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A Case Narrative of the Project Problems with the Denver Airport Baggage Handling System (DABHS)

by

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Source Material:

Applegate, L. M., Montealegre R., Knoop C. I., Nelson H. J., *BAE Automated Systems (A): Denver International Airport Baggage-Handling System,* Harvard Business School Case 396-311, in Glass R.L., Software Runaways: "Lessons learned from massive software project failures", Prentice Hall, ISBN 0-13-673443-X , 1998

Applegate, L. M., Montealegre R., Knoop C. I., Nelson H. J., *BAE Automated Systems (B): Implementing the Denver International Airport Baggage-Handling System,* Harvard Business School Case 396-312, in Glass R.L., Software Runaways: "Lessons learned from massive software project failures", Prentice Hall, ISBN 0-13-673443-X , 1998

Stearns D., *Functionality Of Original BAE Design: Saviour Of Modern Flying,* http://www.csc.calpoly.edu/~dstearns/SchlohProject/function.html

Denver International Airport was scheduled to open on October 31, 1993 with all three of its concourses fully running on the BAE automated baggage handling system that. On February 28, 1995, the new airport finally opened. Its opening came sixteen months late.

The automated baggage system for the Denver International Airport is now running and is regarded as an important introduction in modern airport design. The baggage handling system was designed by BAE Automated Systems and allows airport planners to design airports of larger size, using narrow corridors and tunnels for baggage where no tug and cart system can run. Labour costs in using the system are minimal and the system moves luggage simply and has an equally simple method for pinpointing items as they are transferred between the concourses and terminal buildings. The baggage handling system is completely automatic and runs faster and more reliably than those using traditional technology.

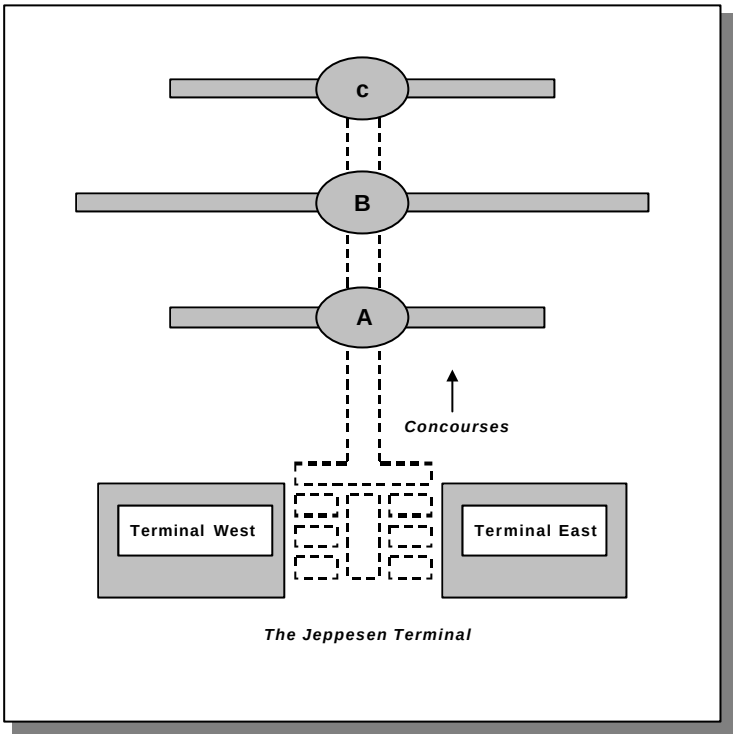

Figure 1. The Airport Terminal and Concourses at Denver International Airport

This document was prepared with the purpose of being able to model the Case Study using UML. It is presented here in order to show a simple and yet comprehensive narrative of the case study

Target Objectives of the DABHS

- Improve ground efficiency.
- Reduce close-out time for hub operations.
- Decrease time-consuming manual sorting/handling.

Risks recognised early in the DABHS Project

- Very large scale of the project.
- Enormous complexity.
- Newness of the technology.
- Large number of entities to be served by the system.

The high degree of technical and project definition uncertainty.

Chronology

September 1989	U.S. Federal officials authorised $60 million to construct a new highly technologically advanced airport for Denver, CO, to be called the Denver International Airport (DIA).
November 1989	Airport started
November 1989	A new Mayor was elected in Denver, CO. They had inherited the project with a target of October 1993 completion, but with **no** commitment to it by the major airlines.
February 1990	a commitment was received from 'Continental'
June 1991	United Airways signed on in with DIA planned to be its second largest hub.
December 1991	a commitment was received from 'United Airlines'
April 1992	BAE was awarded the $175.6 million contract top build the entire airport system.. Company officials hammered out a deal in three intense working sessions
April 1992	BAE systems presented the City of Denver with a proposal to develop “the most complex and automated [and integrated] baggage system ever built.
May 1992	15 May 1992 – Design of the UA baggage handling system was frozen when PMT assumed responsibility for the integrated baggage system.
May 1992	shortly after the baggage system negotiations began, the head of the DIA project resigned.
August 1992	**August 1992** (as an example) UA altered plans for a transfr system for bags changing planes, requesting that BAE eliminate an entire loopof track from Concourse B. (they would operate with one loop rather than two). This saved approximately $20 million, but required a system redesign.
August 1992	additional ski-claim devices and odd-size baggage elevators added in four of the six sections of the terminal, added $1.6 million to the cost of the system.
September 1992	Continental requested that automated baggage sorting systems be added to its west basement at a cost of $4.67 million. The ski claim

	area length was first changed from 94 feet to 127 feet.
October 1992	Chief Airport Engineer Walter Slinger died. He had been a strong proponent of the baggage system and was a key player in the negotiations.
January 1993	this ski claim length was shortened to 112 feet! The first change added $295,800 The second change subtracted $125,000
January 1993,	maintenance tracks were added to permit the Telecars to be serviced without having to lift them off the main tracks. This cost an additional $912,000.
February 1993	Mayor Webb delayed the scheduled **October 1993** opening to December 19, 1993. Later this was put back to **March 9, 1994.** This became the panic drop-dead date.
June 1993	Cars were running in concourse B all summer. However all of the programming was not done and BAE had full control of all the programming.
September 1993	BAE's contract negotiations wih the City of Denver over maintenance of the system, occasioned a 2-day strike of 300 millwrights that was joined by ~ 200 electricians. BAE lost the maintenance contract because they intended to pay $12 per hour for jobs that union wanted $20 per hour.
September 1993	The opening was again delayed until **May 15, 1994.**
October 1993.	Original target opening date for the airport was (delayed seven times over the next three months).
October 1993	October 29, 1993 was the original scheduled completion date for the project.
January 1994	UA requested alterations to its odd-size baggage inputs. This cost an additional; $432,000
March 1994	The motors and circuitry was extremely sensitive to power surges and fluctuations. Feedback continually tripped circuit breakers and filters to remedy this took months to arrive.
April 1994	City of Denver invited reporters to observe the first test of the baggage system without notifying BAE. This was a public disaster! Reporters saw piles of disgorged clothes and other personal items lying beneath the Telecar's tracks.
April 1994	After the test, Mayor Webb deleayed the test yet gain – this time indefinitely

	indefinitely.
May 1994	the Mayor of Denver hired the German firm 'Logplan'
May 1994	The German 'Logplan' was commissioned to asses the state of the baggage handling system.
July 1994	Logplan isolated a loop of track that contained every featur of the automated baggage system and intended to run it for an extended period to test the reliability of the Telecars.
August 1994	Announcement of construction of a back-up system.
August 1994	August 22, 1994, Mayor Webb notified BAE that they would have to pay $12,000-per-day penalty for not implementing the baggage system by DIA's original completion date.
August 1994	31st August 1994 – in an effort to avoid the City of Denver had proposed a "stand still" agreement whereby major parties (the City, UA., and BAE) would waive certain previous rights until the new airport was opened and operational. (this merely pout legal issues on the back-burner for a while).
September 1994	September 7, 1994, BAE went public with a $40 million claim against the City of Denver in which they blamed delays on:
January 1995	Following autumn and winter testing of the system, a full-scale three-hour 10,000-bag practice run of the substitute baggage` system.
February 1995	the airport finally opened
February 1995	February 28, 1995 – the DIA opened with a real flourish including jet flypasts, current/former Mayors and a large crowd including 1725 journalists.

Part A Narrative from Harvard case study Part 1 - Troubled times

Target Objectives

- Improve ground efficiency.
- Reduce close-out time for hub operations.
- Decrease time-consuming manual sorting/handling.

Risks were recognised

- Very large scale of the project.
- Enormous complexity.
- Newness of the technology.
- Large number of entities to be served by the system.
- The high degree of technical and project definition uncertainty.

Initial Start

- **November 1989** Airport started

  Original contract for a baggage handling system raised by United Airlines, but this was subsequently expanded to cover the entire airport.
- Original target opening date for the airport was **October 1993**.
- Delayed seven times over the next three months.
- **May 1994** the Mayor of Denver hired the German firm 'Logplan' following pressure from:
  - Denver residents
  - Federal Aviation Administration (FAA) Commissioners
  - Tenant Airlines
- **November 1989** A new Mayor was elected in Denver, CO. They had inherited the project with a target of **October 1993** completion, but with **no** commitment to it by the major airlines. – this was a key requirement! (the main players were 'United Airlines' and 'Continental', accounting for 70% of the air traffic).
  - **February 1990** – a commitment was received from 'Continental'
  - **December 1991** – a commitment was received from 'United Airlines'
- With respect to the whole airport project, the Mayor of Denver put a very high emphasis on jobs and trade for the city
  - Amongst the legal requirements for funding were the requirements that 30% minority-owned firms were used, and that 6% of women-owned firms were used.
  - Five out of sixty contracts awarded for the design of DIA went to Denver companies.

  - The 60 contracts generated 110 construction contracts and 88 professional service contracts.
  - Between 200 and 300 (max. 400) companies were involved
  - There was a huge local commitment with a 2500+ workforce which peaked at 10,000 in **mid-1992.** At one stage there were 4,000 daily deliveries to the site.

- Communication was a problem from the beginning channels between: (a) The City, (b) The Project Management Team and (c) Consultants, were never well defined
- The tracking system was a disaster. They tried to merge the different systems into one central database `structure. Everybody had their own and it took 3 years to get working.

Project Management

- DIA was financed by a lot of different sources
- The City if Denver staff and the Consultant team shared leadership of the project and co-ordinated initial facets of the design..
- This led to duplication, and so they identified responsibilities. Elements *not* delegated 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
  - Utility agreements
- The city did however delegate elements such as:
  - Value engineering
  - Construction Market analysis
  - Claim management
  - On-site staff and organisation
  - State-of-the-Art project control (computerised management of budget and schedule)

- The Project Management Team (PMT)became responsible fo0r overseeing planning and development.
  - Headed by associate director of aviation
  - Partly staffed by City career civil servants!
  - Consultants supplied other members of the team to added experience and capability.
- The project structure had 5 different areas
  1. Site development
  2. Roadways and parking
  3. Airfield paving
  4. Building design

5. Utility systems

United Airlines Baggage System

- The "friendliness" of an airport is measured in time and baggage handling is a key aspect of this.
- The larger the airport, the more critical the timing aspects of baggage handling because the underground movement of the baggage becomes problematic
- In most airports, airlines build their own baggage handling systems. N Denver, Concourse housed Continental 400m from the Terminal and Concourse B was to host United at 1000m from the terminal. Concourse C housed American, Delta, Northwest America West and TWA at 1600m from the terminal..
- United signed on in **June 1991** with DIA planned to be its second largest hub.
  - UA needed an automated baggage handling system as they wanted to turn aircraft round in 30 minutes.
  - UA commissioned BAE Automated Systems Inc., to develop0e a system for Concourse A
  - A $20million contract was to be completed in 2.5 years. (BAE had independently contracted with UA. They knew that the overall DIA schedule was out of control and fixed their contract with UA prior to DIA going for competitive bidding)
  - BAE had grown out of Boeing Airport Equipment into a company owned by he UK's BTR plc. They7 accounted for 90% of US baggage sorting systems.

Implementing and Integrated Baggage Handling System

- BAE had commenced work on UA's baggage system when PMT recognised benefits of an airport-wide solution. (also other airlines were not moving on the subject at on their own)
- BAE **did not bid** for the larger project
- BAE had installed Telecar (laser barcode readers and conveyor belt system) but never on the size envisaged in the tender offer.– DIA was going to need something much bigger.
- BAE told UA that it would take at least a year to get the system up and running, but no-one wanted to hear that. City of Denver got the same story from technical advisers to the Franz Joseph Strauss airport in Munich (that less complicated system had taken 2 years testing and was running 24 hours a day for 6 months before the airport opened.

Formulating Intentions

- BAE had a world-wide reputation as a superior baggage system builder. Denver approached the company and asked them to study how the United concept that could serve other carriers in the various concourses. BAE came up with a proposal (most ambitious ever – biggest, most complex automated system ever)).
  - It was to be effective in delivering bags to and from passengers .and efficient in terms of reliability, maintainability and future flexibility.
  - The system was to be capable of delivering 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 need ton distribute the baggage as required.
- Bags unloaded from an arriving aircraft at a particular concourse would be barely touched by human hands.
- Moved through the airport at speeds of up on 20 mph, they would be waiting when passengers arrived at the terminal.,

- To prove the capability, BAE proposed to build a prototype automated baggage handling system in a 50,000 sq. ft. warehouse near its manufacturing plant in Texas.
  - The prototype system convinced Chief Airport Engineer (Walter Slinger) that the automated system would work.
- A dilemma was approaching: The City wanted a fully integrated airport-wide system and they had no acceptable proposal.; but UA intended to proceed with their own system and let the rest of the airport be equipped with something else.
- BA arrived at the scene with fully designed 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 he importance and significance of some of the requirements of the baggage handling system, that is:
  - arranging for the space into which it must fit,
  - accommodating the weight that it may impose on the building structure
  - the power that is required to run it
  - the ventilation and air conditioning that may be necessary to dissipate the heat that it generates.

- In **April 1992**, BAE was awarded the $175.6 million contract top build the entire airport system.. Company officials hammered out a deal in three intense working sessions:
- Denver officials accepted these “requirements” (conditions?)
  - They also committed to unrestricted access for BAE equipment.
  - Owing to the tight deadlines, BAE would have priority in any area where it needed to install the system.
  - According to BAE’s chairman, at creation of the contract.:
    - **Concourse A** – Continental Airlines was under bankruptcy law protection. The City was worried that they would be unable to pay for their concourse. They only accounted for about 40%of the equipment.
    - **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 crude because to keep the costs down, the City has no assurance of a revenue stream at that point in time.
  - The City did not get airlines together to ask them what they wanted or needed to operate.

Project Management

- No major organisational changes were deemed necessary on the DIA project to accommodate the new baggage handling system. Some management adjustments were made on the project
- Design of the UA baggage handling system was frozen on **15 May 1992** when PMT assumed responsibility for the integrated baggage system.
- Direct relationship with BAE was delegated to WA4.

  The area manager for this had no experience in airport construction, baggage systems, or the introduction of new technologies or the introduction of new technologies; but possessed vast experience in construction project control management.
- BAE had to change its working structure to conform to DIA's project management team structure. According to BAE's president:
  - There was a senior manager for each concourse and a manager for the main terminal.
  - The baggage system traversed all of these and BAE had to negotiate with each in the course of normal work.
  - As changes were happening rapidly at each of these sites there was no time to have an information that showed what decisions were going on at each location. This "discreet" management led to pandemonium.
- For the first 2 years of the project the BAE chairman was the project manager.
- Then the project was divided into three general areas of expertise:
  - **mechanical engineering:** mechanical components and their installation.
  - **industrial control:** industrial control design, logic controller planning and motor control panels.
  - **software design:** writing real-time process control software to manage the system.
- The major adjustments were operational
  - At the time that the BAE contract was signed, construction had already begun on the terminal on 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 (remove walls, install new floors etc. etc.)
- In **May 1992**, shortly after the baggage system negotiations began, the head of the DIA project resigned.
- In **October 1992**, Chief Airport Engineer Walter Slinger died. He had been a strong proponent of the baggage system and was a key player in the negotiations.
  - His co-operation had been essential because of the crossover with heavy machinery and track moving/installation and general construction work still needed.
  - His replacement was Gail Edmond. She had worked with him and new all the key players well. Her managerial style however was completely different.

  A UA manager summarised:

  - Slinger was a problem, solver – controversial but never afraid to address a problem He had lots of autonomy and used it. She knew the people but little about

the actual construction and had nowhere near the same autonomy.(Th city council really tied her hands).

- The PMT staff echoed this and pointed out that Edmond also retained her previous responsibilities as Chief of Construction and Acting Director of Aviation. (she was regarded as be an excellent and very capable manager who was completely over-stretched).

Emergent problem areas

System Authority

- BAE felt restricted with the breaking over their agreement on unrestricted access which occurred everywhere. Other contractors' work was impeding BAE progress. (key point in original negotiation).

"Complications"

1. Airlines began requesting changes to the system's design even though the mechanical and software designs were supposed to be frozen.

   ⇒ This meant that six months prior to opening the airport they were still moving equipment around, changing controls and changing software design.

   - In **August 1992** (as an example) UA altered plans for a transfer system for bags changing planes, requesting that BAE eliminate an entire loop of track from Concourse B. (they would operate with one loop rather than two). This saved approximately $20 million, but required a system redesign.
   - Still in **August 1992,** additional ski-claim devices and odd-size baggage elevators added in four of the six sections of the terminal, added $1.6 million to the cost of the system.
   - In **September 1992**, Continental requested that automated baggage sorting systems be added to its west basement at a cost of $4.67 million. The ski claim area length was first changed from 94 feet to 127 feet.
   - In **January 1993**, this ski claim length was shortened to 112 feet!
     - The first change added $295,800
     - The second change subtracted $125,000
   - Also in **January 1993**, maintenance tracks were added to permit the Telecars to be serviced without having to lift them off the main tracks. This cost an additional $912,000.
   - In **January 1994**, UA requested alterations to its odd-size baggage inputs. This cost an additional; $432,000

     (AJMD ideas – note the effects of requirements changes and also he impact of non-software matters on projects. Also look up the current "glib" thinking that changing requirements is a good thing. Of course it is, but evolving requirements have to be kept within reason.

     It is all very well making cost savings, but the wider implications have to be taken into account)

     Use dollars as bullets.)

2. The City of Denver was unable to supply clean electricity to the baggage system.

- The motors and circuitry was extremely sensitive to power surges and fluctuations. Feedback continually tripped circuit breakers and filters to remedy this took months to arrive. (**March 1994**).

3. Denver's city laws required that a certain percentage of jobs be contracted to minority owned companies.
   - BAE's original contract had been denied because they did not meet this requirement and BAE engaged outside contractors to address this requirement. BAE estimate that this increased costs by $6 million (a claim rejected by the Mayor's Office of Contract Compliance).
   - In **September 1993**, BAE's contract negotiations wih the City of Denver over maintenance of the system, occasioned a 2-day strike of 300 millwrights that was joined by ~ 200 electricians. BAE lost the maintenance contract because they intended to pay $12 per hour for jobs that union wanted $20 per hour.

Project Relations

- Much of the effort of implementing the baggage system was directed within one of the four working areas.
- The management team had no experience of baggage handling systems and treated it as being similar to pouring in concrete or fitting air-conditioning ducts.
  - This inexperience meant that they continually underestimated their task, insisting that access and mechanical issues were not the problem.
  - **June 1993:** Cars were running in concourse B all summer. However all of the programming was not done and BAE had full control of all the programming.

Lawsuits

- **February 1993:** Mayor Webb delayed the scheduled **October 1993** opening to December 19, 1993. Later this was put back to **March 9, 1994.** This became the panic drop-dead date.
- **September 1993**: The opening was again delayed until **May 15, 1994.**
- **April 1994** City of Denver invited reporters to observe the first test of the baggage system without notifying BAE. This was a public disaster! Reporters saw piles of disgorged clothes and other personal items lying beneath the Telecar's tracks. *(AJMD I have seen this phenomenon of forcing through a public test when the system is not ready)*
- Most of the problems related to software errors, but mechanical problems also played a part.
  - The software that controlled delivery of empty cars to the terminal building often sent cars back to the waiting pool.
  - The "jam logic" software, designed to shut down a section of track behind a jammed car , shut down the whole loop instead.
  - Optical sensors designed to detect and monitor cars were dirty, and caused the system to believe that a section of track was empty when in fact it held a stopped car.
  - Collisions between cars dumped baggage on the tracks and on the floor.
  - Jammed cars jumped the track and bent the rails.

  - Faulty switches caused Telecars to dump luggage onto the tracks opr against the walls of the tunnels

- **April 1994:** After the test, Mayor Webb deleayed the test yet gain – this time indefinitely.
  - The City set the costs of the delay at $330,000 per month.
- **May 1994:** The German 'Logplan' was commissioned to asses the state of the baggage handling system.
- **July 1994:** Logplan isolated a loop of track that contained every featur of the automated baggage system and intended to run it for an extended period to test the reliability of the Telecars.
  - Jams on the conveyor belts caused he test to be halted.
  - The system did no run long enough to determine if there was a fundamental design fault or to analyse where the problems actually were.
  - Logplan recommended construction of a baggage back-up system, using Rapistam Demmag
- **August 1994:** Announcement of construction of a back-up system.
  - The back-up system cost $10.5 million, but electrical upgrades and major building modifications pushed the project cost up top $50 million.
- The City of Denver and many other airlines hired legal firms to assist with negotiations and future litigation.
- The City also had to communicate with such parties as: the United States federal grand jury; the Securities Exchange Commission (SEC) ; and the General Accounting Office (GAO).
  - The federal grand jury was conducting an investigation into the DIA
  - The SEC was investigating the sale of $3.2 billion in bonds to finance DIA's construction.
  - The GAO was investigating the use of Congressional funds.

Mayor Webb's letter requesting a $12,000-a-day penaly for missing DIA's original **29.10.1993** opening date, plus the costs for building the conventional tug-and-cart back-up system.

Part B Narrative from Harvard case study - part 2 - the solution

Some chronological facts:

- In **September 1989**, U.S. Federal officials authorised $60 million to construct a new highlky technologically advanced airport for Denver, CO, to be called the Denver International Airport (DIA).
- In **April 1992**, BAE systems presented the City of Denver with a proposal to develop "the most complex and automated [and integrated] baggage system ever built.
- **October 29, 1993** was the original scheduled completion date for the project.
- On **August 22, 1994**, Mayor Webb notified BAE that they would have to pay $12,000-per-day penalty for not implementing the baggage system by DIA's original completion date.
- The mayor had also ordered a back-up conventional tug-and-cart baggage system for which he expected BAE to pay $50 million!
- The City of Denver insisted on holding BAE respoonsible for failing to finnish the original system.

- **September 7, 1994,** BAE went public with a $40 million claim against the City of Denver in which they blamed delays on:
- BAE's claimed was counterclaim was that the entire airport was behind schedule and that constant design changes had prevented BAE from installing its system. This included:
  - Lack of site access due to City of Denver actions.
  - Permit delays due to City of Denver actions.
  - The city's alleged inability to meet agreed-upon deadlines to build the space that would house different elements of the baggage handling system.
  - The claim also accused the City of breaking contractual promises to make BAE's system the toip priority by allowing other contractors' jobs to take precedence.
- **February 1995** the airport finally opened
  - 16 months behind schedule
  - Close to $2 billio0n over budget
  - The first flight to land, nearly 3 years after BAE was retained, encountered not one state-of-the-art integrate baggage handling system, but three.

Back to "square one"

- **31st August 1994** – in an effort to avoid the City of Denver had proposed a "stand still" agreement whereby major parties (the City, UA., and BAE) would waive certain previous rights until the new airport was opened and operational. (this merely pout legal issues on the back-burner for a while).

  $\Rightarrow$ The moratorium did however break the deadlock.
- Problems had arisen between City of Denver and UA over the baggage handling system.

- UA objected to the manual system because it wouldn't fit their tight time schedules.
- UA offered to modify the automated system to deliver bags on to the planes and rely on tugs and carts to deliver most of the baggage for arriving passengers.
- UA and City of Denver could not agree on who should pay for the modifications
- They approached BAE who indicated that they would not continue without a signed contract

- Both UA and Continental geared up for protracted negotiations and possible litigation.
  - United Airline's law firm pointed out that they had been hired to negotiste the proposed back-up baggage system at DIA – not to initiate litigation procedures
  - Continental maintained that the last-minute baggage system was a breach of contract for which it could sue the City or choose to cancel its lease of DIA `gates.
  - UA urged the City to bring in mediators. "… because of the deteriorating relationship with BAE"
- Following negotiations: the original contract was broken into two pieces:
  (i) The United Airways contract
  (ii) The remaining piece of the City contract
- Under the new contract:
  1. UA used BAE'ssystem to serve its Concourse B and it took over, and used, at reduced speed two loops of track that served concourse C
     - It isolated its operation from BAE's system that served Concourse A
     - The number of cars was reduced from 3,100 to 2,300 and the spacing between cars extended.
  2. The rest of the baggage system was` designed around conveyor belts and propane-powered tugs and carts. Warning lights were installed in the baggage tunnels to guide the tugs.
- Negotiations also brought a change in the organisation structure. UA immediately hired a construction manger with full decision-making authority and contracted with a consulting company for further assistance.
- BAE hired its own consultant to develop and write test plans and prepare commissioning documents. According to BAE chairman:
  - BAE were now working with people who understood the technology and its needs.
  - BAE signed the contract with United Airlines in **September 1994** and five months later the airport was open.
  - The contract with UA required them to make $35 million worth of changes.
  - They formed a team in which everybody had the same goal.
  - They developed a proper schedule.
  - Any time they hit a problem, they would clear it up almost immediately, rarely in more than 24 hours rather than 2 – 3 months with the City of Denver.
  - ❑ All in all: a good example of what can be achieved by working *with* people, rather than working *against* them.

- **January 1995** Following autumn and winter testing of the system, a full-scale three-hour 10,000-bag practice run of the substitute baggage` system.
- **February 28, 1995** the DIA opened with a real flourish including jet flypasts, current/former Mayors and a large crowd including 1725 journalists.
- The airport opened with:
  - 5 runways
  - 88 gates
  - cost of $5.2 billion
  - $18.80 (average) per passenger airline fee (2nd highest in the US)

The Outcome

- In fact the BAE automated system worked well and the back-up system serving the other airlines did not provide any difficulties.
- The baggage system was almost back to the original planned installation with:
  - United Airlines, who carried most passengers at DIA using an automated system while:
  - Other airlines used a conventional system

1. United Airway's $300 million system comprises:
   - 22 miles of rollercoaster-like track
   - 3,500 cars
   - 55 computers handling up to 30,000 pieces of luggage per day.
   - Controlled more of the airport's rights of way than originally planned
   - (Robert Davis "Denver Still Working Out Kinks as its First Birthday Arrives", USA Today (Feb 28, 1996))
2. A simplified automated system served United Airway's Concourse B
3. Continental used a tug-and-cart system on its Concourse A but was expoected to go automated in the future.
4. Other airlines were operating a very conventional, highly labour intensive system.
5. Airlines on Concourse C would have an automated system, only if BAE installed new track, and United Airlines granted rights for access.

And finally… …

6. Given that the back-up system was designed to be 100% independent of BAE's system, there is now not one integrated baggage handling system, but three baggage handling systems!!!