Cardboard production is generally a mature technology. Gains are only made through improvements in logistics, and above all through rapid processing with no malfunctions. One of the most awkward bottlenecks is represented by the interface between the actual production unit and the stacking and transport facilities.

Universal Corrugated bases stacking device on Beckhoff technology

Software PLC takes center stage

Universal Corrugated B.V. are specialists in delivery appliances and systems for sheet goods found in the corrugated board and cardboard markets. Universal, whose headquarters are in Almelo, Netherlands, was founded in 1957, and is a subsidiary of the German company of MINDA Industrieanlagen GmbH. Sales manager Ad Jongmans knows how centrally important his systems are: "If only the tiniest thing goes wrong in our equipment, the whole production line jams." Thanks to a range of innovative developments, and through the use of the TwinCAT software PLC, Universal have achieved a leading position in their sector, with a market share of between 10 and 15 %.

Stacking the individual sheets of cardboard as they are cut from the roll is not, in itself, problematic. The sheets slide up to a stop on a table that is gradually lowered. In the past, the sheets were temporarily held on the conveyor by hand, and the stack was removed, at which point the table returned to its original height. At speeds of up to 400 meters a minute, human intervention is both impossible and undesirable. Universal have developed a special system in which the rear of the first sheet of a new stack that is to be formed is held in place by a vacuum strip. The sheets of the new stack continue to move on at a low velocity, held in place by the vacuum strip moving along with them. This makes it possible to empty the table that is located behind them, and to bring it back into position. In order to prepare for the action of the vacuum strip, a braking stage is installed before the stacker, which causes the sheets to lie over one another like roofing tiles.

Determining the exact moment at which the vacuum strip should begin to act presents the automation engineer with a difficult task. Picking up a sheet too early or too late leads to incorrect job sizes. Because jobs sizes are tending to shrink, changing the product within a few minutes is now more the rule than the exception.

Up to 250 job changes per shift

The stacking system represents an important element within the whole production line, starting at the cardboard machine itself and finishing in the temporary stores. So that the job change and the activity of the vacuum strip are properly synchronized, the first steps are carried out well before the stacker itself. Sensors are attached to the cutting machine and to the subsequent conveyor to follow the process. Software engineer Johan Oude Wesselink: "A signal is passed from the cutting machine to the stacker at every job change. As well as indicating the time at which the rear of the first sheet from the new order passes the vacuum strip, dimension data is also transmitted, so that the stop bar is brought to the correct position at the correct moment." This information is passed on to the equipment that transports the stack away to the intermediate stores. No monitoring cameras are used in the system. The process is followed by electronics alone.

Ad Jongmans likes to compare today's technology with the traditional, manual procedure: "The docket that used to be given to the cutting machine along with a job has been replaced by an electronic "docket" that follows the progress of the job millisecond by millisecond. This electronic production note is entered in preparation for the work, and passed on to the other devices that do further processing at our parent company, MINDA."

Because of the increasing speed and the reducing size of orders, the number of job changes is very large. In the most convenient cases, a job takes several minutes to pass through, but there are also machines that undergo 250 changes within 8 hours. The job change, including the formation of a more slowly running stack with the aid of the vacuum strip, takes a few seconds to occur, so that a fast job change means that a temporary stack is formed and then removed. Error-free communication within the production line is essential for smooth operation.

From relay to software PLC

Until 1986, this system was controlled by relay technology. The various types of hardware PLC then followed. Because of the large quantities of data that must be processed in a very short time, and the ever increasing production speed, Universal changed to the DOS based S2000 from Beckhoff, one of the first software-based PLC systems. They were supported in this project by IAL, Beckhoff's exclusive partner for the Netherlands.

The change to TwinCAT, running under Windows NT, took place five years ago. This control software is particularly suitable for transferring large quantities of data. A Control Panel with a touchscreen has taken the place of the traditional monitor. The display was programmed in Visual Basic by Universal's engineers.

Fieldbus quartet: Profibus, Lightbus, AS-Interface and Ethernet

Data is communicated between the stacker's Industrial PC and the machines in front of and behind it through Ethernet carried by optical fibers. All-plastic fibers are used for shorter links (up to about 30 meters), while "true" fiber optic cable is used over greater distances. The frequency controllers are operated via Profibus network, which can also be used to calibrate the frequency controllers. In this way a new frequency controller installed after a fault is adjusted automatically.

In the meantime, security components have also been integrated into the bus system. Universal used the KL6201 AS-i Master Terminal for this purpose. It implements all the functions of the "classical" AS-i Master in the form of a normal Bus Terminal. This has brought a considerable reduction in the amount of cabling. According to Oude Wesselink, the great advantage of this bus system is the easy programmability. "The AS-i is inadequate for a large number of security systems, but the 32 slaves in the traditional version were more than enough for us."

The control functions are carried out by three Beckhoff C6150 Industrial PCs running TwinCAT. Each has a Profibus connection to the frequency controllers and a Lightbus connection to the Bus Terminals in the control cabinet and to the terminal boxes. The subsidiary AS-i bus is also coupled to the PC controller through these fieldbus stations. The Industrial PCs are connected to one another via Ethernet.

Nearly all the stacker's elements are driven by frequency controlled three-phase motors. A few items are still pneumatically driven; hydraulic actuators are no longer in use.

Commissioning and servicing

From construction through to on-site installation, commissioning and servicing, the series machines built at the Almelo works are managed by a fixed team of mechanics, electricians and software engineers. Most after-sales service is provided remotely, over an (analog) modem connection to the PC-based controllers. The communication uses PC-Anywhere; an Internet connection is planned for the future.

Remote servicing is only provided for the first two years following installation. After this initial phase, the workers on site are sufficiently familiar with the system to avoid or to rectify the most frequent malfunctions. The use of the Bus Terminal system and of self-calibrating frequency controllers means that both the frequency and the duration of down times are very limited.

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Up- and downstacker

In addition to the downstacker – in which the table moves downwards – Universal have also developed a system in which the conveyor belt rises slowly (in step with the material supply): the upstacker. In this case the table remains at the same height. The upstacker allows work to proceed more quickly, because it is easier to remove the stack, and the conveyor belt can return to its original position in the meantime.

It is, furthermore, possible to form small packs, and these can then be assembled into a single large stack on a separate machine. This technique is particularly useful when space is restricted or for products that tend to warp. Alternate packages are turned over before stacking in such cases. Visual checks from time to time are also possible.

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