As a globally leading manufacturer of washing machines and dryers, Miele must prepare itself for changing market situations and strong competition. Therefore, the family-owned company invested approximately DM 95 million into a new assembly center. On seven assembly lines in total, 240 front loader and 60 top loader washing machines as well as 120 dryers can be assembled per hour. “The market always demands other types, versions and forms of laundering equipment”, Dietmar Eusterhus reports. The manager of process automation planned an automation design that is completely based on remote control so that the company can counteract to fast changing requests using flexible production equipment.

PLC, Profibus, and the electronic block terminal
This approach enables to use a programmable controller closely oriented to the actual process progress within the individual production areas and to ensure a cross-machine coordinated operation. In this context, a special feature is the combination of several S7-400 controllers networked via the Profibus with the installation’s peripheral devices based on the electronic bus terminals of Beckhoff. Dietmar Eusterhus: “Our initial reflections to reduce the expenses related to extensive and complex switching cabinets, cable ducts and the installation using the remote approach ought simultaneously to be a reduction of the change-over costs of the line conversion”. For this reason, the Gütersloher equipment developer uses on every assembly or feeding port individual stations equipped with Beckhoff bus terminals as remote I/Os. In these standard terminal boxes, the terminals link the sensors to the higher-level PLC via the Profibus. The advantage during modification: only rewiring is required.
Highly modular block terminal system features space advantages.

Therefore, three requests were the main objectives during the further technical conversion of the automation design. First, it should be possible to flexibly vary the feeding devices of the individual production lines and to be able to operate the lines as if they were autonomously. Fluctuations should be considered at both the production starts and the production interruptions.

The second essential general condition for the automation design was based on the demand that the manufacturing process is supposed to be only minimally affected by the breakdown of an individual station. Finally, the third task requested the conversion of the equipment to another washing machine type to be performed within a weekend.

This automation task was solved in the following way by the developer team made up by 19 members: the developers use two S7-400 programmable controllers as higher-level supervisory stations. These controllers coordinate the individual automation areas and provide for the continuous assembly process. The communication functions in the PLC perform the data exchange between the automation levels.

That is the new installation center.

Adjacent to the modern product distributing center, a new installation center was built for the assembly of washing machines and dryers. On seven assembly lines in total, 240 front loader and 60 top loader washing machines as well as 120 dryers can be assembled per hour. The following key aspects were considered during realization: process-oriented assembly process flows, retrieving principle in the flow of materials, implementation of transparent sequences and avoidance of material buffers. The construction phase up to the commissioning of the first assembly line lasted about three years. A total of 95 million German Marks were invested into a manufacturing area of 20,000 m². The low noise level of only 75 decibels (A) is also to be noted. Each of the seven assembly lines is built up that the cabinet pre and final assembly, the safety test and final inspection, equipment finish and the packaging can occur in one line.

Including driving path, one assembly line requires an area of 1,728 m². Due to this compact setup, short turnaround times within a given time became possible in the assembly. Especially important for Miele as the high-quality leader of the line of business: the process orientation and the remote automation led to a clear reduction of the error rate. A newly developed test method led to absolute process safety. In total, the productivity ramped up by 20% due to the principles used in the new assembly center.
Why take the Beckhoff terminal?

For the field bus connections in control cabinets and industrial equipment, the user can select between the highly modular bus terminals of Beckhoff and the I/O modules of the competition having 8, 16 or 32 I/O points. Take note that the pure I/O prices states little. The entire installation costs ought to be included into the considerations. And here it turns out that a configuration with individual terminals has clearly economical advantages – especially when mixed analog and digital engineering is required.

What is the benefit of using Beckhoff products?

Flexible solution with Beckhoff products: The PLCs of the individual assembly lines access directly these capabilities of the supervisory stations. Every individual automation component of the individual production line is linked to the control station via Profibus, similar to a tree structure. On the one hand, it ensures that the machine and production data of the remote sensors and actuators can be directly exchanged and processed within the shortest response times necessary for the continuous manufacturing process. On the other hand, preset values, speed ranges and diagnostic information of the drives can also be applied to the central unit and coordinated with the machine-related sequencer. A further advantage: the brake-down of an individual station does not affect the entire production sequence of the complete equipment.

In the Miele assembly center, approximately 50 nodes consistently guarantee the continuation of the decentralization. A considerable part of this is made-up by the highly modular 2-channel field bus terminal program of Beckhoff. At every node terminal box, 16 sensors are connected conceivably easily. Dietmar Eusterhus: “We recognized fast that the competitors modules with 4, 8, and 16 I/O points are too inflexible and space wasting compared to the Beckhoff individual terminal.” Only the small partitioning fits the storage requirement of the remote terminal boxes at Miele. However, also a further request is satisfied by the Beckhoff field bus terminal program. “We only wanted one wiring terminal per control loop in the equipment; therefore, only connect the sensor to the field bus terminal and then route the signal directly to the PLC via the Profibus”, the controller expert says.
In the seven installation lines, the bus terminals of Beckhoff integrate vendor-specific system components into a uniform remote automation solution.

...That reduces the costs and fault sources.

The configuration of the bus terminals is also classically plain. With an all-digital use, at Miele, the preset standard terminal must not be configured specifically but it must be lined up as a controller. A further relief is the available baud rate of 1.5 MBd/s, in this way, one could refuse to complex shielding measures while routing the Profibus cable.

The bus terminals of Beckhoff earn special attention through their feature to form a continuous family of systems from different MSR products. In this way, this solution also gains by uniform peripherals, continuous hardware/software interfaces as well as a common program support environment. Complex configurations with different control levels graduated hierarchically and remote architectures like in the Miele example are further to be implemented very fast and economically. In addition, an equipment conception is implemented that can be expanded very plainly or that can be flexibly adapted to changed requirements.

As a fourth essential automation component, the solution is based on communication-capable frequency converters at Miele. The motors of all machines and conveyor systems are equipped with these converters. In the correct sequence, all drive systems communicate with the supervisory controller using the Beckhoff bus terminal via Profibus. In such a way, high operating convenience, integrated electronic motor protection and various setting options up to diagnostic are implemented.

Tailor-made but still standard

The automation design is rounded off by diagnostic routines running periodically and an easy startup at Miele. Alphanumeric operator terminals enable the input of machine data on site via alphanumeric keyboards or programmable function keys. They are used for the plain text display of operations i.e. for visualization of production states, fault messages, production values, schematics and operator guidance.

At Beckhoff, the convincing simplicity and variability of the bus terminals was decisive for the implementation of the open and remote automation design.
The bus terminal, highly modular, rugged and adaptable

In machine and plant engineering, the terminal block has established itself as a standard. The same applies also to the degree of penetration of field bus systems, e.g. Profibus DP/FMS, Interbus, CAN bus or the Beckhoff Lightbus. For users in machine and plant engineering this is the technology pointing into the future in order to be able to smoothly communicate to the peripherals remotely working on site. What seems likely to join proved with new.

The Beckhoff bus terminal – the integrating system of electronic engineering and terminal block – unites the advantages of the mechanical controller and of the field bus systems. The bus coupler is the heading of this electronic terminal block and simultaneously the gateway. It interfaces to the Beckhoff Lightbus, Profibus DP/FMS, Interbus, CANopen, DeviceNet or ControlNet.

A gateway with RS485 or RS232C interface are available for applications that can do without a field bus system.

Using the 50 different field bus terminals of Beckhoff, all usual sensors and actuators with different signal types can directly be connected without further interfacing technology. In addition to the two-channel digital input and output terminals there are analog variants for powers and voltages at standardized signal levels and variants for PT100 and thermocouples. Using a terminal with serial interface and RS232C or 20 mA current loop electrical specifications, intelligent equipment can be connected and parametrized. Also, angle and position measurement variants are available. Having a width of 12 mm, all electronic terminal blocks correspond to twice the width of a mechanical linked terminal with a grid size of 6 mm. With the outside dimension of 68 mm times 100 mm, the external contour perfectly adapts to the dimensions of terminal boxes from a technical point of view.

In the different industry areas of the automation technology, the Beckhoff bus terminal has proven to be successfully effective: automotive industry, food industry, manufacturing, mechanical engineering, instrumentation, handling systems, environmental technology.

Using Beckhoff terminal blocks, planning, designing, wiring, startup and maintenance of equipment and machines is economically.

To reduce the expenditure during the line conversion, the equipment developers use individual stations with bus terminals as remote inputs/outputs at every assembly or feed port.