Weight lifter

ABB robot technology lends baggage loaders a helping hand

Staff report

You check in your bag at an airport desk. A conveyor belt whisks it away and the next time you see it you are in another airport, possibly on the other side of the world. Behind the scenes, a super-computer's worth of processing power has been applied to route the bag through a veritable maze of sorting procedures to the correct destination.

A wonder of automation? Well, not quite. In spite of the gee-whiz technology in the rest of the handling system, the actual handling of the baggage is still done by hand. This ties up a lot of staff – staff who could be more usefully engaged – in an arduous, hazardous and repetitive task.

Help is now at hand. ABB's Automated Baggage Loading System significantly reduces the manual labor needed and at the same time increases security, speed and quality at lower cost. The robotized loader was successfully put through its paces recently in a Zurich airport pilot installation.

It takes a lot of trust to hand over a suitcase full of personal items to an airline and be confident of being able to reclaim it from a carousel, maybe on a different continent, thousands of kilometers away. That is why the image of the air transportation industry is so directly related to how reliably and professionally baggage is handled. It is probably surprising to learn, then, that the loading and unloading of baggage into and out of aircraft containers, so called Unit Load Devices (ULDs), is still done manually. The reason for this is that the sheer complexity of the operation has been, until now, a major obstacle to automation.

Careful handling of baggage is just one aspect; equally important is the welfare of the handlers. Loading is a hard and hazardous task, exacerbated by

its repetitive nature. Larger suitcases weigh some 20 kilos and each handler will typically handle at least a ton of luggage every hour. “Compared with the rest of airport operations, the manual part of baggage handling seems like the Stone Age”, says Dr. Günther Nagel, head of ABB Airport Technologies’ department for automated baggage handling.

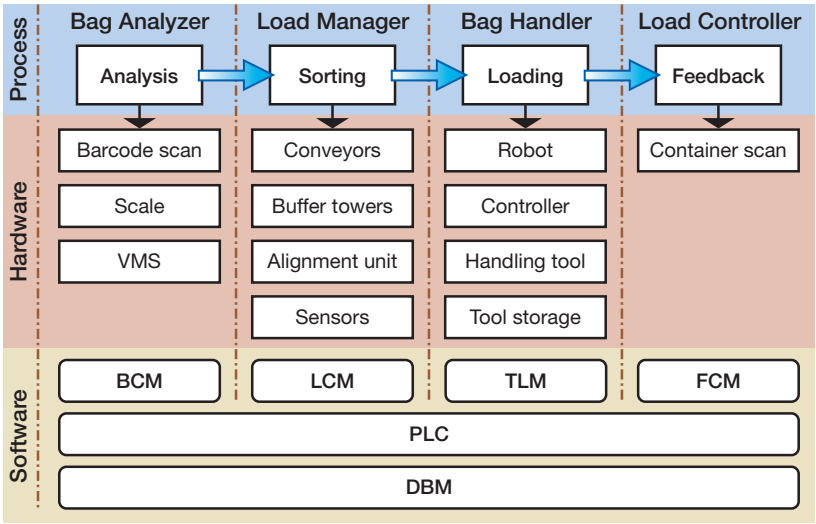
Work-related injuries and long-term impairment are unavoidable consequences of the physical strain of heaving so much baggage. ABB’s automated baggage loading system will significantly reduce the amount of manual labor involved and improve an airport process that desperately needs optimization. And rather than make the worker superfluous, it will boost the quality of the work he performs.

Moreover, the speedy handling that is made possible by the automated loading system helps keep transfer times brief (a major factor for the competitiveness of a modern airport). And, of course, a short waiting time at the baggage carousel greatly contributes to customer satisfaction.

Besides reducing costs and increasing service quality, ABB baggage handling automation also allows a significant increase in an area of special concern today: security.

1 Automated baggage loading involves four key processes: bag analysis, load sequence planning, the actual physical movement of the bags by robot, and verification of the data.

BCM *Baggage Classification Manager*
FCM *Feedback Control Manager*
LCM *Load Control Manager*
TLM *Transfer and Load Manager*



2 Sensors capture the weight, size, destination and flight class of bags as they pass.

Last autumn, ABB Airport Technology, in close cooperation with ABB Corporate Research, installed a pilot automated baggage loading system in Zurich airport. The very successful performance of the installation has shown that the combination of known technologies (IT, instrumentation, robotics, mechatronics) with application know-how has given ABB the lead in this new, fast-growing market. No comparable solution is offered by any other company.

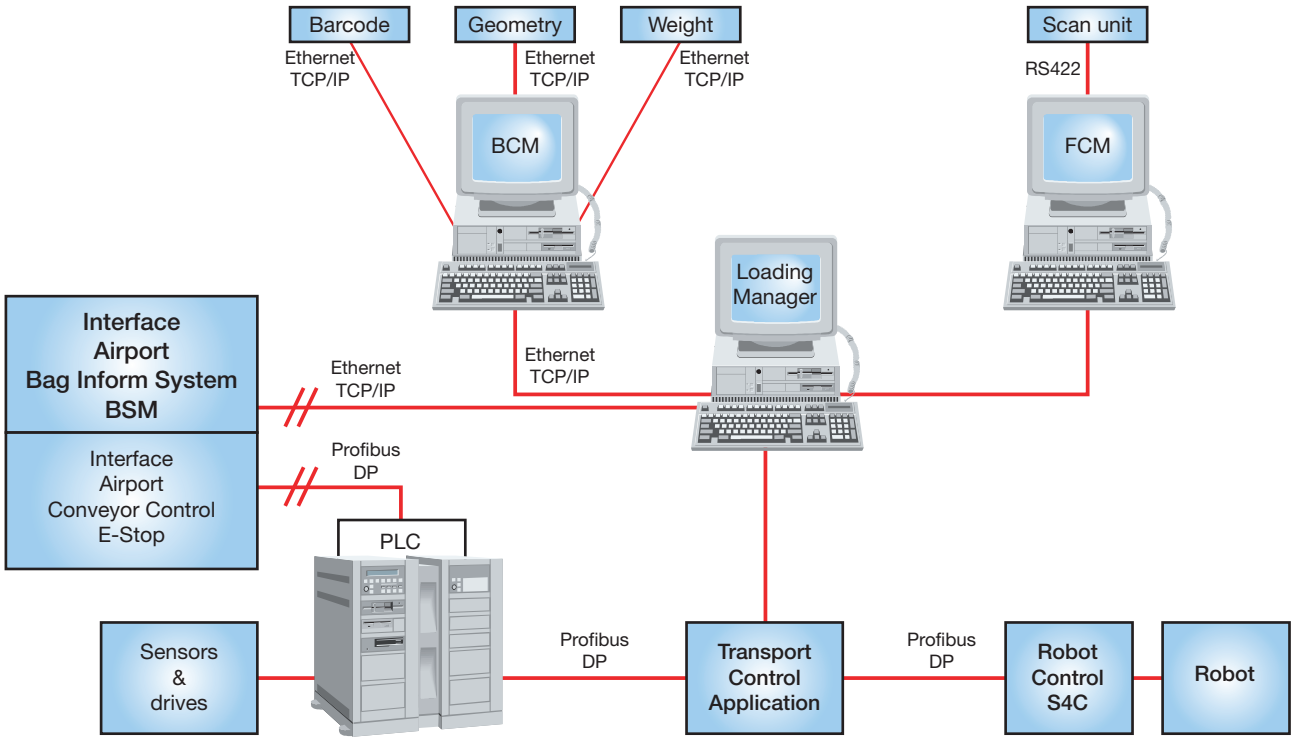
However, the robot itself is only part of the solution. Before the physical handling can take place, two other operations are necessary – bag analysis and loading sequence planning **1**.

Bag analysis

The baggage screening system, where the bag weight, size, destination, flight class and bounding box (the smallest cuboid encasing an object) are determined, represents a major technological innovation. Based on the data obtained from the screening, the robot is able to establish stacking models for optimized load ratios, ie the best usage of space in the ULD.

The bags pass three main sensor units on their way through the analyzer **2**:

3 Analyze, plan and move: The BCM collates bag analysis data and sends it to the LCM, which passes it to the Transport Control Application. This furnishes the robot controller with the data necessary to load the ULD (baggage data plus other data from airport systems). The FCM uses laser scanning technology to verify the accuracy of the result and alerts the LCM should bags unexpectedly shift; the LCM can then adjust the next load action accordingly.



First, a barcode laser scanner reads the tags on the bags to identify and link them to the flight data in the airport departure control system. Then the bags are weighed, on the fly, by a dynamic weighing scale. The weighing can be performed on conveyor belts moving at speeds of up to 2 m/sec. After this, the bag geometry is scanned. All these sensor inputs are used to classify the bag in a scheme which facilitates fully automatic bag handling. The calculation is performed in real time as the bags pass through the analyzer.

This intelligent software module, known as the Baggage Classification Manager (BCM), was specially developed by ABB for this product.

Load control manager

Once the various bag parameters have been established by the BCM, the Load Control Manager (LCM) decides the order in which the bags are to be loaded into the ULD. Not all the bags, however, are loaded in the order in which they arrive; standard bags are quickly and safely arranged in the ULDs, but those having an unusual shape or weight are temporarily stored in adjacent racks until there is a suitable space available.

The operation of the system is strongly linked to the airport baggage handling process; besides using the data from the BCM, the LCM also receives information from the airport flight information system. This can reveal, for example, if the passenger has already checked in and if the bag is eligible to be loaded.

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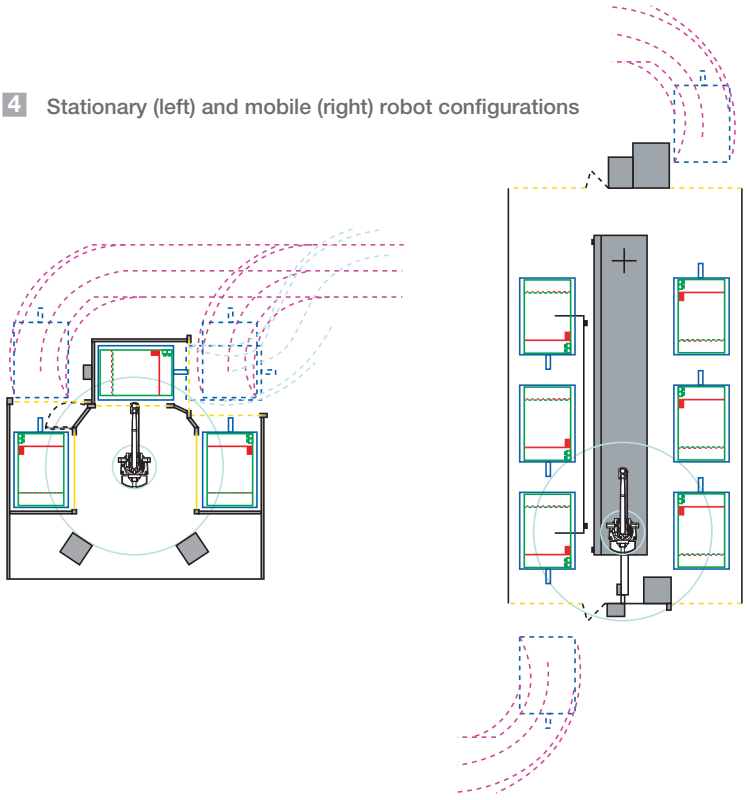
4 Stationary (left) and mobile (right) robot configurations



Furthermore, the Feedback Control Manager keeps track of the currently available space, and its shape, in the ULD and informs the LCM 3. The FCM uses laser scanning technology to verify the accuracy of the information. This makes the overall process more flexible and even more reliable: if the bags should shift unexpectedly, the data is passed to the LCM, which reacts immediately and re-adjusts the next load position, selects another bag or, in a critical situation, forces an operator action.

In addition, a 'loading list' is created which contains the accurate weight of each ULD and details of where each loaded bag can be found. This makes life easy should an item of baggage have to be off-loaded (a plane may not fly with baggage whose owner has not joined the flight). Many flight delays are due to handler crews hunting through aircraft baggage holds for a particular piece of luggage.

Loading the bags

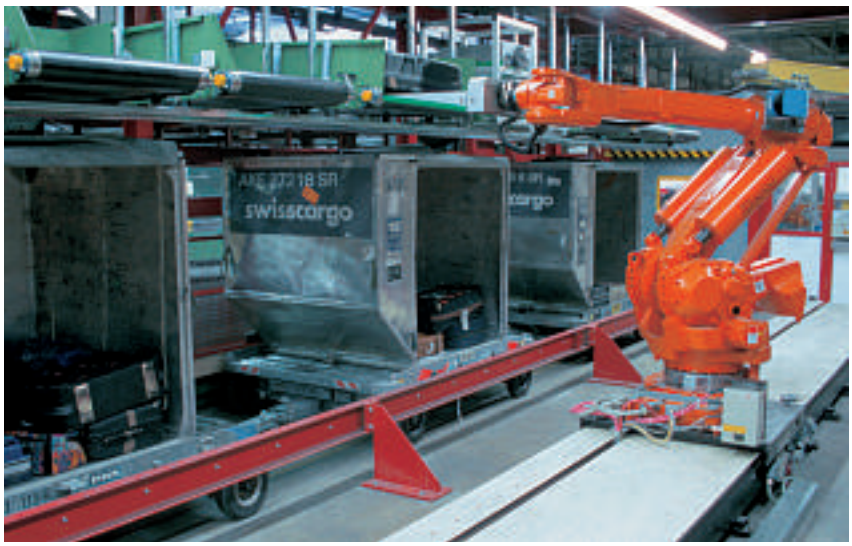
Two basic configurations are available for the robot: stationary and mobile 4. In the former the robot remains in one position, surrounded by a number of ULDs, and is 'fed' bags by two conveyor belts.

In the mobile arrangement the robot travels along a track which has a conveyor baggage feeder at each end 5. Bags are picked and placed in any one of a number of ULDs. The mobile configuration allows more ULDs to be serviced.

The intensity of operations and local topography will determine which configuration is selected for a particular location.

Different tools allow the robot to scoop the bags from the conveyor and transfer them to a shelf of an ULD 6. The tools can be changed on the fly; there is a tool-change station within the cell. Tool selection is determined by the LCM, bearing in mind the bag

5 In the mobile configuration, the robot moves along a track, enabling more ULDs to be serviced.



6 Two basic interchangeable tools are enough to solve most baggage handling problems.

classification and calculated bag position. In this sense, the robot is 'dumb', receiving, as it does, its instructions from the LCM, ie it is not equipped with intelligent vision systems.

On average, a human worker handles 20–30 bags per hour. Depending on the robot cell design, the capacity of the automated baggage loading system can be from 120 to 300 bags per hour. And whereas manual loading is done in three shifts, the robot hardly ever has to stop (availability is projected to be 95%).

But the human element is not completely absent: An operator, who may oversee up to 4 stations, must be available at all times. Should he require to do so, the operator can force the robot to go to the 'Home' position and re-initialize the set-up.

Handling the future

The technological approach taken for this product uses a well thought through combination of known technologies coupled with application know-how, enabling it to be the first and only solution of its kind to date. According to Dr Axel Stepken, Managing Director of ABB Airport Technologies, "The automated baggage handling system is an excellent example of how the diverse expertise within the ABB Group can be used in true synergy: ABB's airport know-how is integrated with ABB robotics and ABB industrial information technology."

As a key element of its *overall* business strategy, ABB has committed itself to a broad program of product development and positioning under the Industrial^{IT} umbrella. This initiative is geared toward increasing standardization of ABB products as the 'building blocks' of larger solutions, while building in functionality that will allow multiple products to interact seamlessly as components of real-time automation and information systems. Far more than a marketing strategy, the Industrial^{IT} umbrella has come to symbolize virtually every business action ABB will take going forward. It is ABB's long-term commitment to this that will distinguish Industrial IT from its imitators. The automated baggage handling system has been designed to fit in with the Industrial IT initiative.

Further, the technology used for bag loading can be easily adapted to a wider range of applications, eg, distribution of goods and commissioning.

The automated baggage loading system is just one product giving ABB the technological lead in this core area of airport business. For example, an unloading solution is under development which uses more simple but equally effective technology (a tilting action moves the bags out of the ramp-cart or ULD onto conveyor belts). The first field test installation is planned for 2002. *(ab)*

Comment ...

Daniel Thévenaz, CEO of Swissport Baggage Sorting AG comments:
"For me, robot-aided loading will prove to be the decisive step in replacing obsolete, unhealthy workplaces with more advanced technology."
Dr. Axel Stepken, Managing Director of ABB Airport Technologies, adds that
"The automated baggage handling system is an excellent example of how the diverse expertise within the ABB Group can be used in true synergy: ABB's airport know-how was integrated with ABB robotics and ABB industrial information technology."