



Endress+Hauser standardizes PCB engineering and production processes for industrial measurement products across distributed locations

Endress+Hauser 
People for Process Automation

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Paul Burger,
Group Leader PCB Design
Research + Development,
Endress+Hauser.

Endress+Hauser standardizes PCB engineering and production processes for industrial measurement products across distributed locations

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering. With PCB data and process management solutions from Zuken, the company has standardized development and manufacturing processes across five geographically-distributed operations, enabling company-wide parts standardization, design-reuse and increased engineering productivity.

Whenever flow rates, filling levels, pressures or temperatures need measuring or liquids analyzed in industrial environments, it is likely you will see products, solutions and services from Endress+Hauser. Founded in 1953 in Maulburg, Germany, Endress+Hauser has evolved into a world leader in industrial measurement technology.

In 2015 the Endress+Hauser Group – which comprises five main operations in Germany and Switzerland housing 12,952 employees – generated revenues of 2.1bn Euro worldwide. The company prides itself on the strength of its partnership with global customers.

Endress+Hauser Maulburg is one of the Group's 5 competence centers.

- Endress+Hauser Maulburg - filling level and pressure measurement
- Endress+Hauser Flowtec - flow metering
- Endress+Hauser Conducta - liquid analysis
- Endress+Hauser Wetzer - temperature measurement
- Endress+Hauser Process Solutions - digital communication and integration, plant asset management and automation solutions.



Results

- PCB engineering toolsets standardized across five operations
- Creation of a single, central CAD library incorporating unified parameters for all operations
- Unification of material master data for all operations
- Synchronization of component information in Zuken DS-2

Endress+Hauser

People for Process Automation

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering, with a network of 100 companies in 44 countries. The company provides process solutions for flow, level, pressure, analytics, temperature, recording and digital communications for a wide variety of industries, including chemical, petrochemical, food and beverage, oil and gas, water and wastewater, power and energy, and life sciences.

CR-8000™

CR-8000 is a comprehensive PCB design suite that enables the development of a product from concept to manufacturing.

Engineering PLM DS-2™

DS-2 is a data management environment that manages and consolidates CAD component libraries, material information, schematic and PCB layout data, and parts lists in a controlled release and revision process.

“We have become much more transparent in everything we do, and we get access to all required data much faster – yet, our data is protected much better than before.”

Paul Burger, Endress+Hauser

Each of the Endress+Hauser operations maintains its own product development organization. Products are generally developed and produced in-house, and provided both as finished products and as components to a worldwide network of subsidiaries and associated product centers in Brazil, China, France, India, Italy, Japan, and the U.S. for assembly and delivery to local customers.

Around 10 years ago the company standardized the engineering toolsets used across all operations, which provided the basis for important synergies through standardizing components, reusing designs, and developing modular products.

Specializing in filling level and pressure measurement technology, Endress+Hauser Maulburg provides central R&D and support for all five operations. Here, Paul Burger, Group Leader PCB R&D and Andreas Währer, CAE Administrator, support the PCB engineering activities. In Maulburg alone they support around 300 employees in research and engineering.

They are dedicated to standardizing engineering methodologies across all Endress+Hauser operations, creating synergy potential and continuous improvement processes across the whole Group.

Standardization of PCB CAD toolsets

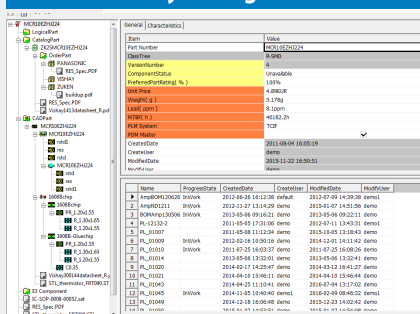
“Around 2003, three of our product centers were looking to replace their PCB design tools,” says Burger. “Our Board of Directors decided that the investment should include standardization across all engineering divisions. After a comprehensive evaluation the decision was taken to deploy Zuken’s CR-5000 environment, which was already used at Maulburg.”

Right from the beginning, the perspective went beyond mere standardization of CAD software to achieving R&D benefits across divisions: “We were aware that a unified CAD environment alone would have provided only limited leverage for synergy effects. After all, the CAD software would only have allowed us to open and view the designs of our fellow operations. Since each operation was using a component database of its own, it was impossible to reuse existing designs across operations,” concluded Burger.

DS-2

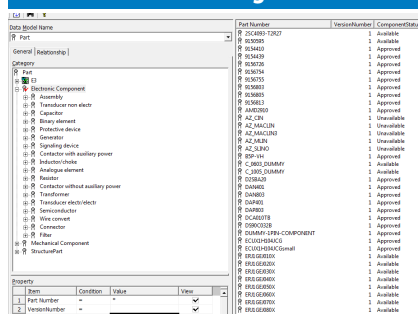
Library Management

- Symbol
- Footprint
- Pin Information
- Related Documents



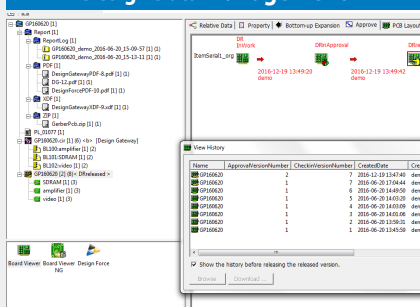
Material Management

- Specification
- Standard/Preferred Flag
- EOL Information
- Cost Information
- Alternative Information
- Datasheet
- Related Documents



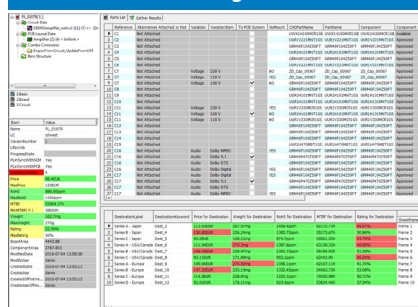
Design Data Management

- Search/View
- Comparison
- Reused History
- Version/Review
- Status
- Template



BOM Management

- Multiple Views
- Live Scoreboard
- Component Selection
- Filtering
- Related Documents
- Alternative Parts



Unified database across all operations

The conclusion was that a unified system only made sense if all operations had access to a unified database with unified component descriptions, material classifications and a centralized repository for design data.

It was an obvious first step to reach out and talk to companies with experience in a similar project. They concluded that they needed to build a dedicated database for electrical engineering with common guidelines and standards – and that they wanted to deploy standard technology as much as possible, with minimum customization. This led them to add Zuken's DS-2 to the shortlist, says Burger.



Each of the Endress+Hauser operations has in-house R&D and manufacturing facilities with high production values.

Common component library

After consolidating the toolsets, the next step was to create a common CAD component library that used identical guidelines and IPC standards for all locations. It also incorporated a comprehensive thesaurus of parameters reflecting the machinery characteristics of the different production facilities that had been built up over many years.

It is useful to take a look at the complex design requirements that Endress+Hauser products need to comply with to illustrate the complexity involved in building a common library:

“Our main requirement is explosion prevention,” says Burger. “Our products are frequently used in hazardous environments,

so comprehensive measures need to be taken so they do not cause ignition – even in malfunctions.”

The challenge is aggravated by substantial space restrictions imposed by the typical cylindrical shape of measurement instruments, which require the complete circuit to be implemented on semi-flexible boards that are folded in three dimensions to fit into the enclosure.

“For this reason we need to combine areas with large components and spacing parameters – e.g. for power supplies – with areas with high packaging densities and miniaturized components. And this is a big challenge,” says Burger.

The challenge is provided by the combination of fine and large pitch structures that require finely balanced parameters for PCB etching, SMD paste print, and reflow welding procedures; which can only be controlled with a great deal of know-how that must be reflected in the parameters. In addition, all footprints must accommodate approved second source components.

Today, the Endress+Hauser Group component library comprises around 5,000 component descriptions.

Synchronizing CAD library and material master data

While the creation of a common component library represented a sizeable effort, the hurdle to establishing a unified material classification for all Endress+Hauser operations proved to be even greater.

Although SAP is deployed in all operations, the data structures of the material master data were proprietary for every installation, so not suitable for exchange between locations. However, considering the requirements of operational safety and highly demanding production cycle rates for Endress+Hauser's products, a digital material master data management and approval process is vital to ensure that only approved and certified components are used.

The order of magnitude is best illustrated using data from the Maulburg operation:

“In the past, we had to manually collect the data for every single task. Today the user pulls up a menu and selects the required documents to initiate automatic generation.”

Paul Burger, Endress+Hauser

Some of the filling level and pressure measurement products are available in up to 3 billion variants. These are created by combining and assembling enclosures, sensors, electronics, adapters, flanges and related documentation, with lead times ranging between 24 hours and 5 work days. Overall, the products turned out by the Maulburg production facility annually require more than 3 million PCBs, containing 260 million electronic components, which are produced, assembled and tested in-house.

To keep up this highly demanding production and delivery rhythm at any given time, it is vital that only certified and approved components are used and that a sufficient number of second source alternatives are available.

Although a material management process had been in place in each operation before the standardization project was initiated, a substantial two-year effort was required to set up and roll out the unified material master data classification scheme into the different SAP installations.

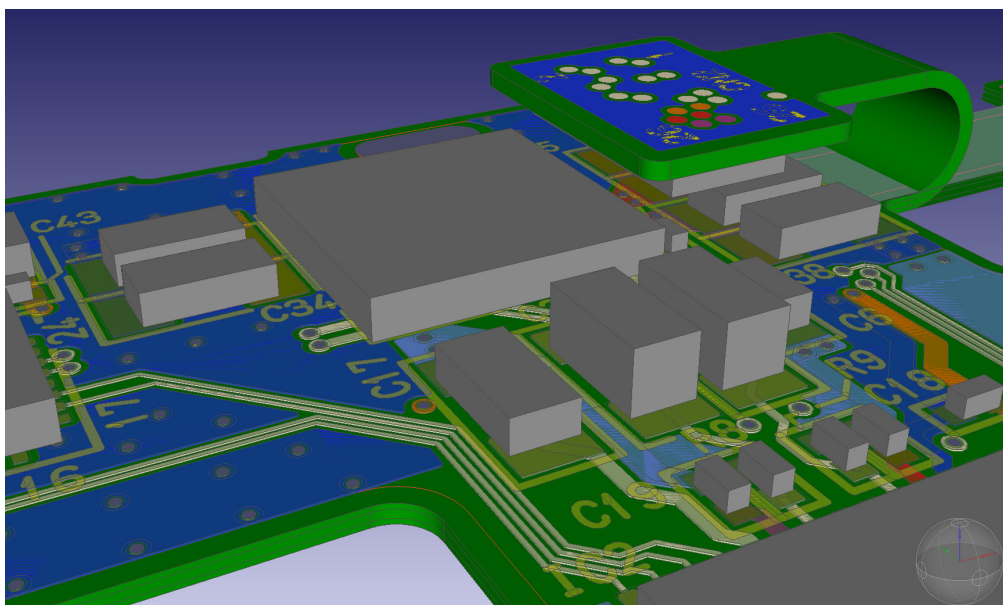
Today, all components used across all operations adhere to a unified material numbering system, and every material number is backed up by a choice of approved and certified second-source components so that the production can be maintained in cases of shortage.

Material master data are imported into DS-2 and provided to the user through a certified interface to the SAP system, through which engineers can download comprehensive specifications, data sheets and approval information directly into their CAE environment (CR-8000 Design Gateway).

“Using the link between DS-2 and SAP, our engineers can access directly the required material information in SAP without having to open SAP themselves,” explains Währer.

Streamlining engineering workflows

With the introduction of a standardized CAD component library and material classification, the foundation was laid for a centralized management of all PCB designs for all locations. “Before that we used a file system to manage our design data,” says Burger, “and the layout engineers were responsible for managing the data.” Although this approach worked well for a long time, the growing number of engineers led to a bottleneck: “Today we have more than 250 people working in Engineering, and all of them need access to data without having to formally request them from the layout team.”



The 3D functionality of CR-8000 Design Force offers great advantages in the layout of flex and semi-flex circuit cards. (picture: Zuken)

Today, all design data generated in the Endress+Hauser Group are managed and provided within DS-2.

Today, all design data generated in the Endress+Hauser Group are managed and provided within DS-2. Each employee can directly retrieve all data they are authorized to access, from within their user profile. If they make a change, the system automatically creates a new revision, so there are comprehensive safeguards in place to ensure that data released for manufacturing are not compromised due to errors.

Additional access control is provided by different user profiles that are based on typical role profiles such as viewer, engineer/author, editor and librarian. The result is quicker availability of the data required for all tasks in engineering, sourcing and production.

"We have become much more transparent in everything we do, and we get access to all required data much faster – yet our data are now better protected," summarizes Burger.

Automated routines increase productivity

All main data transactions are supported by automated routines: "As a rule, we have tried to automate all important transactions within the DS-2 environment," says Burger. New component library entries are guided by workflows, as are approvals of finalized designs. "As soon as a PCB design is approved, the manufacturing department receives

a notification so that the manufacturing engineer can retrieve the design from SAP and send the bill of materials to SAP for further processing."

Automated document generation routines support virtually all value-adding processes when developing PCB assemblies: from Gerber and drilling data generation for bare-board manufacturing, optical inspection of manufactured PCBs, creation of assembly diagrams, and the generation of programs for in-circuit-testing, through to the generation of PDF files of schematics for documentation.

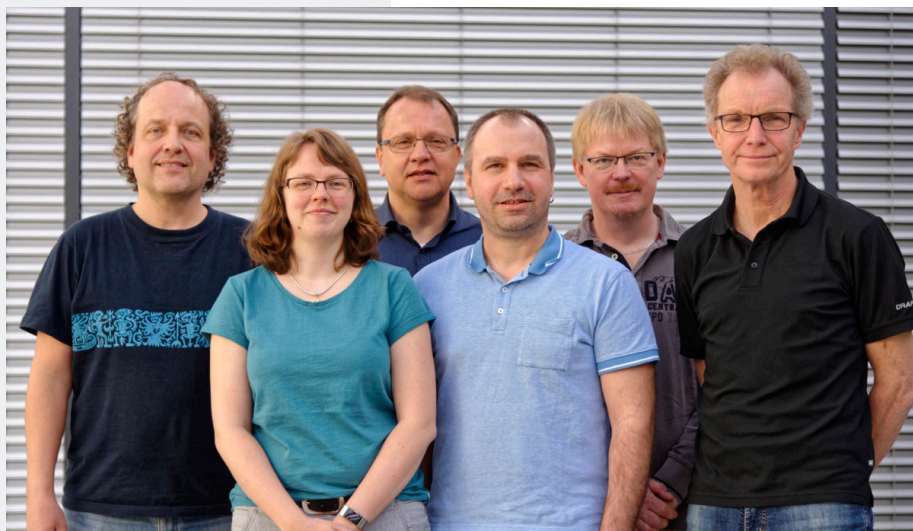
"In the past, we had to manually collect the data for every single task," says Burger. "Today the user pulls up a menu and selects the required documents to initiate automatic generation."

All documents generated in this way are then subject to an approval workflow, in which the date and approver are documented and transferred to SAP.

Controlled change process

Change control of released designs for manufacturing is another area in which DS-2's data management capabilities provide important improvements. If, for example, a component needs changing during production, or certain pads on a PCB show abnormal error rates, a controlled change process is initiated in SAP and routed back to specialized lead engineers in the engineering department. The engineers then analyze the issues using DS-2's query and analysis capabilities and assign tasks for further work to the responsible engineers.

"Today, we probably have one of the most comprehensive DS-2 installations," summarizes Burger. And yet, there are so many additional benefits that can be achieved from the consolidated library and design data management within DS-2. These potential improvements are systematically evaluated and addressed as part of a continuous improvement process (CIP).



The team behind the solution (from left to right): Daniel Hauswirth, CAE-Administrator, Endress+Hauser Flowtec, Claudia Stoltz, Head of Department PCB Design, Endress+Hauser Flowtec, Paul Burger, Group Leader PCB Design, Endress+Hauser Maulburg, Andreas Währer, CAE-Administrator, Endress+Hauser Maulburg, Andreas Garthe, CAE-Administrator, Endress+Hauser Conducta and Gerhard Müller, CAE-Administrator, Endress+Hauser Wetzlar.

“Through the standardization of design data and libraries we have created the foundation for the systematic reuse of existing designs.”

Paul Burger, Endress+Hauser

Next steps: modular design reuse and 3D PCB design

“Through the standardization of design data and libraries we have created the foundation for the systematic reuse of existing designs,” says Burger. The current practice consists of master designs from which the boards for different product configurations are filtered. “These can be configurations for strict explosion protection requirements, or others for less critical applications,” explains Währer. “In this case we simply take out the parts that are required for elevated explosion protection levels. Or we use a different software version.”

In future, design reuse will be extended through the adoption of libraries of modular design elements that can be combined to create new designs in shorter design cycles. “Our design platforms are still too large. We need to break them down into smaller functional units,” says Burger.

Another area that will require attention in the future is PCB technology. While in many cases double sided PCBs with through holes are sufficient, more innovative applications with limited space require HDI boards with up to 10 layers in the so-called 4-2-4 structure.

“That means we have four micro-via layers on each side,” explains Burger.

Currently, the PCB layout environment is being upgraded to CR-8000 Design Force that supports design in 3D in addition to the traditional 2D methodology. “This provides us the opportunity to represent surface mounted devices (SMDs) in 3D, which is a great advantage if we have to fold the boards to fit them into the typical cylindrical enclosures required by our products. By visualizing in 3D, we can immediately identify collisions during layout,” adds Währer.

Additional benefits are expected from the simulation and verification toolsets included in the CR-8000 PCB layout environment, in particular relating to high-speed design. “High speed design is assuming growing importance for us,” says Burger, “and with CR-8000 we hope to make fast progress in this area.”

The company has already taken its first steps by upgrading to Design Gateway, the engineering front-end of the CR-8000 design suite. The transition was made as pain-free as possible through outsourcing the migration, data conversion and testing to Zuken.



Whenever flow rates, filling levels, pressures or temperatures need measuring or liquids analyzed with high accuracy in industrial environments, you will see products, solutions and services from Endress+Hauser.