the 1980s, (2) willing politicians, such as the mayor and governor who saw a new airport as a way to achieve their political goals while at the same time alleviating the worsening problems of capacity and noise at Stapleton, and (3) favorable external circumstances, such as Stapleton being recognized as a key bottleneck and the subsequent strong federal support, disorganized airlines who opposed the new airport, and the media, interest groups, and general public who were unwilling or unable to halt the project.

The final list of lessons learned somewhat summarizes many of the concepts learned throughout the text and include the

following: (1) despite all obstacles, a major American city with determined political leadership, a strong growth coalition, and a favorable economic environment can build a transportation, (5) don't believe the overly optimistic projections of demand and cost, (6) airline deregulation has created tremendous uncertainty for airport planners, (7) the federal government should take a stronger role in protecting competitors and consumers from the predatory and monopolistic pricing and other practices, respectively, of dominant airlines at concentrated hub airports, (8) politicians are essential for building political consensus, but they often feel compelled to reward their supporters, (9) affirmative action can be used to mask political cronyism, (10) new approaches to airport design and implementation are required, (11) intermodal transportation access, while carefully planned in foreign countries, is unfortunately a low priority in the U.S., and (12) federal and local governments should help facilitate airport growth and development and the more efficient use of existing airway and airport capacity.

To summarize, the book by Dempsey, Goetz, and Szyliowicz takes a profound look on the effects of airport development in the U.S. Rather than simply analyzing the problems and successes experienced by DIA since its inception, these authors take a longitudinal look at the City of Denver from its founding until the present. Stapleton Airport is discussed quite heavily as this airport and its capacity constraints were the impetus in the decision to build DIA.

I believe this book is an extremely informative aid for students, professors, and professionals in this industry. It is a large text and can become rather technical at times, but students and professors alike will find the events discussed in this book quite informative. It is indeed a must-read for academicians interested in increasing their knowledge about real-world examples of the airport business. Learning from past practice is but one way in which the airport industry will continue to grow and prosper in the coming millenium. □

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