MORE THAN JUST A FACE LIFT

Tailored measured value processing for the FOMO4524 research engine at the Flensburg University of Applied Sciences

A research engine places demanding requirements on the measured value acquisition and evaluation involved. The processing of measuring signals has to be highly transparent, well documented and easy to adapt due to the relatively frequent changes of operator as well as the frequent modifications to the engine and associated systems compared to industrial and power plant engines.

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Model Based Design

SCADA webMI

An analysis of the measuring technology on the FOMO4524 medium-speed 700 kW research engine at the Flensburg University of Applied Sciences uncovered several weakpoints that had developed over the years. Besides hardware faults, both the programmable controller (PLC) and the evaluation software contained settings and results that were no longer plausible. A repair seemed just as costly as a completely new installation. The decision was therefore taken to implement – at slightly more cost than a repair – a completely new measured value processing system for the slow signals of the engine and its supply systems.

Requirements and solutions

The objective of the new installation was not just restricted to rectifying faults. Several factors had to be taken into account in order to improve the future work at the test stand:

It also had to be ensured that students and employees with a knowledge of engines but without any experience in PLCs could operate and modify the plant, whilst still making it possible to carry out advanced mathematical tasks such as numerical derivations or the filtering of signals. Through the increased automation of the evaluation functions, savings had to be made in personnel costs and particularly fuel costs, which are around 1000 euros per test day. The software used also had to make it easy to present algorithms transparently, provide informative comments for them, as well as document any changes. Besides the clearly designed operation and presentation of results, it also had to have a uniform design and contemporary user interface. Finally, calculation parameters and results values had to be managed easily and saved with backup functions. ▶▶

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With over 4,000 students the Flensburg University of Applied Sciences has become one of the most successful German universities for technology and economics. The Flensburg University of Applied Sciences in North Germany has several modern unique features. These include, for example, the biotechnology and process technology, energy technology, particularly regenerative energy, as well as maritime courses, especially with regard to the training of technical and nautical ship's officers.

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▶▶ PLC programming via MATLAB®/Simulink®

When the university assessed the products available on the market, they particularly took the simplicity and transparency of the PLC programming and maintenance into consideration as well as the purchase cost. Bachmann electronic was chosen since the programming of the M1 automation system could largely be carried out using the MATLAB®/Simulink® software which was available at the university. Students created a tailored measured value system from different hardware and software components, which could stand up in comparison with any solution created professionally. Commands and formulas were combined into graphical blocks in MATLAB®/Simulink® and then uploaded onto the PLC unit. Besides the basic functions of measured value processing, such as the calculation of a heat flow rate from temperature, mass flow rate and

specific heat capacity, new functions such as signal filtering using parameterizable low pass filters or the automatic determination of the stationary operating state using the time derivation of status signals could be implemented.

Improved result quality

Since the skills required for this type of PLC programming could be learned quickly, several additional functions were defined which served to improve the quality of the results. In the simpler version, the specific heat capacity values still used as constant parameters could thus also be included in future with a minimum of effort as temperature-dependent variables. The graphical user interface also enabled more complex functions to be displayed without any knowledge of an extensive syntax.

Tailored graphical user interfaces

The measured data is visualized via the ›M1 webMI pro‹ software, which is installed directly on the PLC. This enables any device with a web browser and a network or Internet connection to the PLC to be used as an HMI (Human Machine Interface). The software supports the clear display of the operating data over several monitors and also enables the measured data of different locations to be viewed simultaneously via an Internet connection. This last feature is particularly important for the FOMO4524 run in Flensburg since the Flensburg Maritime Center collaborates with partners in Southern Germany, Austria and Switzerland. The measured data visualization is output in scalable vector graphics (SVG) format, allowing the loss-free changing of the display scale.

Uniform and individually tailored

The visualizations are designed and configured in ›atvise® builder‹. This offers several ready-to-use displays which can be configured
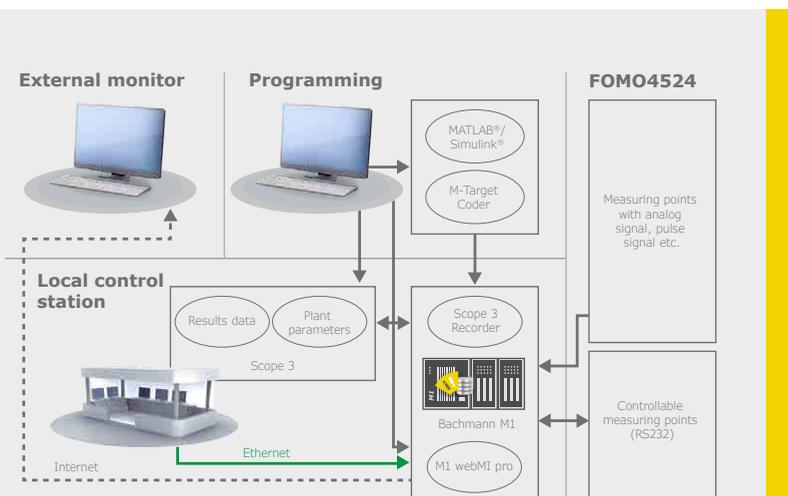
▲ Interaction of hardware and software components of the new measured value processing system

▲ Visualization of the measured values for the exhaust system

easily to suit particular requirements. Displays and interface animations can also be created easily by the users themselves. The object-oriented program structure enables parameters of the same type to be shown in different displays. In this way, changes on a reference display unit can be transferred to all connected devices. This ensures the uniform appearance of the HMI that is tailored to the requirements at hand.

When the HMI was created, the new functions included tabs for the structured ordering of different display areas, as well as links to jump labels for changing between different displays and bar graphs for mean value deviations. Superimposed graph curves, autoscaling functions, as well as color changes for out of range values were also positively received by the project team and gave rise to a visually attractive design for greater functionality.

The clear programming structure even enables major adaptions to be made by relatively inexperienced users after a short introduction. The expansion of the fuel system planned for 2015 will therefore also be possible with very little effort with regard to the after-care of the measured value processing.

Documentation of measured values
Both the raw data measured at the engine as well as the different values calculated are documented using the ›Scope 3.0‹ software. This includes the saving of the data on the PLC as well as the creation of archives in CSV format on the PC. The visualization now enables the choice between real-time data and saved archive data, and the display of measured values as configurable plots. Time step widths can be set in groups of measured values independently of the visualization and the documentation. In this way result parameters for different signals can be stored so that any superfluous data collections are avoided. The possibility to set the data storage function to individual requirements enables different storage strategies to be used for the saving of test data for stationary and mobile operation within one recording. In the forthcominig months, the most suitable method for processing the archive data will be examined as part of another student-based project. This will make it possible to provide a clear and attractive design for test reports with a minimum of effort in terms of personnel.

» **The simplicity and transparency in the M1 automation system made a big impression on us.** «

Prof. Dr.-Ing. Michael Thiemke, Marine engineering, FH Flensburg

Conclusion
The introduction of the new hardware and software completely fulfilled the hopes of the university for a cost-effective way to considerably improve the processing of measured values. The idea of letting the students take care of the PLC and visualization largely on their own also proved to be successful. The Flensburg University of Applied Sciences is therefore planning in the next two years to modernize further engine test stands in the same way.