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ENHANCED OPERATIONAL RESILIENCE OF AIRPORT BAGGAGE HANDLING SYSTEMS

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ABSTRACT

This case study was part of a major redevelopment programme currently ongoing at one of the major UK airports. More specifically, it dealt with the reconfiguration of its baggage handling system, and was driven principally by new regulations and standards for bag screening (so called 'standard 3') as well as sustained steep demand growth. In this paper, we will show how two different parallel streams of discrete event simulation works helped us to support the airport operator to make strategic choices that lead to enhanced operational resilience of the developed system. The first stream of work was based on the customization of an existing Java library for the specific case of airport baggage handling systems, while the second stream adopted the Rockwell Arena simulation software.

1 THE PROBLEM

Most of airport baggage handling happens in the background, as passengers we tend to forget easily about our bags as soon as we have dropped them at check-in. Despite being out of sight and mind, the Baggage Handling System (BHS) is still a major component of successful airport operations. When they are hit by significant operational disruptions or technical faults, such as breakdowns of conveyor belts or X-ray bag scanners, they frequently end up affecting the whole day of operation (BBC 2016) and flights take off without bags. When problems escalate and the airport is an international hub, the numbers of flights and passengers disrupted worldwide reach levels that imply extremely high costs and long lead times (days, weeks) to reconcile "short-shipped bags" (bags missing their flight) with their owners.

Daily BHS operations that are resilient to known disruptions are key to an airport's commercial success and reputation. As soon as any operational issue hits customers, e.g. the BHS stops and check-in concourses quickly fill up with angry passengers worried about missing their flight, the reputation of the airport is at risk. With growing demand for passenger air transport and an always tighter competition, airports cannot simply afford to get their baggage handling that wrong, even for just a day or two per year.

In this case study, we have worked with one of the major airports in the UK on their major programme looking at renovating their BHS. Some of the processes under investigation were still not fully known with certainty at the time we started our study. For instance, many countries are quickly moving towards so-called Standard 3 machines and processes for automated hold bag screening, which are currently not available at most airports. Parallel challenges are posed by the growing numbers of passengers, year on year, with capacities of many systems having to be soon expanded. The latter challenge requires quick and effective solutions to maintain and enhance the levels of operational resilience reached by the current BHS, prior to implementing the new processes.

2 SIMULATION APPROACH AND DISCUSSION

2.1 Approach to Simulation Modelling and Analysis

Two separate levels of simulation modelling and analysis were chosen for the project. In the short to mid term the current BHS needed enhancements for it to cope with steadily growing demand over the next year or two. In the longer term, resilient, Standard 3 compliant, BHS architectures had to be developed. These two timescales and problems required separate simulation approaches (see remainder of Section 2).

2.2 BHS Line Balancing

A BHS at a major airport comprises a number of parallel interlinked conveying lines that route bags from check-in via X-ray to so-called make-up positions (MUPs), where they are arranged in containers (trolleys, ULDs) for transfer to their flight. In the short term, capacity is fixed, and if demand increases rapidly, airports quickly risk running out of resources, particularly MUPs. Enhanced, dynamic, allocations of bags to MUPs based on continuous updates on the dynamic status of the BHS are needed to make the best use of available resources. The best architecture of possible routings must be first understood, before it can be implemented in the BHS control systems (e.g. Programmable Logic Controllers). Dynamic bag routings also improve the speed of recovery of the system when disruptions such as line breakdowns take place.

Using Java, we extended the existing SSJ (Stochastic Simulation in Java) library (L'Ecuyer, Meliani, and Vaucher 2002) into a BHS-general discrete event simulation library (to be discussed in a separate paper) and then implemented out of it an ad-hoc simulation model of the BHS under study. Our Java model enabled us to optimise various parameters related to bag dynamic routing and BHS line balancing, in a relatively short time, ready for implementation of the needed modifications into the system PLC.

2.3 Early Bag Storage Services

Nowadays, more airports offer the possibility for passengers to check-in their bags earlier than usual, e.g. on the evening before the date of departure for morning flights, benefiting both passengers and airports. For a BHS where bag storage facilities are not available, an Early Bag Store (EBS) is the primary solution to enable such a service offer in the mid term. Using Rockwell Arena, we have supported the design and optimisation of the EBS and related processes at the partner airport, studying different solutions where bags are processed by time of departure, by flight, and by segregation (i.e. specific bag grouping, e.g. transfer bags).

3 MAIN RESULTS AND BENEFITS TO THE AIRPORT OPERATOR

On BHS Line Balancing, we developed a simple enhanced PLC logic that enhances the capability to recover from a line breakdown, based on anticipating the recovery effort through different routings when the build-up of bags caused by the fault is still far from reaching the check-in concourse. This alone led to up to 6% improvement on system availability with respect to the current BHS, on extremely disrupted, peak-days of operation (i.e. a gain in system up-time of up to 72 min/day). On EBS Sizing and Logic, we demonstrated the effectiveness of running the operations within the EBS by arranging bags by flight as opposed to by scheduled departure time (solution proposed by EBS vendor). This alternative logic lowered the average bag in-system time by ca. 50%, considerably expediting the delivery of bags to the right MUP.

Senior managers from our partner airport working with us considered the above (and other) results and included a selected package of them into the specifications for the reconfiguration of their BHS control system, to be ready for operation over Summer 2016.

REFERENCES

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