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When you've endured an epic baggagehandling fiasco, such as the one that struck Denver International Airport in 1994, it's understandable why you would place a strong emphasis on preventing baggage system breakdown. Denver International now has careful plans in place to avoid the type of meltdown that caused the new airport's opening to be delayed for more than a year while engineers worked to get the baggage handling system operational – at an extra cost of US\$560m.

The simple fact is that Denver overstretched itself with complex plans to create the world's largest baggage handling system. The goal was to automate baggage handling for the entire new airport across all three concourses. However, severe technical problems put back the airport's opening for 16 months during which time the combined cost of maintaining the empty airport and paying interest charges on construction loans cost the city of Denver US\$1.1m per day. When the airport finally opened, the greatly simplified baggage handling system was used on one concourse, by a single airline for outbound flights only, while a manual tug and trolley system handled the rest. In August 2005 the system was scrapped altogether.

"We learned many lessons from what happened two decades ago," says David Rhodes, Denver Airport's director of special projects. "Our focus now is on preventing breakdowns. The big difference from 1994 is not necessarily that the modern system is more robust, but that we have greater sophistication in maintenance and prevention."

Rhodes says it's vital to back up the baggage handling computer system and then to back it up again. If a problem does occur, the team discusses what happened.



ABOVE: Denver International Airport, Jeppesen Terminal BELOW: Beumer's CrisBag offers 100% tracking during baggage handling



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"We ask what we did right and what we didn't do very well, and use the answers to modify our procedures," he explains. "It sounds simple, but if we don't do it we'll make the same mistakes again. To improve performance we also provide incentives and invoke penalty clauses for the contractors who deal with baggage maintenance."

Keeping it simple

The experience of dramatic failure has taught Denver to scale back its ambitions. The designs for the 1994 automated baggage system suffered from an excess of hubris. The plans proved too complex for engineers to implement fully.

Denver's modern system doesn't have the same level of complexity. There is a measure of redundancy and there are contingency plans to bypass broken pieces of equipment. When outages occur, they don't involve the entire system, just one small part. The consequences are still serious, though, including delays, bigger queues and crowding. "The symptoms depend on where the outage occurs," Rhodes says. "If it's at the ticket counter or bag check-in, and the belt goes down and bags start to backup, they will have to be physically moved. It becomes a people solution and you will need manpower to move bags down into the system." But he points out that hold-ups may not be visible to passengers. "There's a lot more of the system no one sees, and bags could be piling up at lower levels without passengers even realizing. We mobilize people to divert them to other conveyors. Any such issue involves using a standard procedure as well as a human, spontaneous evaluation."

Plan ahead

An element of improvisation may be necessary on occasions, but there is danger in deviating too far from pre-ordained plans, according to Andrew Price, head of airport operations at IATA. He says that in the event of disruption, it's critical to stick to a clear plan of action so that everyone knows where they are moving the bags and what their roles are. "Lots of people change plan during the disruption and you get communication issues between all the people involved and everything stops working," he says.

The successful implementation of a plan includes training all personnel to follow it through and having contingency plans if something goes wrong. Heathrow Airport learned the importance of this lesson the hard way after the infamous







disaster that befell Terminal 5 when it opened in 2008: 28,000 bags were mishandled and hundreds of flights had to be canceled. An investigation suggested there had been both a lack of staff training and an inadequate number of qualified employees managing problems.

Since such high-profile cases, airports and airlines have become far more aware of the dangers. "Most airports are doing well and if an airport has a big early bag store, such as at Frankfurt, Heathrow and Amsterdam Schiphol, they can put problem bags in there, fix the issues, and then carry them on their way," says Price. "We've seen hiccups recently at Heathrow and Copenhagen, but they have recovered well."

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were mishandled and hundreds of flights were canceled

Failsafe technologies to cope with baggage system breakdowns

The potentially severe consequences of baggage handling system (BHS) breakdowns have persuaded manufacturers to make their technologies as failsafe as possible.

Beumer Group, for example, puts its faith in its tote-based CrisBag system. It claims that this approach offers higher redundancy and more operational flexibility than conventional systems. "A tote system has many alternative routes for fallback scenarios because the layout is like a matrix," says Johan Rajczyk, international sales manager at the Beumer Group Airport Division. "This means a very low capacity loss in a fallback situation. Each CrisBag section has two belts, so if one breaks the totes can still be conveyed using the other one." Rajczyk says the control system also makes the technology failsafe. "We use redundant servers and have strong diagnostic systems that quickly resolve errors." Tobias Nittel, manager at SEW Eurodrive, a provider of intelligent drive and automation technology for baggage sorting, says it has become imperative for his company to build failsafe functionality into its drive technology. He says that after a BHS system breaks down and the motors are switched off, the time for recovery can be slow. Therefore more failsafe functions are required to prevent the system shutting down.

"SEW products, such as its mechatronic drive system, Movigear, and the DRC.. electronic motor, include a safe-torque-off (STO) function, which ensures that no torque-generating energy can continue to act on a motor and prevents unintentional starting. Using the STO function shortens the recovery time considerably and reduces the risk of problems during power-on."

Vincenzo Campanella, marketing manager at Cassioli, says its airport division has developed

an innovative system for security checking hand baggage, but that it always has to be installed in a bespoke manner to make it more failsafe. Fast2Check is an automated checkpoint solution, which uses a tray recovery system with separate management of suspicious baggage and is designed in modular fashion to be easily reconfigured. Campanella says, "We make sure we have a detailed understanding of an airport's layout and needs before we design the system layout."

Alstef has installed BHS's all over the world, including in international and domestic terminals at Istanbul Atatürk Airport in Turkey. "The choice of the technology and the design of the system are key to creating the most failsafe BHS," says sales director Philippe Hamon. "We build as much flexibility and redundancy into the system architecture as possible."

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However, no one is immune from failure. Price believes that there are three major causes of baggage handling system problems: The first is having no data for bags; the second arises if the system breaks down; and the third is when bad weather disrupts flights.

"One example of not having data for the bags was when London Heathrow T5 had a power cut in June 2015," he says. "All the data was lost both operationally and passenger-facing. The impact to the baggage system was that the data was sent, but not received. The system therefore had no messages for the outbound bags, so they had to be reprocessed to match the passenger movements. For a busy airport like Heathrow, it's a huge task."

Baggage tracking

One measure that should help to address the problem is baggage tracking, which IATA has made mandatory for all its member airlines from June 2018. Airlines will have to demonstrate the delivery and acquisition of bags in three locations – aircraft loading, arrivals and transfers. "Existing infrastructure will suffice in most cases," Price says. "But airlines, airports and ground handlers will have to examine their operations for gaps. Most airlines, but not all, are capable of it at this point, and the element we see least of is tracking at arrivals."

Price believes tracking bags is a critical step in planning departing flights. He says, "IATA has shown that airlines with good tracking have far fewer mishandling errors than their competitors who don't have good tracking."

System breakdowns, although more unusual, still have to be catered to. Most systems have redundancy built in and a solid plan is essential ABOVE: Baggage reclaim at Heathrow Terminal 5. T5 is home to Europe's biggest singleterminal baggage handling system



IATA Resolution 753 comes into force in June 2018, requiring members to maintain an accurate inventory of baggage



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in fallback mode. "Airports play a huge role in enabling airlines to understand how the system operates and what it's capable of, and knowing it well enough to anticipate issues," Price says.

Finally, when bad weather arrives, such as the ice storms that hit the USA last year, there are challenges for teams. "They have to get people off flights quickly, clear people off stands and handle diversions. In such a situation you have to be able to store and process bags quickly," he says.

Overcoming hold-ups

Although Price lists three main causes of disruption, the outcomes are similar each time and therefore it's not essential to plan for every eventuality. When things go badly the solution is always to get the bags out of the system to a safe place as quickly as possible. "What happens if things go wrong? Output stops working and the sortation part starts filling up. Full check-in stops. But you can't afford to stop check-in altogether, so airlines have to keep people moving through as fast as they can."

There are strategies that can help to reduce the risks of long hold-ups, he says. Under IATA's Fast Travel Program, for example, passengers can have their bags ready to go by printing and attaching their bag tags themselves. Airlines

The future of the baggage handling market

According to a report issued by global market research firm Lucintel, the future of the global commercial airport baggage handling system market looks promising. The report, *Growth Opportunities in the Global Commercial Airport Baggage Handling System Market 2016-2021: Trends, Forecast, and Market Analysis*, reveals that the market is forecast to grow at a CAGR of 4.0% from 2016 to 2021. There are opportunities for growth in the conveyor system, scanner and sorting device segments.

The major drivers of this growth are the construction of airport terminals and the expansion of existing facilities. Lucintel forecasts that the RFID segment is expected to show above-average growth during 2016-2021; and the conveyor system segment is expected to remain the largest market.

The report predicts that Europe is expected to remain the largest market due to tightening of airport security standards and increasing investment in terminal expansions. The Asia-Pacific region is expected to witness major growth over the forecast period because of growth in passenger traffic, setting up of new airports, and huge demand for airport infrastructural improvement.

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can offer a dedicated touchpoint for baggage acceptance. Similarly, SITA's BagFast application allows on-demand printing of fallback bag tags, which are suitable for reading by a baggage handling system. If fallback tags are needed, the user starts the BagFast application on their workstation and notifies the operatives how many tags are required, for which carrier, and in which loading area. BagFast then prints the required number of fallback tags for the appropriate baggage handling system loading area.

Price also recommends having a 'tiger team' to review processes. "Every two weeks you get together everyone involved in the baggage journey – the airlines, airport, baggage handlers, system managers and security people. The idea is not to point fingers but to go through any big problems. It's designed to avoid failures of communication, such as the one I witnessed recently at a US airport between security and the operations team, when one of the security machines was taken down for maintenance at a peak time with 400 bags on it. It cost around US\$100 a bag to fix. The lesson is to establish a planned maintenance schedule and communicate it to everyone."

What works in Phoenix might not work in, for example, New York, because the layout of the terminals is different



ABOVE: At Frankfurt Airport baggage tracers solve 95% of reported luggage losses within two or three days

Airlines greatly improve baggage handling in 2015

In April 2016, SITA released its latest *Baggage Report*, which showed that in 2015, baggage mishandling rates dropped to their lowest ever. Here are the key facts:

- The rate of mishandled bags was 6.5 bags per 1,000 passengers in 2015, down 10.5% from the previous year, less than half the rate in 2003, and the lowest ever recorded
- This improvement comes despite an 85% rise in passenger numbers since 2003
- However, in total, mishandled bags still cost the industry US\$2.3bn in 2015
- About 40% of airlines and airports now provide self-service bag-tag printing at kiosks and over 75% are expected to do so by 2018
- Almost a third of passengers are expected to be using bag drops – either at a dedicated staffed station or fully self-service – in 2016
- The air transport industry has cut the number of mishandled bags by 50% globally since 2007, for an estimated total cost saving of US\$22bn

Software issues

A major source of breakdown is problems with software, as occurred in May at Sky Harbor International Airport, Phoenix, Arizona, when more than 3,000 bags missed their flights. A TSA computer error meant every piece of luggage had to be searched by hand. "It was a unique situation," says TSA spokesman Nico Melendez. "While contractors worked on it we had to use alternative screening methods to cope, including bringing explosive detection canine teams from other airports and trucking bags from Phoenix to other airports in San Diego and Los Angeles to have them screened there. After we reviewed what went wrong we identified software issues we needed to look at across our 442 airports nationwide to ensure it doesn't happen again."

Despite the software lessons learned from other airports, contingency plans have to be drawn up carefully by individual airports and airlines. "What works in Phoenix might not work in, for example, New York, because the layout of the terminals is different," Melendez says. "Every TSA airport has to work with the airlines to create their own contingency plans."



A TSA computer error at Sky Harbor in May 2016 resulted in all luggage being searched by hand and more than 3,000 bags missing their flights