

## **Modernisation of laboratory automation during ongoing operation**

**User-oriented modernisation of automation systems by a system integrator boosts the effectiveness and reliability of the industrial laboratory and cuts the costs of service and maintenance. Here is an application example from the cement industry.**

Control and automation technology improves the quality and effectiveness of industrial laboratories. However, laboratory automation systems can become a handicap for operational processes if, to some extent, components have become outdated after a prolonged period of operation and adjustment to modern device technology is no longer possible. Such systems are difficult to maintain and become increasingly susceptible to faults. System modernisation that automates customary operating processes anew on the basis of standard technology enables considerable performance increases here. At the same time, the know-how of an experienced automation system integrator like ECKELMANN AG, Wiesbaden, ensures the maximum possible protection of existing investments and also trouble-free replacement of an old system during ongoing operation.

### *The quality laboratory of Dyckerhoff Zement AG at the Ämoneburg location*

For years now, Dyckerhoff Zement AG has run a laboratory automation system for quality analysis in parallel with cement production at its plant in Wiesbaden Amöneburg. Its core is a fully automatic robot laboratory in which samples delivered by pneumatic post are prepared and analysed on diverse analysis devices. A series of semi-automatic testing and analysis operations on devices distributed over several rooms of the laboratory belongs to the robot laboratory.

The robot laboratory's most important functions are:

- 1) Automatic preparation of samples
- 2) Fully automatic transport of samples to and from the analysis devices and to magazines with the aid of an industrial laboratory and diverse conveyor belts
- 3) Fully automatic analyses involving processing of several samples in parallel
- 4) Sample evaluation in accordance with prescribed rules with delivery of results to an LIMS (*Laboratory Information Management System*) for long-term archiving

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### *Restrictions in operation due to outdated automation technology*

The system control existing before modernisation, which was about ten years old, was based on an HP1000 computer that was in need of both hardware and software renewal. After such a prolonged period of operation, the system was no longer in line with the times and was increasingly developing towards becoming an obstacle to modernisation and optimisation. In particular, the following circumstances were turning out to be drawbacks:

- Expansion and modernisation of the equipment pool were only possible with unreasonably great effort.
- Lacking availability of spare parts and increasingly complex maintenance and service effort
- To some extent, the system documentation was outdated and no longer corresponded to the actual state of the system.
- Outdated operator prompting

In total, this resulted in a higher failure rate and increased maintenance costs for the system operator. In particular when the system was operating continuously, with tight night-shift staffing, this state of affairs had a detrimental influence on the laboratory system's profitability in the long term.

In this situation, Dyckerhoff AG decided in favour of partial modernisation of the laboratory. Essential system components, for example the pneumatic post system, sample preparation devices and the majority of the analysis devices, were to be kept. By contrast, the entire automation technology, including the cabling of the industrial robots and individual analysis devices were to be renewed.

The essential requirements of this project are summarised here:

- Modern computer technology and automation hardware
- Modern software with the Windows user interface

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- Modular software that is easy to expand
- Informative messaging and logging system
- Networked workstations with access from the offices
- Integration of a new industrial robot
- Integration of new analysis devices
- Free parameter definability of the system

*High demands on the automation partner*

From the operator's point of view, the focus was on two fundamental requirements in the planning and order placement of the modernisation project described:

- 1) As far as possible, the modernised system was to emulate the customary and proven business processes identically, using modern methods and solutions.
- 2) To ensure minimum down times, the entire conversion process was to take place in parallel with operation.

Ultimately, Dyckerhoff AG entrusted the project to the Wiesbaden-based ECKELMANN company. During the course of realisation, ECKELMANN was able to contribute its entire experience as a system integrator of industrial automation concepts. This means that the developers very precisely checked which of the existing components conformed to the current performance standards and could be kept and which of the components had to be replaced to boost performance. For the new solution, recourse to industrial hardware and software standards ensures optimum expandability and, at the same time, no-problem interfacing to all IT systems installed at the customer's, in particular also interfacing to higher-level systems such as production planning and quality data administration.



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New overall solution on the basis of industrial standards

The new system is designed as a network with one server PC and three operator control PCs for the linked semi-automatic laboratory stations.

In a particularly space-saving arrangement, the new server computer system is accommodated in a 19" control cabinet. It is equipped with industrially proven standard components: an IPC with an Intel Pentium III processor and a level 5 Raid controller, an integrated uninterruptible power supply and an interface module with twelve serial interfaces. The external hardware consists of a 17" monitor, a keyboard and a mouse and also an ISDN modem. A PLC for sequential control of the robot laboratory is also used as the subordinate control system.

The laboratory workstations consist of standard office PCs. Thanks to the network architecture, new stations can be added to the three clients in the existing laboratory room at any time.

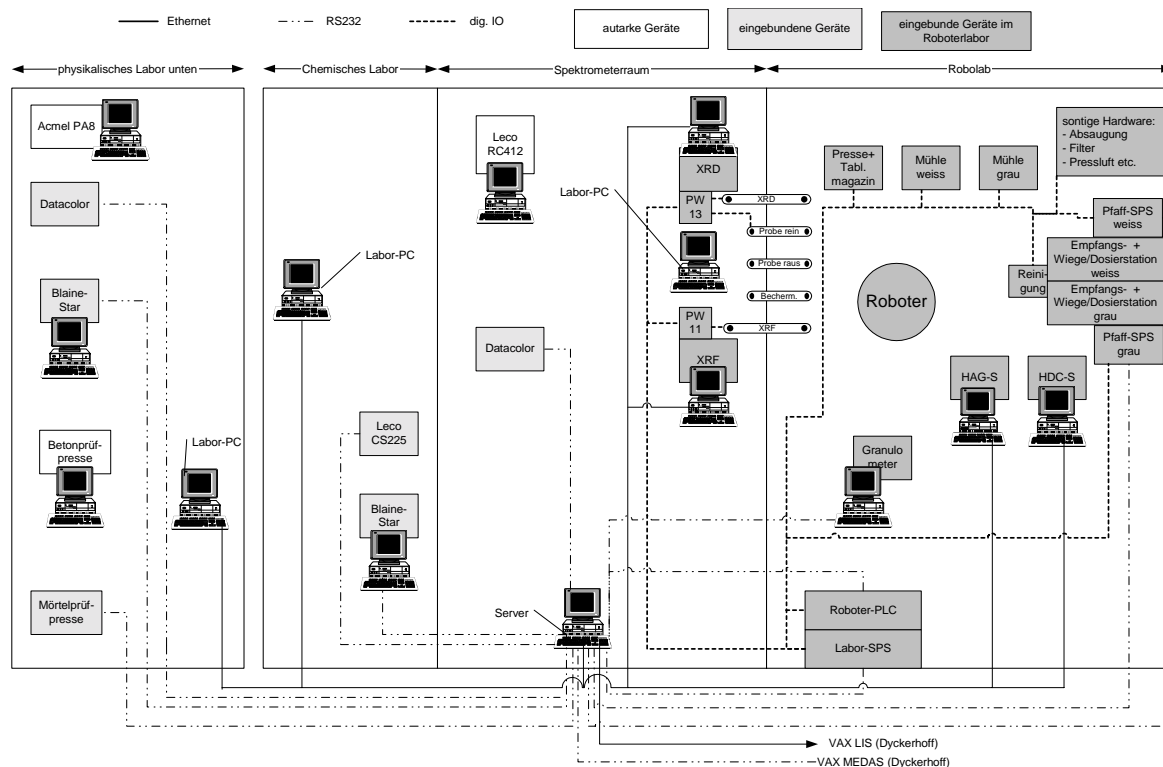


Fig. 1: Structure of the new system



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The multi-user and multitasking-enabled 32-bit WINDOWS NT operating system with graphical user interface was chosen as the operating system. The newly created laboratory system database consists of a multi-user and multiple station-enabled high-performance database based on ORACLE 8.0. The database is installed centrally on the server PC. All other PCs gain access to it via the Ethernet network, thus dispensing with local data retention on the workstations. PCAnywhere/32 is used as the software for remote maintenance and operation via ISDN.

### *All in one: the new laboratory computer*

The laboratory server computer is the core of the new laboratory automation system. All tasks of sample transport, sample preparation and analysis and administration of all relevant sample data can be handled via the user-friendly graphic user interface. The scope of functions can be subdivided into the following main features:

- Automatic and manual sample registration
- Fully automatic sequential control of all transport, preparation and analysis devices in the robot laboratory
- Priority management in relation to parallel processing of differing samples
- Acquisition of all fully and semi-automatically gathered analysis data via serial interfaces or Ethernet
- Definition of sample-specific test processes, and easy definition of their parameters, by the operator
- Control of the automatic pneumatic post system
- Plausibility check of all analysis data
- Transfer of analysis data to the on-site laboratory information system
- Automatic calculation of current setpoints for production control
- Visualisation, logging and archiving of all sample data and (error) messages
- Configuration of report pages
- Robot laboratory process visualisation

The results of the fully automatic and semi-automatic and manual analyses were integrated for all sample data visualisation, logging and archiving and the transfer of sample data and messages. Therefore, a complete and homogeneous system for the administration of all relevant quality data is at the operator's disposal.



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Parameter definition and error messages: user-oriented programming

During the course of the design of the application software and, in particular, of the database, maximum value was placed on enabling, for the user, simple and process-oriented parameter definition of sample-specific testing sequences, i.e. selection of specific analysis devices, program selection for the applicable devices and input of the transport sequence from and to a device.

At the same time, these parameter definition functions enable maximum effectiveness and also flexibility of the entire laboratory installation. Following the modernisation process, future additions of new devices and test operations can be programmed at any time, while retaining the now existing automation architecture.

The same applies to dynamic system visualisation encompassing the current operating state of the transport, preparation and analysis devices and the status of all samples to be currently processed.

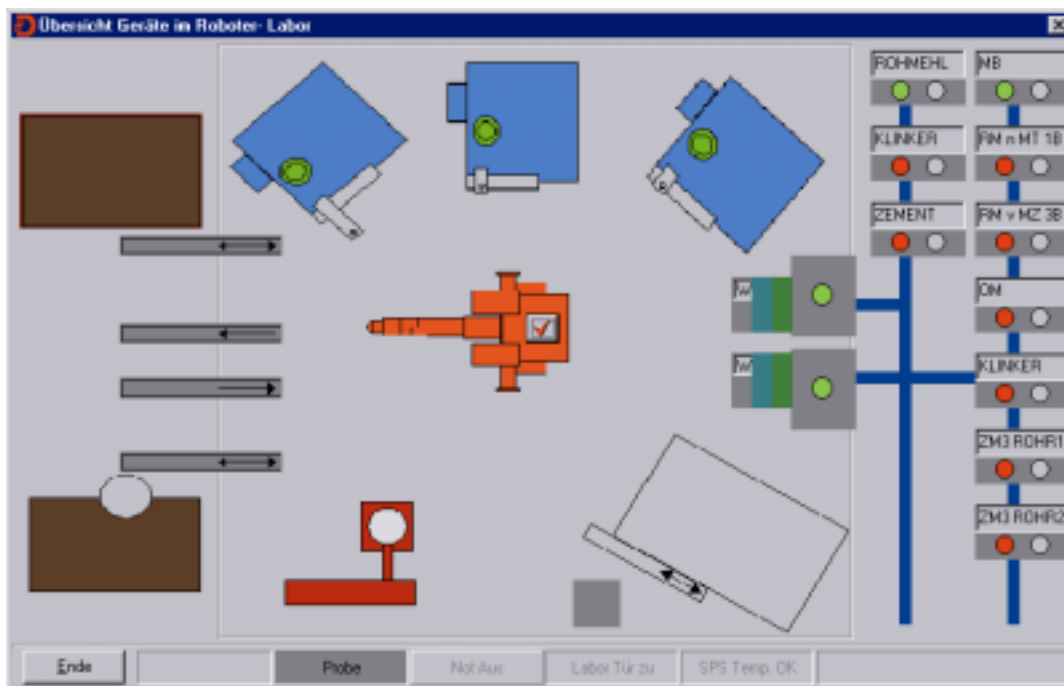


Fig. 2: Clearly arranged system visualisation with the ECKELMANN user interface

Operating reliability is optimally supported by the message system featuring complex programming. Operating, alarm, error or warning messages are visualised clearly on the central server and on all workstations, and are written into the long-term archive. In the event of a system malfunction, this message data serves to ensure fast and targeted troubleshooting.



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### Smooth changeover

Following years of practical experience in the automation of industrial installations and especially in laboratory automation, ECKELMANN possess wide-ranging experience in the successive commissioning of modernised subsystems. All modernisation solutions are conceived so as to enable parallel operation of old and new components. At the same time, the new components can undergo extensive pre-testing. This strategy minimises down times and reduces possible sources of errors in the changeover to the new system.

Thus, it was also possible to successfully and completely commission the modernised laboratory automation system at Dyckerhoff recently. The quality of the overall solution is probably documented best by the fact that Dyckerhoff AG has now decided to modernise a second plant in Göllheim. In this new application, not only the laboratory automation system will be realised in a complete system from ECKELMANN, but also the entire pneumatic post control and processing engineering closed-loop control functions.



Fig. 3: Robot in the cement laboratory