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Sociology, Empowerment



Harvard Business School 9-396-311 Rev. November 6, 1996 BAE Automated Systems (A): Denver International Airport Baggage-Handling System No airport anywhere in the world is as technologically advanced as the Denver International Airport. 1 It's dramatic. If your bag [got] on the track, your bag [was] in pieces. 2 In November 1989 ground was broken to build the Denver International Airport (DIA). Located 25 miles from downtown Denver, Colorado, it was the first major airport to be built in the United States since the opening of the Dallas-Fort Worth Airport in 1974.

In 1992, two years into construction, the project's top managers recommended inclusion of an airport-wide integrated baggage-handling system that could dramatically improve the efficiency of luggage delivery. Originally contracted by United Airlines to cover its operations, the system was to be expanded to serve the entire airport. It was expected that the integrated system would improve ground time efficiency, reduce close-out time for hub operations, and decrease time-consuming manual baggage sorting and handling.

There were, however, a number of risks inherent in the endeavor: the scale of the large project size; the enormous complexity of the expanded system; the newness of the technology; the large number of resident entities to be served by the same system; the high degree of technical and project definition uncertainty; and the short time p for completion. Due to its significant experience implementing baggage-handling technology on a smaller scale, BAE Automated Systems Inc. , an engineering consulting and manufacturing company based in Carrollton, Texas, was awarded the contract.

Construction problems kept the new airport from opening on the originally scheduled opening date in October 1993. Subsequently, problems with the implementation of the baggage system forced delays in the opening of the airport another three times in seven months. In May 1994, under growing pressure from shareholders, the business community, Denver residents, Federal 1Fred Isaac, Federal Aviation Administration regional administrator, quoted in “ Denver Still Working Out Kinks as Its First Birthday Arrives,” USA Today (February 28, 1996), p. 4b. Fred Renville, United Airlines employee quoted in “ Denver Still Working Out Kinks as Its First Birthday Arrives,” USA Today (February 28, 1996), p. 4b. Assistant Professor Ramiro Montealegre and Research Associate H. James Nelson of the University of Colorado at Boulder, Research Associate Carin Isabel Knoop, and Professor Lynda M. Applegate prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. Some names have been disguised. Copyright © 1996 by the President and Fellows of Harvard College.

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Aviation Administration (FAA) commissioners, and the tenant airlines and concessionaires, Denver mayor Wellington Webb announced that he was hiring the German firm Logplan to help assess the state of the automated baggage system. In July, Logplan issued an 11-page report to the City of Denver that characterized BAE's system as "highly advanced" and "theoretically" capable of living up to its promised "capacities, services and performances," but acknowledged mechanical and electrical problems that "make it most improbable to achieve a stable and reliable operation. Logplan suggested that it would take approximately five months to get the complete BAE system working reliably. It also suggested that a backup system of tugs, carts, and conveyor belts could be constructed in less than five months. In August 1994, Mayor Webb approved the construction of a backup baggage system. At the same time, he notified BAE of a \$12,000-a-day penalty for not finishing the baggage system by DIA's original October 29, 1993 completion date. Webb also demanded that BAE pay for the \$50 million conventional tug-and-cart baggage system.

Gene Di Fonso, President of BAE, knew that his company could demonstrate that flaws in the overall design of the airport and an unsystematic approach to project changes had affected implementation of the integrated baggage system. He wondered whether he should just cancel the contract and cut his losses, or attempt to negotiate with the city for the support required to finish the system as specified, despite the severe deterioration in communication and rising hostility. Could the problems with the automated system be overcome with the dedication of additional resources?

Given that the system represented a significant departure from conventional technology, would reducing its size and complexity facilitate resolution of the problems that plagued it? And, if the city could be persuaded to accept a simplified system, would the tenant airlines, particularly those with hubbing operations that had been promised more advanced functionality and better performance, be likely to sue? Building the Most Efficient Airport in the World

Until about 1970, Denver's Stapleton Airport had managed to accommodate an ever-growing number of airplanes and passengers.

Its operational capacity was severely limited by runway layout; Stapleton had two parallel north-south runways and two additional parallel east-west runways that accommodated only commuter air carriers. Denver's economy grew and expanded greatly in the early 1980s, consequent to booms in the oil, real estate, and tourism industries. An aging and saturated Stapleton Airport was increasingly seen as a liability that limited the attractiveness of the region to the many businesses that were flocking to it. Delays had become chronic.

Neither the north-south nor east-west parallel runways had sufficient lateral separation to accommodate simultaneous parallel arrival streams during poor weather conditions when instrument flight rules were in effect. This lack of runway separation and the layout of Stapleton's taxiways tended to cause delays during high-traffic periods, even when weather conditions were good. Denver's geographic location and the growing size of its population and commerce made it an attractive location for airline hubbing operations. At one point, Stapleton had housed four airline hubs, more than any other airport in the United States.

In poor weather and during periods of high traffic volume, however, its limitations disrupted connection schedules that were important to maintaining these operations. A local storm could easily congest air traffic across the entire United States. ³ According to James Barnes [1993], " By 1994, Stapleton was one of the top five most constrained airports in the US. There were over 50, 000 hours of delay in 1988 and by 1997 the FAA had projected that Stapleton would experience over 100, 000 hours of delay per year. " ² Purchased by Ashley Matcheck (com) on April 11, 2012

BAE Automated Systems (A): Denver International Airport Baggage-Handling System 396-311 The City and County of Denver had determined in the mid-1970s that Stapleton International Airport was in need of expansion or replacement. In July 1979, a study to assess the airport's needs was commissioned by the City of Denver to the Denver Regional Council of Governments. Upon completion of the study in 1983, a report was issued saying that, due to its size and geographic location, and strong commitments by United and Continental Airlines, Denver would remain a significant hub for at least one major U. S. carrier. The study recommended expansion of Stapleton's capacity. Political Situation⁴ The City of Denver's 1983 mayoral race precipitated initiatives to improve the airfield infrastructure. Three candidates were vying for mayor: Monte Pascoe, Dale Tooley, and Frederico Pena. Pascoe, a prominent Denver attorney and former State Democratic Party co-chair, seized upon the airport issue, forcing other candidates to adopt stronger positions on airport expansion than they might have

otherwise. 5 Pena and Tooley, however, drew the highest numbers of votes in the general election, and were forced into a runoff.

At the persistent urging of the Colorado Forum (a collection of 50 of the state's top business executives), Pena and Tooley signed a joint statement committing themselves to airport expansion. Pena won the runoff. Committed by a public promise that could have been enforced, if necessary, by the most highly motivated members of the region's business leadership, Pena immediately restated his intent to expand Stapleton. The City of Denver and neighboring Adams County began to develop plans for long-term airport development in 1984. In 1985, a new site northeast of Denver was chosen.

Consummation of the airport siting issue, however, was left to Adams County voters, which had to vote to permit the City of Denver to annex property therein. The city hired a consulting firm to help organize its resources and its efforts to work through the legal process. The data that was gathered through the master planning and environmental assessment later proved useful for public education. An "Annexation Agreement" between Adams County and the City of Denver was reached on April 21, 1988. Adams County voters approved a plan to let Denver annex 43.3 square miles for the construction of an airport.

In a special election on May 16, 1989, voters of Denver endorsed a "New Airport" by a margin of 62.7% to 37.3%. According to Edmond, "Those two referendums passed largely on the merits of the economic benefits: jobs and sales tax revenues." Economic Considerations A number of trends and events in the mid-1980s alarmed bank economists and other of the region's

business leaders in the mid-1980s. The collapse of oil shale ventures between 1982 and 1986 saw mining employment fall from 42, 000 to 26, 000 jobs, while service support jobs fell from 25, 300 jobs to 13, 700. Construction jobs fell from 50, 700 to 36, 600 jobs, and the value of private construction plummeted from \$24 billion to \$9. 5 billion. 7 A lackluster economy led many government officials in counties and municipalities as well as in Denver to embark upon an unprecedented policy of massive public construction to save the region from what was regarded in 1987 as an economic free-fall. A \$180 million-plus municipal bond was issued for public improvements, including a new downtown library, neighborhood and major roadway improvements, and a host of overdue infrastructure investments.

During the same period, 4Extracted from: Moore, S. T. : “ Between Growth Machine and Garbage Can: Determining Whether to Expand the Denver Airport, 1982-1988,” Annual Meeting of the Southern PoliticalScienceAssociation, Atlanta, Georgia, November 4, 1994. 5Ibid. 6 7 Colorado Business Outlook Forum, University of Colorado School of Business, 1990. Small Area Employment Estimates; Construction Review, U. S. Department of Commerce, 1990 3 Purchased by Ashley Matcheck (com) on April 11, 2012 396-311 BAE Automated Systems (A): Denver International Airport Baggage-Handling System he Pena administration moved decisively to confront an increasingly aggressive Chamber of Commerce leadership that was promoting airport relocation. The determination of the “ pro-New-Airport” clan was growing. The project was being marketed as a technologically advanced, state-of-the-art structure to draw businesses, import federal capital, and fund the creation of new jobs

with bonded debts to overcome the short-term decline in the economy. The airport was to become a grandiose project to revive the Colorado economy and a master showcase for the Public Works Department. The entire business community," recalled a member of the Mayor's administrative team: The Chamber of Commerce, members of the city council, the mayor, and state legislators, participated in informational discussions with other cities that had recently built airports. [This enabled] everybody to understand the magnitude of the project. So we studied the other two airports that had been built in the United States in the last 50 years and said, " Tell us everything that you went through and all the places you think there will be problems. " We were not going into it blindly.

Forecasts of aviation activity at Stapleton by the Airport Consultant team, the FAA, and others, however, did not anticipate events such as a new phase of post-deregulation consolidation, the acquisition in 1986 of Frontier Airlines by Texas Air (the owner of Continental), significant increases in air fares for flights in and out of Stapleton, and the bankruptcy of Continental. Consequently, the level of aviation activity in Denver was overestimated. Instead of rising, Stapleton's share of total U. S. domestic passenger enplanements fell 4% per year from 1986 through 1989. 8 The Master Plan

The City of Denver's approach to preparing a master plan for the airport was typical. " One hires the best consultants on airfield layout, noise impacts, terminal layout, on-site roadways, off-site roadways, cost estimating, financial analysis, and forecasting," observed DIA administrator Gail Edmond. " They brainstorm and generate as many alternate layouts as possible. " Alternatives were discussed and eliminated at periodic joint

working sessions, and a technical subcommittee was organized to gather input from the eventual airport users, airlines, pilots, and the FAA. “Everybody knows how to begin an airport master plan,” Edmond added.

Following a bid, the consulting contract was awarded to the joint venture of Greiner, Inc. and Morrison-Knudsen Engineers for their combined expertise in the fields of transportation and construction. The consulting team, working under the direction of the DIA Director of Aviation, focused first on four elements: site selection; the master plan; the environmental assessment; and developing support by educating the public on economic benefit. The final master plan presented to the city by the team in the fall of 1987 called for the construction of the world’s most efficient airport.

It was to be created from the ground up with no predetermined limitations. The plan was to allow the airport to grow and expand without compromising efficiency. Twice the size of Manhattan at 53 square miles, the nation's largest airport was to be designed for steady traffic flow in all weather conditions. It was to comprise a terminal with east and west buildings joined by an atrium structure, three concourses, an automated underground people mover, and five parallel 12, 000-foot-long runways on which as many as 1, 750 planes could take off and land daily.

Its flow-through traffic patterns would allow planes to land, taxi to concourse gates, and take 8 Furthermore, when selling the project to voters, planners at one point forecast up to 36 weekly flights to Europe by 1993. The number recorded in 1993, however, was four. The number of passengers departing form Denver was to rise from 16 million in 1985 to some 26 million by 1995. The 1994 figure, however, was about the same as the number of passengers

in 1985, or half of Stapleton's capacity. 4 Purchased by Ashley Matcheck () on April 11, 2012 BAE Automated Systems (A): Denver International Airport Baggage-Handling System 396-311 off again all in one direction. The ultimate buildout, projected for the year 2020, was to include up to 12 full service runways, more than 200 gates, and a capacity of 110 million passengers annually. Estimated cost (excluding land acquisition and pre-1990 planning costs) was \$2 billion. By the end of 1991, the estimated cost had increased to \$2.66 billion. Plans called for the project's completion by the fall of 1993.

In September 1989, Federal officials signed a \$60 million grant agreement for the new airport, which was to be financed in multiple ways—by issuing revenue bonds and securing federal grants— supplemented by a sizable investment by the city [county of Denver 1991]. Estimated federal grants for the new airport originally totaled \$501 million. Portions of these were forthcoming from the FAA, for federal fiscal year 1990 in the amount of \$90 million and for federal fiscal year 1991 in the amount of \$25 million. The remainder of the \$501 million letter of intent was to be received on an annual basis through fiscal year 1997.

The revenue bonds assumed the “ Date of Beneficial Occupancy” (DBO) to be January 1, 1994, with bond repayments to begin on that date. At that time, the city determined that DIA would meet the DBO no later than October 31, 1993. A member of the Mayor's administrative team described the approach. What we did was plan the DBO date and then we planned an extra six months just in case there was a lag in the opening, which, in essence, allowed us to create stability in the market. The other thing we did

was that we conservatively financed and filled every reserve account to the maximum.

So we borrowed as much money as we could at the lower interest rate and were able to average the debt cost down, not up, as we thought it would be. A Build-Design Project By the time construction began at DIA in November 1989, a transfer of authority was taking place in the City of Denver. Wellington Webb was elected the new mayor. According to one of his assistants, the Pena administration had announced that the airport would be operational in October 1993. " This was a build-design project, which means that we were building the airport [while] we were designing it," he explained. Because of the delays early on in the project, we had to accelerate construction immediately. There was a lot of pressure and too many players. This was an airport built by committee. We had regular meetings to straighten things out, but it didn't always work. " Although the Webb administration inherited the airport project without a commitment on the part of the major carriers, the support and input of concerned airlines were absolutely key, not only financially but also in terms of input on overall airport layout, scope, and capacity, and supporting systems such as fueling and baggage handling.

Denver launched the DIA program without specific commitments from either of Stapleton airport's two major tenant airlines, United and Continental, which together accounted for more than 70% of existing passenger traffic. Continental committed to the new airport in February 1990, United in December 1991. Fundamental changes were made to the airport layout plan and facilities (some already under construction) to accommodate the

operational needs of these carriers. The Webb administration followed the predecessor administration's emphasis on assuring that the project's greatest beneficiaries would be local businesses.

The desire was to involve as many individual firms as practicable and to use Denver area talent. It was reasoned that local talent was easily accessible to the program management team (PMT), knew Denver building codes and practices, and had available the necessary professional labor pool to accomplish the design in accordance with the demanding schedule. In addition, existing law stated that 30% minority-owned firms and 6% women-owned firms had to participate in a public works program. The result was a contracting philosophy that maximized opportunities for regional businesses and the local workforce to compete for the work.

At least five of 60 contracts awarded for the design of DIA went to Denver area firms. These 60 design contracts generated 110 construction contracts. Eighty-eight professional service contracts also had to be coordinated. Many local firms had to be hired and the program was 5 Purchased by Ashley Matchcheck (com) on April 11, 2012 396-311 BAE Automated Systems (A): Denver International Airport Baggage-Handling System chopped up into many small projects. Involvement totaled 200 to 300 firms and reached 400 during the construction phase. Five different firms designed the runways, four the terminal.

The city's emphasis on encouraging everyone to compete and yet be part of the project increased the potential for interface and coordination problems. Denver's flat economy led the administration to keep construction money within the city. Although this benefited the city, it introduced an additional

burden on administration. As many as 40-50 concurrent contracts involved many interrelated milestones and contiguous or overlapping operational areas. The estimated daily on-site work force population exceeded 2, 500 workers for a 15 to 18-month period beginning in mid-1991 and peaked at between 9, 000 and 10, 000 in mid-1992.

Adding to the human resource coordination problems was a forecasted 4, 000 deliveries daily. Construction volume for six months in mid-1992 exceeded \$100 million per month. The prolonged period of assessment and negotiation prior to final approval of the project, and the financial plan selected (which required that bond repayments begin on January 1, 1994), pressured the PMT to push the project ahead at all cost. Because the project had to assume the characteristics of a " fast-track" project early in the construction startup, the compressed design period precipitated a more dynamic construction effort than might be anticipated for a " competitively bid, fixed price" program. Reliance on a design/build method for the project was, according to one DIA official, " unusual because projects this complex normally happen during separate stages. For example, you need to finish up the site selection before you begin the master planning. " Moreover, communication channels between the city, project management team, and consultants were neither well defined or controlled. " If a contractor fell behind," a resident engineer who reported to one of the area managers said, the resident engineer would alert the contractor and document this.

The resident engineer would document what would have to be done and what additional resources were necessary to get back on schedule and finish the contract on time. As a public agency it was enormous, the amount of

documentation that we did. I don't know how many trees we cut down just for this project. The resident engineer had about five to eight 12-drawer filing cabinets of documentation and this was nothing compared to what the area manager had. It was just incredible. There were at least four to six copies of everything. The scheduling manager described the evolution of the tracking system that was used.

One of the biggest problems we had was keeping track of all the changes. So we developed a database system that was installed at each one of the resident engineer's trailers and each contract administrator was then charged with keeping that system up to date and feeding us disks, which we would then merge together periodically to produce an integrated report. But every party had developed their own tracking system before the start of the project. That worked well for each group, but there was no way to take each one of these divergent systems and combine it into one, comprehensive report.

So when we introduced the change tracking system everybody said, " fine, that's wonderful, and I'll update it when I get to it and when I get time. " It took three years to implement the tracking system. Project Management In a fast-moving, ever-changing environmentsuch as the development of a new airport, the management structure must be able to rapidly produce engineering alternatives and the supporting 6 Purchased by Ashley Matcheck (com) on April 11, 2012 BAE Automated Systems (A): Denver International Airport Baggage-Handling System 396-311 ost and schedule data. 9 But because DIA was financed by many sources and was a public works program, project administrators had to balance administrative,

political, and social imperatives. 10 The City of Denver staff and consultant team shared leadership of the project and coordinated the initial facets of DIA design. "The initial thought," reflected one staff member, "was that the city staff would do their thing and the consulting staff do theirs and later we would coordinate. It became evident within a very short time that we were doing duplicate duties, which was inefficient.

Finally the city decided to coordinate resources. "The city selected a team of city employees and consultants and drafted a work scope document that clearly separated the city's from the consultants' responsibilities. The elements the city did not delegate to consultants included ultimate policy and facility decisions, approval of payments, negotiation and execution of contracts, facilitation of FAA approvals, affirmative action, settlement of contractor claims and disputes, selection of consultants, and utility agreements.

The city delegated some elements such as value engineering, construction market analysis, claim management, on-site staff and organization, and state-of-the-art project control (computerized management of budget and schedule). Exhibit 1 depicts the DIA management structure. The program management team became the organization dedicated to overseeing planning and development for the new airport. Headed by the associate director of aviation, the team was partially staffed by citycareerservice employees.

To add experience and capability, the city augmented the PMT with personnel from the joint venture of Greiner Engineering and MorrisonKnudsen Engineers, the consulting team. Observed one program

management team member, “ This working partnership of the City of Denver and consulting joint venture team developed into a fully integrated single organization, capitalizing on the best to be offered by all participants, and optimizing the use of personnel resources. ” DIA’s operational project structure comprised five different areas subdivided into smaller units.

The working areas were: site development (earthmoving, grading, and drainage); roadways and on-grade parking (service roads, on-airport roads, and off-airport roads connecting to highways); airfield paving; building design (people-mover/baggage-handler, tunnel, concourses, passenger bridge, terminal, and parking); and utility/special systems and other facilities (electrical transmission, oil, and gas line removal and relocation). An area manager controlled construction within each area.

Area managers were responsible for the administration of all assigned contracts and, in coordination with other area managers, for management of the portion of the overall site in which their work took place. United Airlines’ Baggage System From the public’s perspective, the “ friendliness” of any airport is measured by time. No matter how architecturally stimulating a new airport structure, the perception of business or leisure travelers is often registered in terms of efficiency in checking luggage at the departure area or waiting to claim a bag in the arrival area.

The larger the airport, the more critical the efficient handling of baggage. Remote concourses connected by underground tunnels present special problems for airport planners and operators because of the great distances passengers and baggage must travel. The purpose of an airport being to move passengers as efficiently as possible, moving bags as quickly is 9 The

DIA project used the so-called "fast-tracking" method, which made it possible to compress some activities along the critical path and manage the construction project as a series of overlapping tasks. 0 These included considerations such as affirmative action, local participation, neighborhood concerns, civic pride, input from the disabled community, art, secondary employment benefits of contract packaging, concern for the environment, and political interest. 7 Purchased by Ashley Matcheck (com) on April 11, 2012 396-311 BAE Automated Systems (A): Denver International Airport Baggage-Handling System part and parcel of that responsibility. Rapid transport of frequent flyers accomplishes very little if bags are left behind.

DIA's Concourse A, which was to house Continental Airlines, was situated some 400 meters, and United Airlines' Concourse B nearly 1, 000 meters, north of the main terminal. Concourse C, home to other carriers including American, Delta, Northwest, America West, and TWA, sat parallel to the other two concourses more than 1, 600 meters north of the main terminal. The initial project design did not incorporate an airport-wide baggage system; the airport expected the individual airlines to build their own systems as in most other American airports. 1 United Airlines, which in June 1991 signed on to use DIA as its second-largest hub airport, proceeded to do just that. Needing an automated baggage handling system if it was to turn aircraft around in less than 30 minutes, United, in December 1991, commissioned BAE Automatic Systems, Inc. , a world leader in the design and implementation of material handling systems, to develop an automated baggage handling system for its B Concourse at DIA. The contract, which

included engineering and early parts procurement only, was valued at \$20 million; and the task was estimated to be completed in two and one-half years. We began working at DIA under a contract directly with United Airlines," recalled Di Fonso. " Obviously, United Airlines has experience with airports. They concluded that the schedule had gotten totally out of control from the standpoint of baggage and they acted to serve their own needs, basically to protect themselves. We contracted with United and were already designing their portion of the system before the city went out for competitive bidding. " BAE was founded as a division of Docutel Corporation in 1968.

Docutel, which had developed the Telecar (a track-mounted automated baggage system), constructed an automated baggage system for United Airlines at San Francisco airport in 1978. When Docutel ran into financial difficulties during this installation, United asked Boeing, a major supplier of its aircraft, to take over the company. Boeing agreed and the new company, a wholly-owned subsidiary dubbed Boeing Airport Equipment, completed the San Francisco installation. In 1982, Boeing sold the company to its senior management, which renamed it BAE Automated Systems.

In August 1985, BAE became an operating unit of Clarkson Industries, a wholly-owned subsidiary of London-based BTR plc. BTR plc (formerly British Tire and Rubber), was a \$10 billion conglomerate with global interests in building, paper and printing products, and agricultural and aircraft equipment. In 1994, BAE's 365 employees worked on projects across the United States and in Europe and Australia. In-house engineering, manufacturing, and field support capabilities enabled BAE to develop,

design, manufacture, install, and support every project it undertook from start to finish.

BAE also provided consulting, engineering, and management services for airport projects and a variety of material handling applications. With sales of \$100 million in 1994, up from approximately \$40 million in 1991, BAE accounted for 90% of U. S. baggage sorting equipment sales. Between 1972 and 1994, the company had successfully designed, manufactured, and installed nearly 70 automated baggage handling systems (worth almost \$500 million dollars) at major airports in the United States, in New York, Dallas-Fort Worth, Chicago, San Francisco, Atlanta, Miami, Newark, and Pittsburgh.

It had also installed systems in Vancouver and London and was selected, in 1992, as a consultant to the \$550 million main terminal for the New Seoul Metropolitan Airport in South Korea. BAE was a very self-contained, integrated company structured along two business lines: manufacturing and engineering. Its approximately 200, 000 square foot manufacturing facility was capable of producing nearly all of the components required by BAE systems save motors, gearboxes, and bearings. The engineering department was structured according to major projects. Each project was assigned a project manager who reported directly to the company president. 1 Rifkin, G. : " What Really Happened at Denver's Airport," Forbes, SAP Supplement, August 29, 1994. 8 Purchased by Ashley Matcheck (com) on April 11, 2012 BAE Automated Systems (A): Denver International Airport Baggage-Handling System 396-311 Implementing an Integrated Baggage-Handling System BAE had already commenced work on United's baggage

system when the PMT recognized the potential benefits of an airport-wide integrated baggage system. Moreover, as one DIA senior manager explained, "airlines other than United simply were not coming forward with plans to develop their own baggage systems. Airport planners and consultants began to draw up specifications and the city sent out a request for bids. Of 16 companies contacted, both in the United States and abroad, only three responded. A consulting firm recommended against the submitted designs, on the grounds that the configurations would not meet the airport's needs. BAE was among the companies that had decided not to bid for the job. BAE had installed the Telecar system at a number of other airports and the basic technologies of the Telecar, laser barcode readers, and conveyor belt systems were not new. What was new was the size and complexity of the system. A grand airport like DIA needs a complex baggage system," explained Di Fonso, "Therefore the type of technology to be used for such a system is the kind of decision that must be made very early in a project. If there is a surprise like no bidders there is still time to react. At DIA, this never happened. Working with United Airlines, we had concluded that destination-coded vehicles moving at high speed was the technology needed. But quite honestly, although we had that technology developed, its implementation in a complex project like this would have required significantly greater time than the city had left available.

A United project manager concurred: "BAE told them from the beginning that they were going to need at least one more year to get the system up and running, but no one wanted to hear that." The City of Denver was getting the same story from the technical advisers to the Franz Josef Strauss

Airport in Munich. The Munich Airport had an automated baggage system, but one far less complex than DIA's. Nevertheless, Munich's technical advisors had spent two years testing the system and the system had been running 24 hours a day for six months before the airport opened.

Formulating Intentions

As BAE was already working on United's automated baggage handling system and enjoyed a world-wide reputation as a superior baggage system builder, Denver approached the company. BAE was asked to study how the United concept could be expanded into an integrated airport system that could serve the other carriers in the various concourses. BAE presented the City of Denver with a proposal to develop the "most complex automated baggage system ever built," according to Di Fonso. It was to be effective in delivering bags to and from passengers, and efficient in terms of operating reliability, maintainability, and future flexibility.

The system was to be capable of directing bags (including suitcases of all sizes, skis, and golf clubs) from the main terminal through a tunnel into a remote concourse and directly to a gate. Such efficient delivery would save precious ground time, reduce close-out time for hub operations, and cut time-consuming manual baggage sorting and handling. Although an automated system was more expensive initially than simple tugs and baggage carts, it was expected that it would reduce the manpower which was required to distribute bags to the correct locations.

Bags unloaded from an aircraft arriving at a particular concourse would barely be touched by human hands. Moved through the airport at speeds up to 20 mph, they would be waiting when passengers arrived at the terminal.

To prove the capability of its mechanical aspects, and demonstrate the proposed system to the airlines and politicians, BAE built a prototype automated baggage handling system in a 50, 000 square foot warehouse near its manufacturing plant in Carrollton, Texas. The prototype system convinced Chief Airport Engineer Walter Slinger that the automated system would work. [The City of Denver] approached us based on one core concept," recalled Di Fonso. " They wanted to have a fully integrated, airport-wide baggage system. The city 9 Purchased by Ashley Matcheck (com) on April 11, 2012 396-311 BAE Automated Systems (A): Denver International Airport Baggage-Handling System had two major concerns. First, they had no acceptable proposal. Second, United was probably going to go ahead and build what it needed and the rest of the airport would have been equipped with something else. Di Fonso continued, When we arrived on the scene, we were faced with fully defined project specs, which obviously in the long run proved to be a major planning error. The city had fallen into a trap, which historically architects and engineers tend to fall into as they severely underplay the importance and significance of some of the requirements of a baggage system, that is, arranging things for the space into which it must fit, accommodating the weight it may impose on the building structure, the power it requires to run, and the ventilation and air conditioning that may be necessary to dissipate the heat it generates.

In April 1992, BAE was awarded the \$175. 6 million contract to build the entire airport system. According to Di Fonso, company executives and city officials hammered out a deal in three intense working sessions. " We placed

a number of conditions on accepting the job," he observed. The design was not to be changed beyond a given date and there would be a number of freeze dates for mechanical design, software design, permanent power requirements and the like. The contract made it obvious that both signatory parties were very concerned about the ability to complete.

The provisions dealt mostly with all-around access, timely completion of certain areas, provision of permanent power, provision of computer rooms. All these elements were delineated as milestones. Denver officials accepted these requirements and, in addition, committed to unrestricted access for BAE equipment. Because of the tight deadlines, BAE would have priority in any area where it needed to install the system. Di Fonso elaborated, When we entered into the contract, Continental Airlines was still under bankruptcy law protection.

The city was very concerned that they would be unable to pay for their concourse. They only contracted for about 40% of the equipment that is now in concourse A, which was the concourse that Continental had leased. Beyond that, concourse C had no signatory airlines as leaseholders at the time. The city, therefore, wanted the simplest, most elementary baggage system possible for concourse C. The outputs and inputs were very, very crude, intentionally crude to keep the costs down because the city had no assurance of revenue stream at that point in time.

The city did not get the airlines together or ask them what they wanted or needed to operate. The approach was more along the lines of " we will build the apartment building and then you come in and rent a set of rooms. "

Project Organization and Management No major organizational changes to

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accommodate the new baggage system were deemed necessary, although some managerial adjustments were made on the DIA project. Design of the United baggage system was frozen on May 15, 1992, when the PMT assumed managerial responsibility for the integrated baggage system.

The direct relationship with BAE was delegated to Working Area 4, which also had responsibility for building design efforts such as the people-mover, airside concourse building, passenger bridge main landside building complex and parking garage, and various other smaller structures. The area manager, although he had no experience in airport construction, baggage system technologies, or the introduction of new technologies, possessed vast experience in construction project control management. BAE had to change its working structure to conform to DIA's project management structure. Di Fonso explained, 10

Purchased by Ashley Matchcheck (com) on April 11, 2012 BAE Automated Systems (A): Denver International Airport Baggage-Handling System 396-311 There was a senior manager for each of the concourses and a manager for the main terminal. The bag system, however, traversed all of them. If I had to argue a case for right of way I would have to go to all the managers because I was traversing all four empires. In addition, because changes were happening fast at each of these sites, there was no time to have an information system to see what is concourse A deciding and what is concourse B deciding.

We had to be personally involved to understand what was going on. There was no one to tie it all together and overlap all these effects because the basic organization was to manage it as discrete areas. It was pandemonium.

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We would keep saying that over and over again. Who is in charge? For the first two years of the project, Di Fonso was the project manager. The project was divided into three general areas of expertise: mechanical engineering, industrial control, and software design.

Mechanical engineering was responsible for all mechanical components and their installation, industrial control for industrial control design, logic controller programming, and motor control panels, and software design for writing real-time process control software to manage the system. At the time the contract with BAE was signed, construction had already begun on the terminal and concourses. Substantial changes had to be made to the overall design of the terminal and some construction already completed had to be taken out and reinstalled to accommodate the expanded system.

Installation of the expanded system was initially estimated to require more than \$100 million in construction work. Walls had to be removed and a new floor installed in the terminal building to support the new system. Moreover, major changes in project governance were taking place during the baggage system negotiations. In May 1992, shortly after the baggage system negotiations commenced, the head of the DIA project resigned. The death in October 1992 of Chief Airport Engineer Slinger, who had been a strong proponent of the baggage system and closely involved in negotiations with BAE, also exerted a significant impact on the project.

His cooperation had been essential because of the amount of heavy machinery and track that had to be moved and installed and the amount of construction work required to accommodate the system. His replacement, Gail Edmond, was selected because she had worked closely with him and

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knew all the players. Her managerial style, however, was quite different from Slinger's. A Public Works manager recalled his first reaction to the change: "[The airport] is not going to be open on time. " A United Airlines project manager summarized Edmond's challenge thus: Slinger was a real problem solver.

He was controversial because of his attitude, but he was never afraid to address problems. He had a lot of autonomy and could get things done. Gail was in a completely different position. Basically, she had a good understanding of how the project was organized and who the key players were, but didn't know much about the actual construction. Also, the city council didn't give her anywhere near the autonomy and the authority that Slinger had and she had to get approval from the council on just about all decisions. They really tied her hands and everyone knew it.

Di Fonso echoed the project manager's assessment: Walter [Slinger] understood that one of the things we had to have was unrestricted access. I think he clearly understood the problem the city was facing and he understood the short timeframe under which we were operating. He was the one that accepted all of the contractual conditions, all the milestones of the original contract. He really had no opportunity to influence the outcome of this project, however, because he died within months after the contract was signed. I think Gail 11 Purchased by Ashley Matcheck (com) on April 11, 2012 96-311 BAE Automated Systems (A): Denver International Airport Baggage-Handling System did an excellent job [but] she was overwhelmed. 12 She just had too much. The layers below focused inward, worrying about their own little corners of the world. " Not only did we not get

the unrestricted access that was agreed upon,” Di Fonso emphasized, “ we didn’t even have reasonable access. ” Ten days after Slinger’s death, a BAE millwright found a truck from Hensel Phelps, the contractor building Concourse C, blocking her work site. She asked someone to move the truck or leave the keys so it could be moved.

According to a BAE superintendent, “ she was told that ‘ This is not a BAE job and we can park anywhere we please: is that clear? ’” Elsewhere, BAE electricians had to leave work areas where concrete grinders were creating clouds of dust. Fumes from chemical sealants forced other BAE workers to flee. Di Fonso pleaded with the city for help. “ We ask that the city take prompt action to assure BAE the ability to continue its work in an uninterrupted manner,” he wrote. “ Without the city’s help, the delays to BAE’s work will quickly become unrecoverable. 13 To further complicate matters, the airlines began requesting changes to the system’s design even though the mechanical and software designs were supposed to be frozen. “ Six months prior to opening the airport,” Di Fonso recalled, “ we were still moving equipment around, changing controls, changing software design. ” In August 1992, for example, United altered plans for a transfer system for bags changing planes, requesting that BAE eliminate an entire loop of track from Concourse B. Rather than two complete loops of track, United would have only one.

This change saved approximately \$20 million, but required a system redesign. Additional ski-claim devices and odd-size baggage elevators added in four of the six sections of the terminal added \$1. 61 million to the cost of the system. One month later, Continental requested that automated

baggage sorting systems be added to its west basement at an additional cost of \$4.67 million. The ski claim area length was first changed from 94 feet to 127 feet, then in January 1993, shortened to 112 feet. The first change added \$295,800, the second subtracted \$125,000, from the cost.

The same month, maintenance tracks were added to permit the Telecars to be serviced without having to lift them off the main tracks at an additional cost of \$912,000. One year later, United requested alterations to its odd-size baggage inputs—cost of the change: \$432,000. Another problem was the city's inability to supply "clean" electricity to the baggage system. The motors and circuitry used in the system were extremely sensitive to power surges and fluctuations. When electrical feedback tripped circuit breakers on hundreds of motors, an engineer was called in to design filters to correct the problem.

Although ordered at that time, the filters still had not arrived several months later. A city worker had canceled a contract without realizing that the filters were part of it. The filters finally arrived in March 1994. A third, albeit disputed, complication related to Denver's requirement, and city law, that a certain percentage of jobs be contracted to minority-owned companies. The City of Denver had denied BAE's original contract because it did not comply with hiring requirements, where upon BAE engaged some outside contractors in lieu of BAE employees. Di Fonso estimated that this increased costs by approximately \$6 million, a claim ejected by the Mayor's Office of Contract Compliance. Then, in September 1993, BAE's contract negotiations with the City of Denver over maintenance of the system resulted in a two-day strike of 300 millwrights that was joined by some 200 electricians. BAE

negotiated with Denver for maintenance workers to earn \$12 per hour on certain jobs that the union contended should be worth \$20 per hour. As a result, BAE lost the maintenance contract. 12 In addition to her role as Chief Airport Engineer, Edmond kept her previous responsibilities as Chief of Construction and Acting Director of Aviation. 3 Rocky Mountain News, January 29, 1995 12 Purchased by Ashley Matcheck (com) on April 11, 2012 BAE Automated Systems (A): Denver International Airport Baggage-Handling System 396-311 Project Relations Much of the effort for implementing the baggage system was directed within one of the four working areas. " The relationship with the management team was very poor," recalled Di Fonso. The management team had no prior baggage handling competence or experience. This was treated as a major public works project.

The management team treated the baggage system as similar to pouring concrete or putting in air-conditioning ducts. When we would make our complaints about delays and access and so forth, other contractors would argue their position. The standard answer was, " Go work it out among yourselves. " . . . With contractors basically on their own, this led almost to anarchy. Everyone was doing his or her own thing. Another perspective was offered by a project manager from Stone & Webster, a consultant to the PMT, reflecting on the work done by BAE: " This contractor simply did not respond to the obvious incredible workload they were faced with.

Their inexperienced project management vastly underestimated their task. Their work ethic was deplorable. " 14 PMT management insisted that access and mechanical issues weren't the problem. " They were running cars in

Concourse B all summer (1993)," Edmund observed. " The problem was that the programming was not done and BAE had full control of the programming. " 15 Lawsuits and a Backup Baggage System In February 1993, Mayor Webb delayed the scheduled October 1993 airport opening to December 19, 1993. Later, this December date was changed to March 9, 1994. Everybody got into the panic mode of trying to get to this magical date that nobody was ready for," a senior vicepresident for BAE recalled. In September 1993, the opening was again postponed—this time until May 15, 1994. In late April 1994, the City of Denver invited reporters to observe the first test of the baggage system, without notifying BAE. Seven thousand bags were to be moved to Continental's Concourse A and United's Concourse B. So many problems were discovered that testing had to be halted. Reporters saw piles of disgorged clothes and other personal items lying beneath the Telecar's tracks.

Most of the problems related to errors in the system's computer software, but mechanical problems also played a part. The software that controlled the delivery of empty cars to the terminal building, for example, often sent the cars back to the waiting pool. Another problem was " jam logic" software, which was designed to shut down a section of track behind a jammed car, but instead shut down an entire loop of track. Optical sensors designed to detect and monitor cars were dirty causing the system to believe that a section of track was empty when, in fact, it had held a stopped car.

Collisions between cars dumped baggage on tracks and on the floor; jammed cars jumped the track and bent the rails; faulty switches caused the Telecars to dump luggage onto the tracks or against the walls of the tunnels. After the

test, Mayor Webb delayed the airport's opening yet again, this time indefinitely. " Clearly, the automated baggage system now underway at DIA is not yet at a level that meets the requirements of the city, the airlines, or the traveling public," the mayor stated. The city set the costs of the delay at \$330, 000 per month.

Recognizing that his reputation was staked on his ability to have a baggage system performing to a point at which the new airport could be opened, Mayor Webb engaged, in May 1994, the German firm Logplan to assess the state of the automated baggage system. In July, Logplan isolated a loop of track that contained every feature of the automated baggage 14 15 Forbes, ASAP Supplement, August 29, 1994. Forbes, ASAP Supplement, August 29, 1994. 13 Purchased by Ashley Matcheck (com) on April 11, 2012 396-311 BAE Automated Systems (A): Denver International Airport Baggage-Handling System system and intended to run it for an extended period to test the reliability of the Telecars. Jams on the conveyor belts and collisions between cars caused the test to be halted. The system did not run long enough to determine if there was a basic design flaw or to analyze where the problems were. Logplan recommended construction of a backup baggage system, and suggested using Rapistan Demag, a firm it had worked with in the past. Construction of a backup system was announced in August 1994. The system itself cost \$10. million, but electrical upgrades and major building modifications raised the projected cost to \$50 million. In the meantime, the City of Denver, as well as many major airlines, hired legal firms to assist with negotiations and future litigation. " We will have enough legal action for the rest of this century," a city administrator mused. The City

of Denver had to communicate with such parties as the United States Federal grand jury, Securities Exchange Commission, and the General Accounting Office. The federal grand jury was conducting a general investigation concerning DIA.

The SEC was investigating the sale of \$3.2 billion in bonds to finance DIA's construction, and GAO the use of Congressional funds. Di Fonso, reviewing Mayor Webb's letter and requests that BAE pay a \$12,000-a-day penalty for missing DIA's original October 29, 1993 completion date, as well as assuming the costs of building the \$50 million conventional tug-and-cart baggage system, summed up the situation thus: " We have gotten to the point with the city that literally we are not talking to each other. Consultants recommended a backup baggage system, and the minute that the decision was made, the city had to defend it.

We are left out in limbo. " 14 Purchased by Ashley Matcheck (com) on April 11, 2012 396-311 -15- Exhibit 1 Organization Chart Acting Associate Director of Aviation Denver International Airport City Attorneys Contract Compliance DIA Coordinator Tenant Facilities Administrative Assistant Marketing/Public Information Manager Planner Program Manager Computer Systems Administration Deputy Program Manager Airline Specialty Systems Environmental Engineer Contracts Risk Management Financial Manager of Design Contract Administration Administrative Assistant

Manager of Project Controls Architectural Supervisor Engineering Supervisor Document Control Contracts Staff Clerical Staff MIS Schedule Cost Estimating Project Managers & Support Staff Manager of Construction Project Controls

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Support Staff Safety Manager Senior Project Engineer QA/QC Manager
Employee Relations Area 1&2 Manager Area 3 Manager Area 4A Manager
Area 4B Manager Area 5 Manager Construction Support Staff Source: City
and County of Denver, Colorado, Airport System Review Bonds, Series
1991D, October 1991. Purchased by Ashley Matcheck (com)
on April 11, 2012