Control system with integrated package unit controls

Basics and an example from process engineering

Package unit controls - state of the art

In almost all production facilities, not only the actual process engineering components have to be operated, but also additional machines and units that represent a kind of infrastructure of the production facility that is essential to operation. Typical examples from chemicals and pharmaceuticals production are exhaust air purification systems, driers, centrifuges and weighing and dosing stations.

These machines are supplied by specialised machine manufacturers as so-called package units (PUs) complete with integrated controls. The controls mostly consist of PLC-based solutions with operation and visualisation on diverse hardware and software platforms. In most cases, the package units run separately, i.e. without control system interfacing to higher-level master control systems. Depending on system size and complexity, an overall system that is highly heterogeneous may come into being due to the operation of numerous PUs.

Drawbacks of the currently usual solutions

For the operator, above all the diversity of the various operator control and display philosophies is a burden that causes increased familiarisation effort. Ultimately, inhomogeneous operator control processes and alarm systems may even represent a safety risk and may have a detrimental influence on system availability.

The separate PUs also cause difficulties in terms of logging production steps in accordance with the requirements for modern quality records. Complete batch logs containing all relevant process steps, i.e. also the messages of the PU controllers, have to be gathered together from separate datasets in a tiresome process. This detrimentally impacts the quality and effectiveness of quality records. Troubleshooting that takes recourse to message and alarm memories may also be made difficult. A comparison, for example of trend diagrams based on different time axes, will only produce very unsatisfactory results.

However, even more fundamental drawbacks become apparent at the latest during the course of planning, implementation and maintenance of the master control system: the master control system supplier could counteract the absence of global standardised visualisation, data logging and alarming by serially interfacing the package units. However, this complex and also cost-intensive process would still not provide a standardised engineering tool for overall automation of the system. This means, though, that users are faced with the task of individually linking new or modified components with every change in the system configuration. In the worst case, a change in the PU controllers is not even possible at all due to their lack of transparency.

Even if the hardware of package units has been adapted to the respective production plant with considerable effort, from the control engineering point of view they remain foreign bodies with a substantial inconvenience potential.

Solution thanks to complete integration of PU controllers in the master control system

All aforementioned problems in relation to handling of PUs can be circumvented if their controllers are realised as integral components of the master control system. In the case of this solution approach, it is no longer a question of adapting different PU control systems to the master control system and of linking them by means of individual programmed interfaces. Instead, the design and the engineering tools are conceived so that even the complete PU controller can be realised.

This dispenses with all the aforementioned problems in relation to the data interfaces and unified engineering. The master control system offers a global operator control and visualisation system that also covers all PUs. It stores and administers all data relevant to the quality records and encompasses a central message and alarm system. All engineering tools of the master control system are also available at the level of the PUs. Thus, ready-made and proven automation objects such as single control elements or data acquisition objects can also be used for the PU controller. The system therefore not only becomes more homogeneous, but also more reliable and convenient, right down to the PU level.

It goes without saying that such an expansion of the master system's functions places elevated demands on its performance capability. As, on average, the PUs' machine controllers place higher demands on cycle times than typical process engineering applications, the master control system's realtime capability must be above-average.
However, the strategy of integrating the PU controller in the master control system also places particular demands on the responsible automation partner. The automation partner needs not only to possess experience in master control system technology, but also has to bring along a detailed knowledge of machine controllers on different platforms. This is a typical task for a system integrator who has an overview of the hardware and software market and universally applicable programming tools.

Application example: pharmaceutical production at Boehringer Ingelheim Pharma GmbH & Co. KG

A possible implementation of this strategy for the automation of integrated PU controllers will be elucidated here with reference to the example of an application from pharmaceuticals production at Boehringer Ingelheim. Among other things, the package units that were to be integrated consisted of centrifuges (slip finger centrifuges), filter driers and an air conditioning system of the production facility.

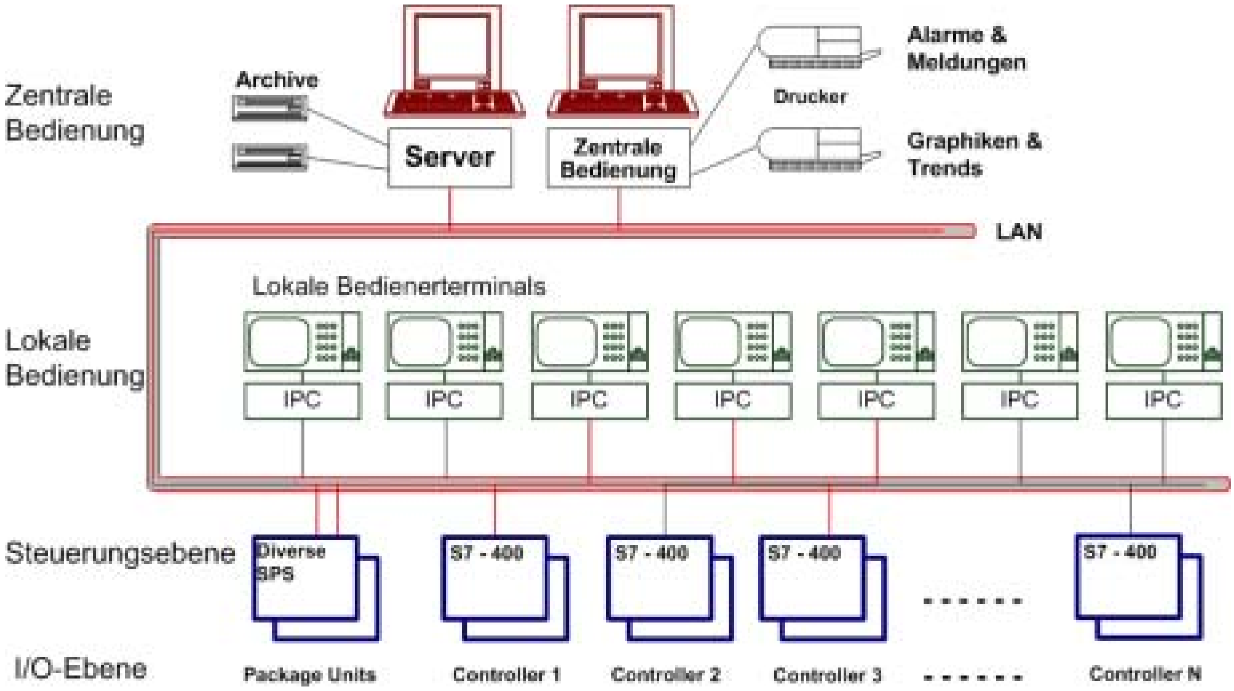

Fig. Structure of the master control system

The system integrator's master control system is based on the use of industrial PCs and standard PLCs: Several Siemens SIMATIC S7 type controllers are used at the level of the process-oriented components (POCs). At the operator control level, IPCs are used as on-site or office operator workstation computers and also as servers.

Units in the Challenger series of the manufacturer GeCMA are used as on-site operator control terminals in the explosion-hazard area. A LAN (Industrial Ethernet and TCP/IP) links the master control system and the POC level, to which the PUs also belong.

The software is based on Windows NT and the MS SQL server as the database. The standard master control system software PROLEIT Plant i.T., which is distinguished by considerable openness and consistency, is the basis for development of the application. Disclosed internal interfaces based on the standard MS Windows interfaces (OLE, OCX) allow the system integrator to modify and extend Plant i.T. with great degrees of freedom.

Therefore, as far as this is concerned, the complete master control system was designed with standard components. The STATECASE programming tool developed by ECKELMANN AG, Wiesbaden, is used so as to enable programming of the PU controllers on the basis of this standard configuration.

STATECASE – the development tools for compact and clear sequential control

The STATECASE programming environment was developed for graphical presentation especially of control sequences. With the state graph SFT (Sequential Function Table), it offers its own form of presenting state automata, thus enabling particularly compact and clear planning, implementation and online visualisation of sequence-oriented events. Complete description with SFT considerably boosts the intelligibility of controller programs.

An SFT is in precisely one state at one given time. There are no parallel sequences within one SFT. Accordingly, typical control systems are composed of a large number of mostly hierarchically arranged SFTs. A condition is executed once only for each SFT, even if it triggers state transitions in several states. Several SFTs can by synchronised via their step enabling conditions. To enable clear recognition of cross-relationships between SFTs, the SFT editor administers a project in which all associated SFTs are placed. The cross-references are presented graphically.

The individual sequences of a task often exhibit common features that are independent of the application. This results in fixed phases (e.g. INITIALISATION, NORMAL OPERATION, SHUTDOWN OPERATION, STOP, EMERGENCY_STOP) and conditions that have to be taken into account in every partial sequence (e.g. INITIALISING, STARTING, STOPPING, EMERGENCY_STOP). These common features can be specified in an SFT root, from which the SFTs needed for a task are derived later.

The validated integrated code generators convert an SFT directly into program code for the target system. Therefore, the result is that there are no differences between planning and implementation. Code generators are available for C, C++, Borland Delphi, Java, SCL and STL (the latter are Siemens programming languages for the S7-SPS).

STATECASE offers particularly effective diagnostic support comparable to that of a flight recorder's trace function. It logs every state change of every SFT in accordance with categories configured by the developer as NORMAL, REQUIRING REPORTING, ERROR, etc. For analysis purposes, users can search for relevant information in the trace, supported by parameter-definable filters.]

The easily intelligible presentation of control sequences facilitates project planning and the operation of systems because the master control system project planner and instrumentation and control personnel on the one hand, and process technicians and system operators on the other hand speak a common language.]

Example: centrifuge control

The system operator Boehringer Ingelheim formulated the special requirements for the master control system to be delivered in a procurement specification. These

requirements also encompasses the functionality of the PU controllers that was to be realised. Exact clarification of the scope of delivery and service and of overall responsibility took place in close cooperation with the PU manufacturer.
The performance capability of STATECASE in the programming of some functions for a slip finger centrifuge for automated solid/liquid separation is elucidated briefly here:

- A special formulation-based mode of operation was programmed for the slip finger centrifuge in accordance with the operator's specifications.
- In conformity with the centrifuge manufacturer's safety notes, a special realtime-enabled interlock was programmed for the operating mode in which the filter bag used is slipped out in a precisely defined mode of operation.
- The operator placed quite special demands on inertisation of the centrifuge. This function was also created in STATECASE.

STATECASE, with which the sequences created were also loaded into the control, was used exclusively to program the sequential control.

All master control system functions were also programmed with the same programming tool, STATECASE. In total, therefore, it was possible to create a homogeneous system whose control functions and the associated operator control and visualisation components for all automation levels are based on the same engineering tool. One engineering tool and one engineering station suffice for planning, implementation and continuous modification of the overall system including all PUs.

Batch logging, which now encompasses all system components, is covered by the Plant i.T solutions. System diagnosis is supported conveniently and reliably, in particular by the trace function implemented in STATECASE.

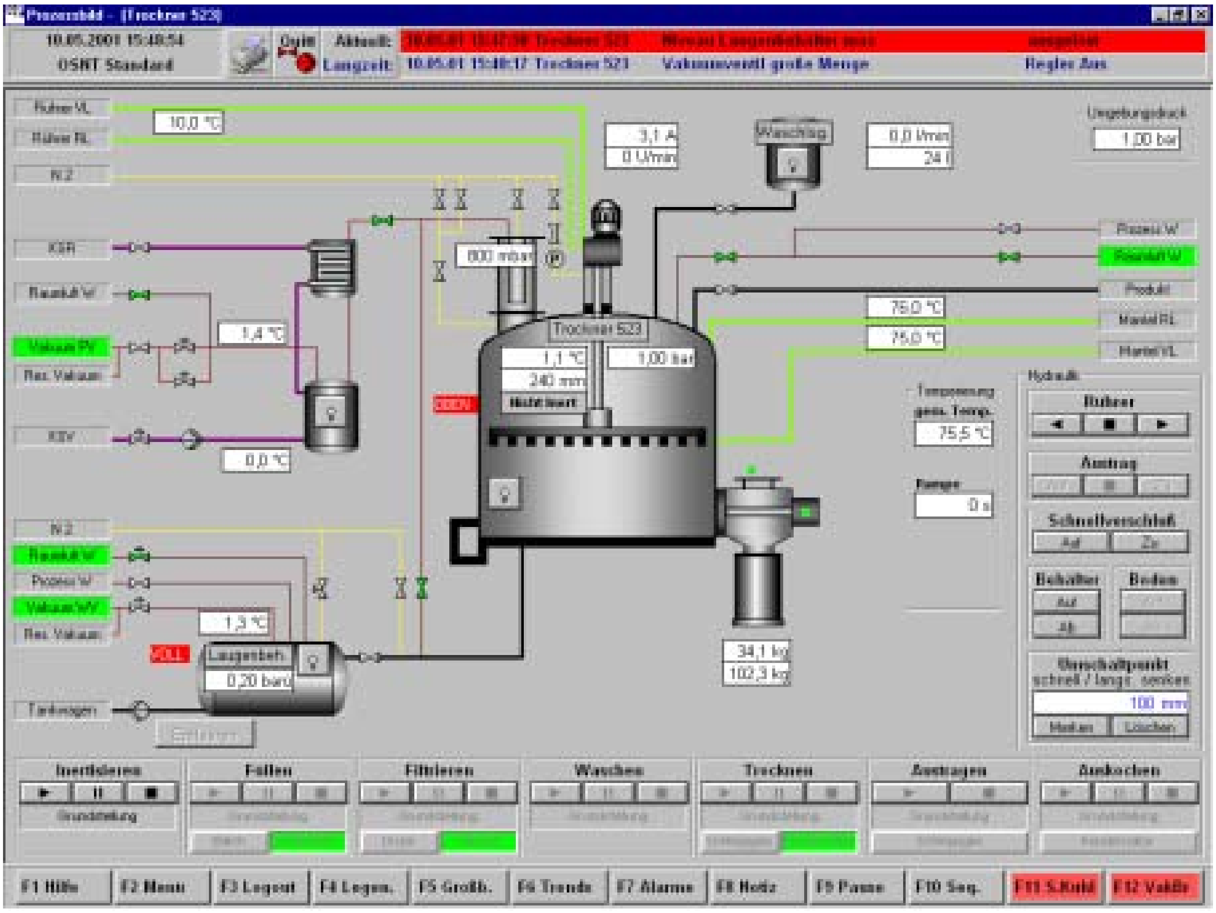

Fig.: Graphical system visualisation – Torckner.bmp]

Outlook

The PU integration strategy is sure to increasingly gain in importance. Thanks to fundamental developments in automation technology, the following aspects speak in favour of this:

1. First of all, the trend towards an increasingly higher degree of automation is calling for increasingly in-depth integration of all participating components. The standard control of the PU will be increasingly seldom capable of achieving this.
2. The demands on quality records are expected to rise even more. The required complete process logging remains ineffective without complete integration of the PUs.
3. In view of the costs of service and maintenance, the demand for easy modifiability of systems and rising demands on system availability, to an increasing extent users

will favour automation solutions that optimally support system maintenance through intelligibility and homogeneity.

In future, it will only be possible to fulfil all these requirements with qualified master control systems and on the basis of powerful universal programming tools. In this connection, it is certainly conceivable that, in future, also larger-scale, complex and ready-made programs will be integrated directly in a master control system to implement tasks from the areas of fuzzy control, neural networks and system simulation.

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