Informatics

Flexible **LIMS** Maximizes **Effectiveness**

BMW Group replaces in-house system with global, integrated solution

▶ Andreas Dobbertin, Ph.D., and Wayne Verost

The competitive and highly regulated nature of the automotive industry requires all aspects of an organization to provide the highest quality results in the most efficient manner. With this in mind, BMW Group's Department of Laboratory Technology was seeking a replacement for an existing in-house system in order to maximize the effectiveness of their multi-national intranet computing infrastructure, which serves a large number of diverse end users. Due to the special requirements of the industry, they needed to identify a laboratory information management system (LIMS) with a high measure of efficiency, flexibility and automation.

The Department of Laboratory Technology has several hundred employees within a matrix-like structure over several international locations, including Germany, the U.S., the United Kingdom, South Africa and China. Serving a wide range of BMW technical and management departments, these laboratories are organized into different testing specialties that include materials engineering, chemical analytics, process materials, component reliability and damage/failure analysis. They are responsible for providing analytical information and recommendations for 25,000 to 30,000 requests each year from over 2,500 internal clients who submit their requests as separate batch orders via a Web portal. These orders are then scheduled for testing by the appropriate laboratories.

Technical requirements

In order to ensure success, it was essential for the new LIMS to be integrated seamlessly into the software architecture of the department. The system also needed to accommodate all of the standard requirements for BMW. These included the integration of the BMW user authentication system to avoid the need to log in to the LIMS via the Web portal. Different interfaces to other BMW software systems (exchange server directory, database for parts, suppliers' data bank, project accounting system, and so forth) also were required in order to eliminate any data redundancy and to ensure that all data is updated in real time.

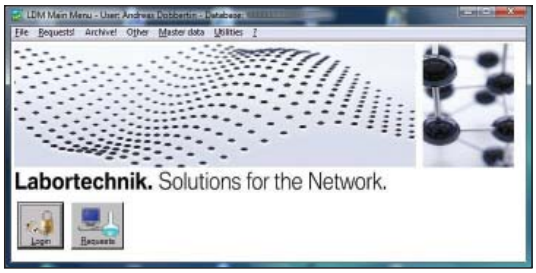

FIGURE 1: In order to make the software logical and appealing to use, essential visual aspects begin with static elements, such as the logo that appears on the main LIMS screen.

The following goals were set for the project:

- higher transparency of business processes
- improved schedule monitoring and controllability
- improvement of system ergonomics
- shorter order turn-around times
- reduced administrative effort
- configurable style elements
- ability to integrate pictures when evaluating failure analysis
- high, worldwide, multilingual system availability
- improved customer satisfaction

The project team also decided during the planning phase to use existing software resources. On the backend, this implied the continued use of a mainstream database engine (in this case Oracle) and a modern Web server environment (Microsoft IIS). On the front end, the software must continue to make use of the Microsoft Office components.

After evaluating several options, BMW decided that Quality Systems International's (QSI) WinLIMS was the best fit for their requirements, as well as to meet their specific cultural and technical challenges. This decision was based upon WinLIMS' depth of functionality, as well as its software maintenance and support options, which allow for expansion into the future.

Planning and conception

Due to the complexity of the project and the wide range of available LIMS functionality, the design of the system could only be outlined roughly during the initial implementation stage. During the planning phase of the LIMS, a project team of IT staff members and key users within all of the automotive technology laboratories was assembled. The framework of the project was specified in regularly scheduled meetings together with the QSI project management team and the targeted workflow processes were discussed in detail based on a general target.

Informatics

It was decided that it would be crucial to find a basic, common workflow solution for the processing of requests to all of the various lab groups during the concept phase of the project. This general workflow would replace the current highly complex system that often was confusing because the general rules differed from one lab group to another. The new system was designed using a holistic strategy to describe all complex processes. Starting with this standard process, the requirements for individual workflows were addressed.

This procedure provided a clearly structured concept, with a well-arranged description of the target processes in an effort to divide a massively complex project into less complex stages that would build upon each other. During the implementation process, the common workflow was implemented as phase one of the project, which formed a measurable milestone that marked the general basis for the project. A follow-up phase required a fine study to ensure that the detailed needs of the submitter community and each laboratory group were accommodated.

Project implementation

An efficient implementation approach was followed whereby the system would be immediately available for use for some processes while the configuration and implementation was developed for others. In typical manner, the off-the-shelf (OTS) system was installed and the static data modules were populated to allow the general processing of samples. This served as a basis for the configuration of the more refined operational sequences of the system that were defined and developed during the regular project meetings.

By having an operational system available during the development process, instantaneous feedback between the user community and project team was possible, which allowed the actual product to be continuously aligned to the targeted functionality and user interface. This information flow was a crucial element in achieving all of the goals of the project, and inclusion of the user community during the development process assured acceptance of the new system.

In principal, all individual business processes, including WinLIMS modules and functions, passed through a separate development lifecycle that was steered and supervised by the project team from the initial concepts, through the configuration process, to the approval of each process. Each of these controllable project segments was incrementally approved for each operation in the project work statement and, when all were released, the project came to a natural and successful conclusion.

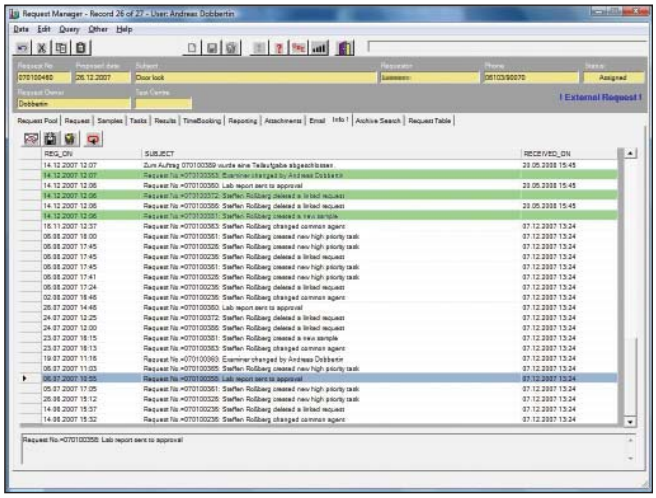

FIGURE 2: Configurable style elements include color-coded marking of prioritized and scheduled laboratory requests in the in-box.

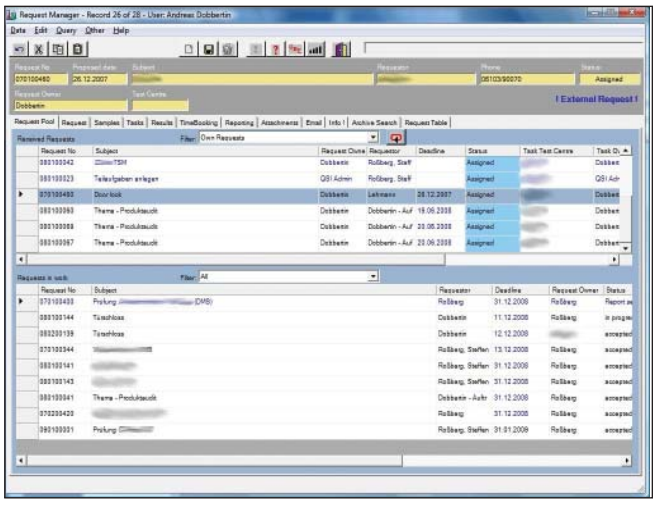

FIGURE 3: All open requests associated with the current user are presented using different colors for the various workflow status levels.

Functionality

WinLIMS.NET was designed and configured to represent the initially required target process both ergonomically and functionally. Since this initial target process is subject to change as needs evolve, the plans include use of built-in features that allow authorized users to configure the LIMS system and the screen design as needs arise, without requiring custom code.

The visible design of the system, i.e. the layout of the LIMS screens, is important for the user's identification of information within the system. A great deal of importance was placed upon configurable style elements in order to make the software logical and appealing to use by both clients and laboratory staff members. These essential visual aspects begin with static elements, such as the logo that appears on the main LIMS screen (Figure 1), and the color of table columns or fields and other dynamic elements within the system, such as the colored marking of prioritized and scheduled laboratory requests or entries in the LIMS Mail (Figure 2).

In order to improve system ergonomics when compared to the legacy system, different processes were optimized to minimize user interaction and to provide color-coded visual cues. The Web portal to

Informatics

WinLIMS is presented within the BMW standard layout for Web sites to allow staff members to quickly submit work and to review reports based on samples that were evaluated by the various laboratories. Immediately upon entering the system via the central BMW authentication system, all open requests submitted via the Web portal (Figure 3) that are associated with the current user either directly (entire or partial order) or indirectly (laboratory affiliation, representative regulation) are presented using different colors for the various workflow status levels.

The request pools represent a logical reference point for the work that is performed by each analyst. The visual presence of a selected order, along with its associated samples, results, files, and so forth, can be accessed and edited with a few mouse clicks. These site-specific ergonomics are unique to the workflow at BMW and contribute substantially to the clarity and transparency of the operational sequences.

Different interfaces to existing BMW software systems, such as the Exchange server (directory function), the parts database, the suppliers database and the project accounting system, contribute to the system in many different places, eliminating a great deal of manual data entry. Duplicated data is eliminated via direct access to other vendors' systems. For example, as a user registers the results and amount of time spent performing an analysis on a part, the appropriate information is entered into both the parts database and the project accounting system.

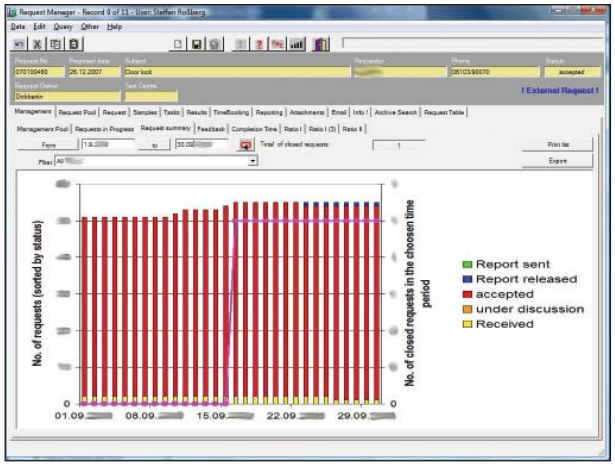

FIGURE 4: All management summary reports are displayed as embedded, configurable Microsoft Excel diagrams and data sheets.

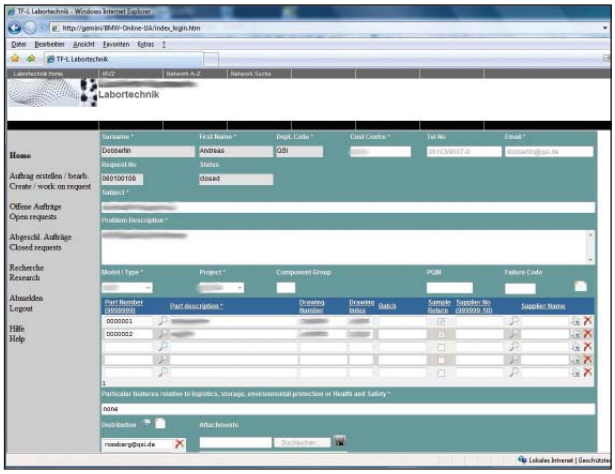

FIGURE 5: The Web portal is accessible from any browser and provides a full-text search tool.

The integration of MS Office into the system is another important factor that provides instantaneous information flow pushed out of the system based on workflow events. As request orders are accepted and processed by the laboratory, e-mails containing configurable dynamic contents via MS Outlook are automatically produced and sent to the client to keep them informed of all updates to their work request.

Other items that make use of the MS Office suite, including version-controlled laboratory reports, work lists and overviews, are generated using the integrated QSI Reporter for Microsoft Word.[1] This LIMS functionality provides users with automated data transfer from LIMS to a report that can be further edited, allowing subjective information and recommendations to be added prior to issuing the client report.

Since the ability to integrate pictures is essential to the laboratories when evaluating failure analysis, an additional capability that was critical

New Products

to the success of the system was the ability to integrate files from the QSI Document Management System (DMS).[2] Images, spreadsheets and additional Word files can automatically be inserted into the laboratory report, which is converted to PDF format before the file is stored in the DMS. Both the original Word and PDF documents are stored in the DMS.

After approval, the laboratory report is available in the Web portal as a PDF document. All management summary reports for the department, including request submissions, turnaround times, on-time reports and lab costs, are displayed as embedded, configurable Microsoft Excel diagrams and data sheets in the LIMS Screen (Figure 4), which can be saved as individual files on demand.

The Web portal gives the internal clients an extensive, easy-to-use tool that is accessible from any browser (Figure 5). The Web page can be used to register new requests registration, monitor the status of each request and administer existing requests. Most importantly, it provides a full-text search tool that makes locating information within WinLIMS as easy as performing a Google search.[3] This ability is an essential tool for the wide variety of clients who use the services of the department.

Summary

Using feedback from clients and lab staff, the design of the system was refined while in production. This "in-use" development contributed substantially to project success by incrementally adding the functions that were deemed necessary by users and not introducing a complex, force-fed system that may or may not have satisfied BMW's needs.

All planned project targets were achieved. The implementation of the WinLIMS.NET software has led to a higher quality in the processing of laboratory requests, as well as shorter turn-around times, and the department is already experiencing improved customer satisfaction, as well as decrease in internal costs. As a result, several near-term expansions have been planned to further maximize the system's benefits, including

- rollout to the Asian BMW plants
- introduction of WinLIMS into other BMW departments
- implementation of a direct interface to an image acquisition and processing system. SC

References

1. Dobbertin, A., Roßberg, S.: *GIT, Laborfachzeitschrift*, 12, 1422-1423 (2000)
2. Köster, F.W.: *GIT Labor-Fachzeitschrift* 12, 1129-1131 (2004)
3. Google is a registered trademark of Google.

Andreas Dobbertin is a project manager and Wayne Verost is President of Quality Systems International. They may be contacted at editor@scientificcomputing.com.