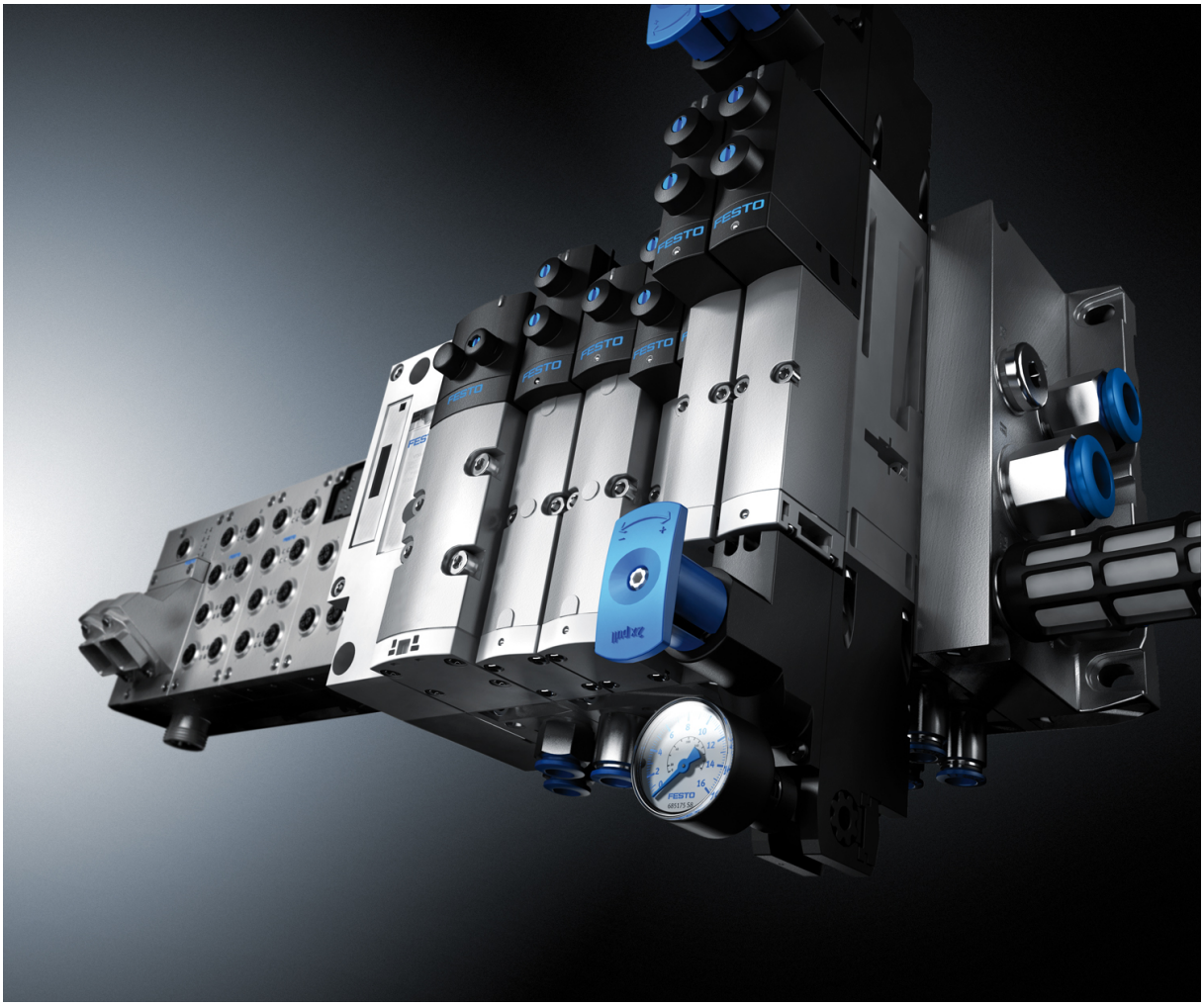
White paper

Plants based on the Lego principle

Modular automation with valve terminals



Smaller batches and different types of product in the same plant – these are the market demands to which more and more manufacturers in the process industries need to adjust. The answer is plants based on the “Lego principle”. Users can add modules or switch them off in line with requirements. But this is only possible with modular automation.

State of the art: centralized automation

At present, the design and engineering of process plants is precisely tailored to the respective task, whether for the production of a specific product in x units per time unit or for the throughput of a specific substance in x quantity per time unit. The mechanical design of the plant as a whole is geared towards meeting specifications and guaranteeing the required performance data over the projected life cycle of the plant. The corresponding automation is carried out using management systems comprising process-specific (control) components, operating and monitoring stations as well as engineering stations. The entire process is centrally controlled by a single management system.

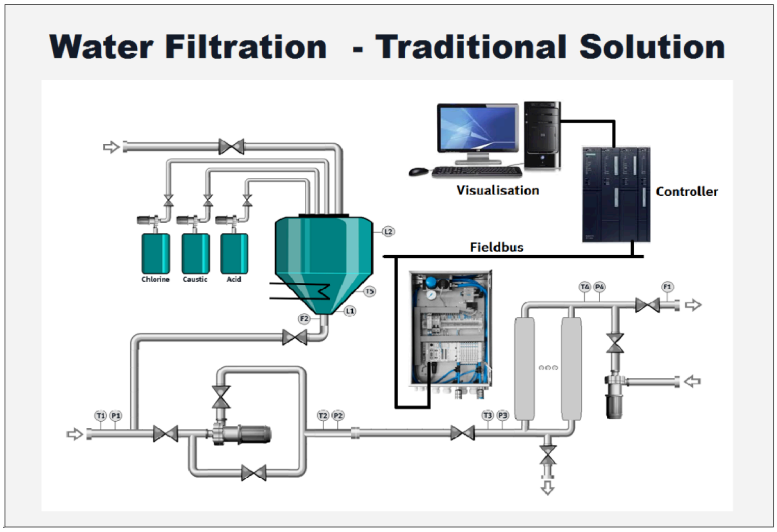


Figure 1 - Traditional process plant design (water filtration plant)

Changes/optimizations to the process sequence require detailed knowledge of all the application software, even for subprocesses. Any increase in production capacity the plant operator might want can be impossible or at best costly to achieve, and frequently results in the construction of a new plant. Reducing production capacity can also be problematic, since this can affect product quality and undoubtedly the profitability of the plant. Maintaining and servicing plants of this type poses its own challenges for the operators,
e.g. having to shut down a continuous process every year.

Changing market requirements require modular plants and automation concepts

The markets are increasingly demanding short product development times and at the same time customised products, particularly in the biotech/pharma, fine chemicals, food and beverage and water treatment industry segments. This results in a fundamental shift in the design and engineering requirements for process plants. The necessary flexibility is achieved through consistent modularisation, i.e. dividing a complete plant into functional units. These production modules are combined to produce specific process plants which can be extended almost indefinitely by adding modules, thus enabling immediate adaptation to market and production requirements. Capacity is increased by numbering up instead of scaling up. The option to temporarily sideline production modules from the current production process means that the modular concept also has positive effects on the operation and servicing of process plants.

A case study: modular automation of water filtration plants

Figure 1 (see above) shows the traditional design for a water filtration plant with valves, pumps, tanks, filter modules, sensors and pipes. The required components for actuating the field devices are installed in a control cabinet and a valve terminal as a remote I/O system with integrated pneumatic section is connected to a central controller with visualisation (management system) via a fieldbus.

Plants of this type can be easily modularised by breaking down the process into subprocesses and defining a module for each subprocess with all the mechanical and automation components required for standalone operation.

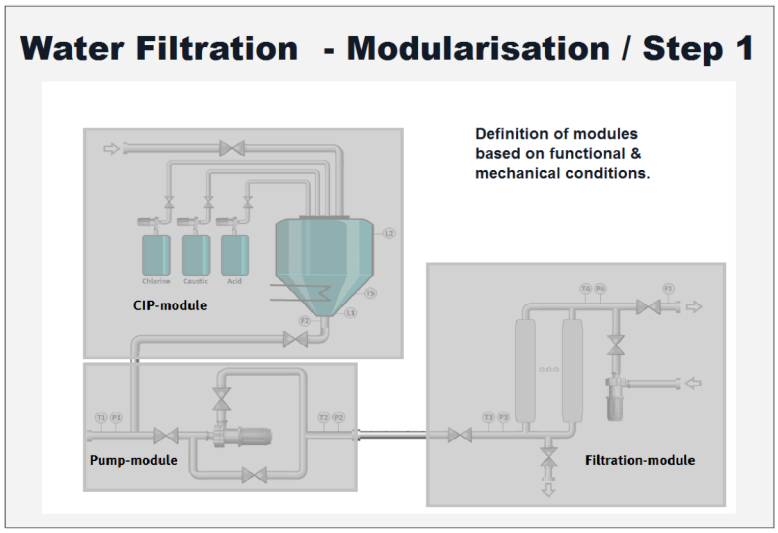


Figure 2 - modularization of the mechanical and functional tasks of a water filtration plant

The automation components are also modularized: the control cabinet components and the "central intelligence" (the application software for the process) are divided up so that the modules each have their own controllers, remote I/O components and pneumatic actuators.

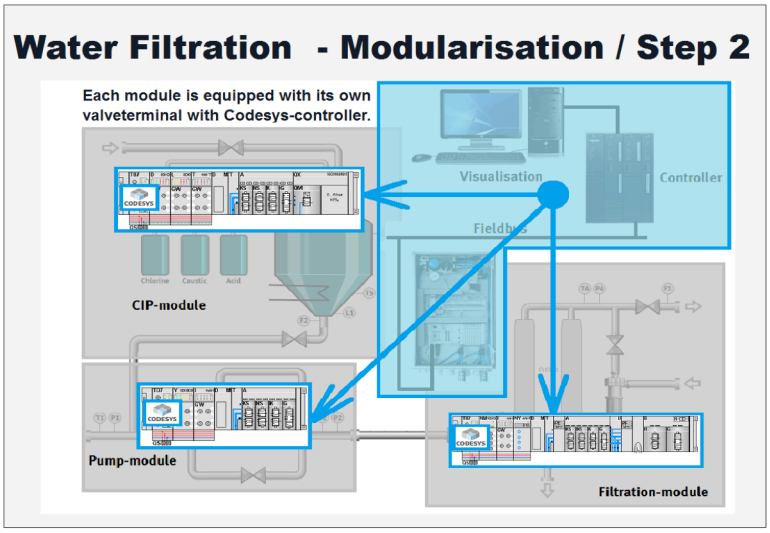


Figure 3 - modularization of the automation tasks of a water filtration plant

Each module provides its specific functionality discretely at a data interface, i.e. after the modules are interconnected to form a process plant, characteristics like operating mode, status, process measurements, alerts, etc. can be read/written in order to realise the functionality of the plant as a whole. A process management system is required to coordinate the module functionalities in the complete system, i.e. to manage the process. Unlike traditional management systems, this system has a greatly reduced range of functions since the process-specific control functions are realised in the standalone modules.

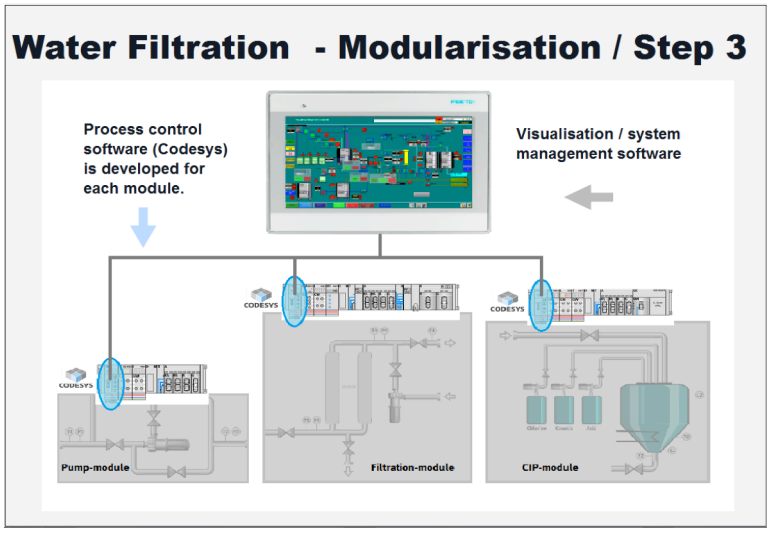


Figure 4 - modularized water filtration plant

Modules of this type enable customized plants of any configuration to be assembled by adding modules of identical construction and function: numbering up instead of scaling up.

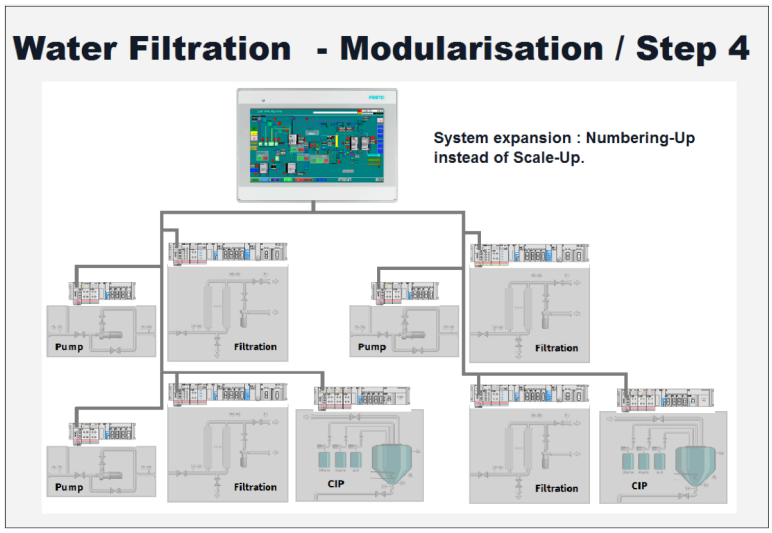


Figure 5 - system expansion by numbering up

Valve terminals are ideal components for automating modular plants, since they provide the necessary functions in a compact design:

- ✓ **Controller for the application software for a module (IEC 61131-3/CODESYS)**
- ✓ **Remote I/O for connecting binary signals and analogue measured variables**
- ✓ **Pneumatic section for activating actuators**

And lastly a valve terminal with the appropriate protection class can be installed directly in the field (in the plant framework) without the need for a control cabinet:

- ✓ **IP65/IP67**

No disadvantages, only advantages!

The modularization solution shown above has been consistently implemented for water filtration plants and can be applied similarly for processes and plants in other industry segments.

It is not just plant operators who benefit from the flexibility offered by modular automation in adapting plant sizes to different production requirements, plant manufacturers also benefit from the modular concept:

- Modules are precisely defined units with clear functionality.
- Modules are equipped with their specific application software, which reduces the respective software complexity.
- Modules are easy to change/extend in terms of their (clear) functionality.
- Modules can be manufactured in small series and fully tested prior to delivery.
- Customized complete systems are assembled from different modules of identical construction (numbering up).
- Modules are programmed using CODESYS (as per IEC 61131-3, no license costs), i.e. independence when selecting the automation hardware.

In the context of “Internet of Things” and based on the NAMUR recommendation “NE 148”, modular automation will effect a fundamental shift in the design and engineering of process plants. Modularization will not be possible to the same extent for all industry segments or every process; however, the technical design process for each plant should include a review and assessment of whether modular concepts can be applied so both the plant operator and plant manufacturer can benefit from the associated advantages.

Contact:
Craig Correia
Head of Process Automation
Festo Corporation

Ph: 631-404-3407
Cell: 508-380-4673
Email: craig.correia@festo.com
www.festo.us/industrialwater
www.festo.us/processproducts

Author:
Norbert Franz
Application Engineer

Festo AG & Co. KG
Rechbergstr. 19
73770 Denkendorf, Germany
Tel.: +49 711 347 53825
E-mail: nrfz@de.festo.com

