Meeting the Need for Speed
A Food Testing Lab Integrates BAX and LIMS Technologies

By Pat Ehrman

Collecting data in a busy lab is always important, and when that lab is testing product for potentially lethal microbes, obtaining accurate data is imperative to public health and commercial success. It is equally important to accurately record, store and report that data.

One lab rose to the challenge by combining the newest testing and data tracking technologies: They upgraded their testing methods to the latest automated DNA-based technology, and then imported those test results directly into their LIMS database.

Speeding Up Sample Processing and Data Management

Lab managers concur with *Food Quality*'s observation, "Microbiologists in the food industry are feeling the need for speed." (Aug-Sept 2004 issue, Microbiology in the Fast Lane). Tina O'Rielly, Microbiology Laboratory Manager explains: "We deal with fresh product that requires further processing before being frozen, and the turnaround time is very important to our customers."

O'Reilly heads the Microbiology Lab at a leading North American food producer's Brooks, Alberta, division. The company had recently switched from ELISA based, phenotypical antigen-antibody reaction tests to a polymerase chain reaction (PCR) system. They chose DuPont Qualicon's BAX® detection system (BAX). The BAX system screens for pathogens and other microorganisms, and can process up to 96 unique samples per batch. O'Rielly noted that although both systems have merit, the BAX "has a higher specificity with a lower false positive rate."

The BAX test produces a positive result when amplified DNA from targeted bacteria in the processed sample generates a fluorescent signal. If the sample contains no amplified DNA, the result is negative. The BAX system application analyzes the signals and displays the findings on the instrument's computer screen. The display graphically represents the test rack's 96 sample wells in an 8x12 "table". Each on-screen result corresponds to the sample's physical location in the BAX test rack, and is represented by a red (positive) or green (negative) icon.

At the same time, the organization was tuning up its new laboratory information management system (LIMS). While its parent company had been using MSC-LIMS, Mountain States Consulting, LLC's (MSC's) Access-based LIMS, for nearly a decade, O'Reilly's group had only recently found the time to upgrade. "Sample tracking is a major component of being a lab that is accredited to the ISO 17025 standard," O'Rielly points out. "And the LIMS was a great improvement to our overall system of sample logging and sample tracking."

The lab had quality tools and highly skilled staff. But they lost momentum performing repetitive data entry.

Stalled at the Data Entry Crossroads
The BAX system keeps its own records of test results for each sample, and each sample's identification and description must be "known" to the BAX. Obviously this means data entry. In a lab that also maintains sample data in a LIMS, that can mean double the entry of sample characteristic data.

 "We were required to enter all the sample information into the LIMS system, and then post-incubation reenter all the information into BAX, including the ten-digit LIMS i.d. number," O'Rielly recalls. "A full BAX run of 96 samples worth of information having to be reentered took significant time. We typically run multiple BAX runs a day as well." A technician would then read the BAX screen and transcribe completed test results into the corresponding sample record in the LIMS. This meant hand-entering data for up to 200+ samples per day. "Not only was this tedious, it represented the possibility of transcription errors, which in a laboratory has serious consequences."

The obvious solution is to enter sample data once, then share that data between applications. Again quoting from *Food Quality*'s Rapid Microbiology overview: "The BAX platform … can either be used as a stand-alone system or integrated into most LIMS systems..."

That is good news. But just how does a lab actually go about integrating the two systems?

Integrate BAX and LIMS
The need for seamless integration between instruments and in-house data systems is well recognized in programming circles, affirms Jeff Rohrbeck, BAX system developer. "The DuPont Qualicon software team decided early on that we would serve our customers best by making the BAX® system easy to integrate with external record-keeping systems, such as LIMS. The BAX® system uses simple, text-based files to capture data. This enables customers to use external systems to generate and export tracking files to the BAX® system for testing, and then import results back into the external system."

Enter MSC-LIMS. O'Rielly quickly discovered that MSC-LIMS' unique Excel interface could also be used to integrate their LIMS with their BAX.

MSC's founder, Rick Collard, has spent a decade integrating lab instruments, field instruments and existing report formats with the LIMS. Collard has amassed a vast "programmer's library" of Excel tricks and tools, and has even been referred to as the "Master of Excel". He chuckles. "I don't know that I'm THE master. Seriously, Excel has proved to be incredibly useful as "middleware" between lab or field instruments and MSC-LIMS. We have used it successfully to import data into the LIMS from hand-held PCs, balances, and other lab instruments such as 3M™'s Petrifilm™ Plate Reader. The process here was essentially the same."

Rohrbeck commends the middleware concept. "It is not a coincidence that BAX® system files work well with Microsoft Excel," he notes. "Using Excel as a middleware tool provides many advantages. It aids our development, customer service, and end users by giving us ready access to data files without writing specialized tools."

Collard designed two Excel templates to serve as middleware between the BAX and the LIMS. Visual Basic for Applications (VBA) code in the appropriate worksheet executes tasks in the correct order. The first template instructs Excel to receive sample data sent from the LIMS, and then to send the data along to the BAX system. The second template instructs Excel to fetch test result data from the BAX system and then to make it available upon request by the LIMS.

O'Reilly configured her LIMS to recognize specified analytes (such as salmonella, genus Listeria, E coli., etc.) as BAX "targets". The LIMS was then configured to accept specified values for results, so that validation occurs automatically when results are imported into the LIMS.

Exporting LIMS Samples into the BAX

With Excel in place behind the scene, the process is straightforward: Technicians log samples into the LIMS as usual. When gearing up for a BAX test run, technicians use the LIMS' query tools to select the samples slated for testing, and then view the sample(s) data in a specified report format. Once the sample selection is verified, they use the LIMS' [Export to MS Excel Template] button; in the ensuing Excel Data Transfer screen they select the custom "BAX Rack Setup" Excel template from a pick list and click [OK] to export the report's data to the template. See Figure 1.
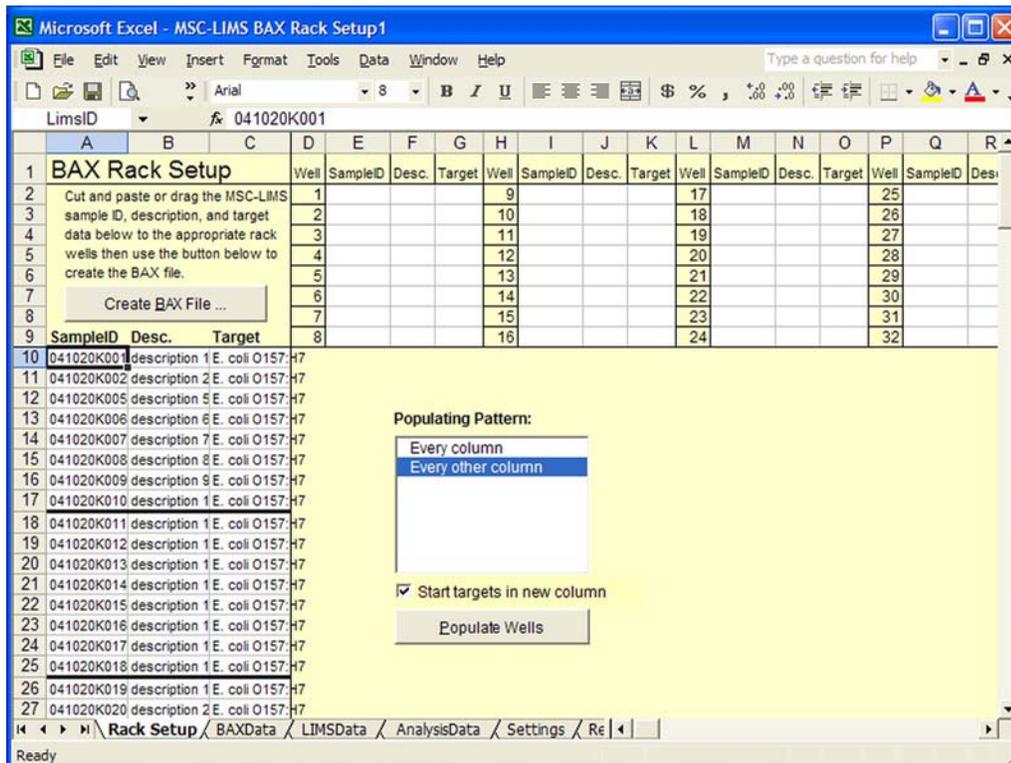

Figure 1 - MSC-LIMS BAX Rack Setup Screen

The BAX Rack Setup template is a performance ride in and of itself. After the samples' IDs, descriptions and target data are imported to the template the user selects a predefined well

populating pattern from the pick list. According to the populating pattern chosen, each sample's information is automatically placed into one of the workbook's 96 cells, which graphically represent the test rack's 96 sample wells in an 8x12 "table".

Now each LIMS sample occupies the on-screen equivalent of its electronic representation on the BAX system monitor screen AND the sample well's physical location in the BAX rack. Visual verification is simple.

Users click to create the BAX "pre-run" file, then click save. They then use the BAX system's own software to load the pre-run file into the BAX system, and run the test as usual.

"Tweaking" is intuitive. For example, technicians may place sample information into any of the well locations on the Excel export spreadsheet. Or, if only half of the BAX rack's 96 sample wells will be used in a given test run, technicians may select the pre-defined well populating pattern that targets alternate columns. The sample data then automatically populates alternate columns in the spreadsheet, and thus in the BAX system as well. See Figure 2.
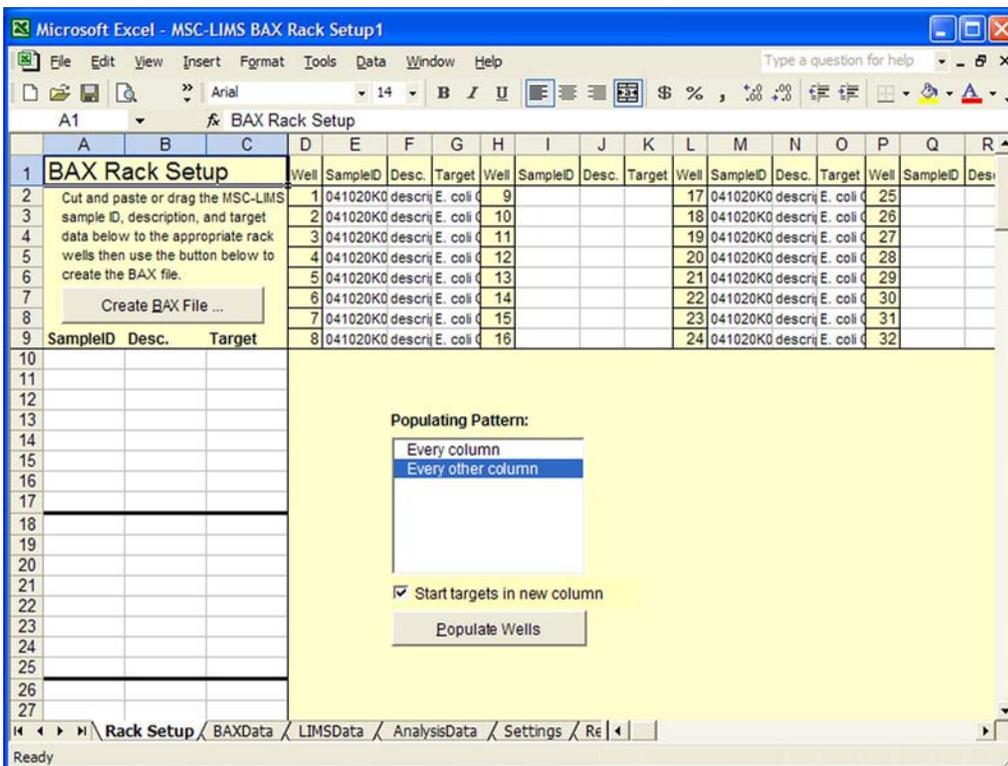

Figure 2 - MSC-LIMS BAX Rack Setup with alternate column Populating Pattern

An essential revision was requested by O'Rielly: "After implementation we found that it would be helpful to have each different analyte in a different BAX column, and MSC added a "start targets in new column" check box, and it works perfectly." The potential for cross-contamination is reduced.

Importing BAX Test Results into the LIMS

The BAX system independently records the results of its test run. To copy the test results into the LIMS, technicians activate the second customized Excel template. Using its controls they locate and select the BAX file to import, then with one click the samples and test results are automatically imported to the template. See Figure 3.
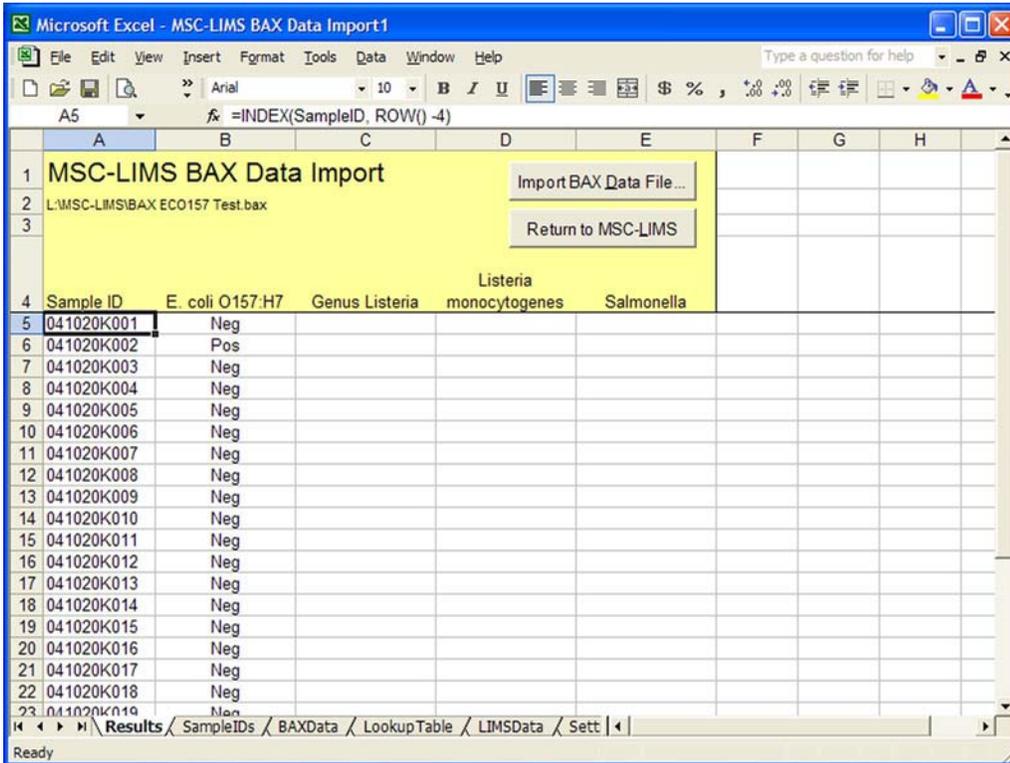

Figure 3 - MSC-LIMS BAX Data Import Screen

Back in MSC-LIMS, technicians query and retrieve the LIMS samples whose results are now available. They then retrieve the Excel data and view the results - see Figure 4 - and then import the data into the LIMS' Results by Analyte screen(s).

The Data is Secure

It is important that no changes are made to the BAX system's files. Rohrbeck stresses this point: "One potential issue with this kind of access is data security and the need to guard against data manipulation - either accidental or intentional - that might present an erroneous result. The BAX® system handles this with a Cyclical Redundancy Check (CRC) code that is computed by the BAX® system when results are calculated. Any manipulation of the file, including the file name, will result in an error message when viewed in the BAX® system."

The Excel middleware concept poses no threat, provided it simply "copies and pastes" information. The copied sample information and test results are then available in two locations, one of which may be a flexible, secure LIMS with multi-level security, audit trail and error tracking capabilities. And because the entities remain separate, the Excel worksheets can be easily revised to respond to any future BAX system upgrades.
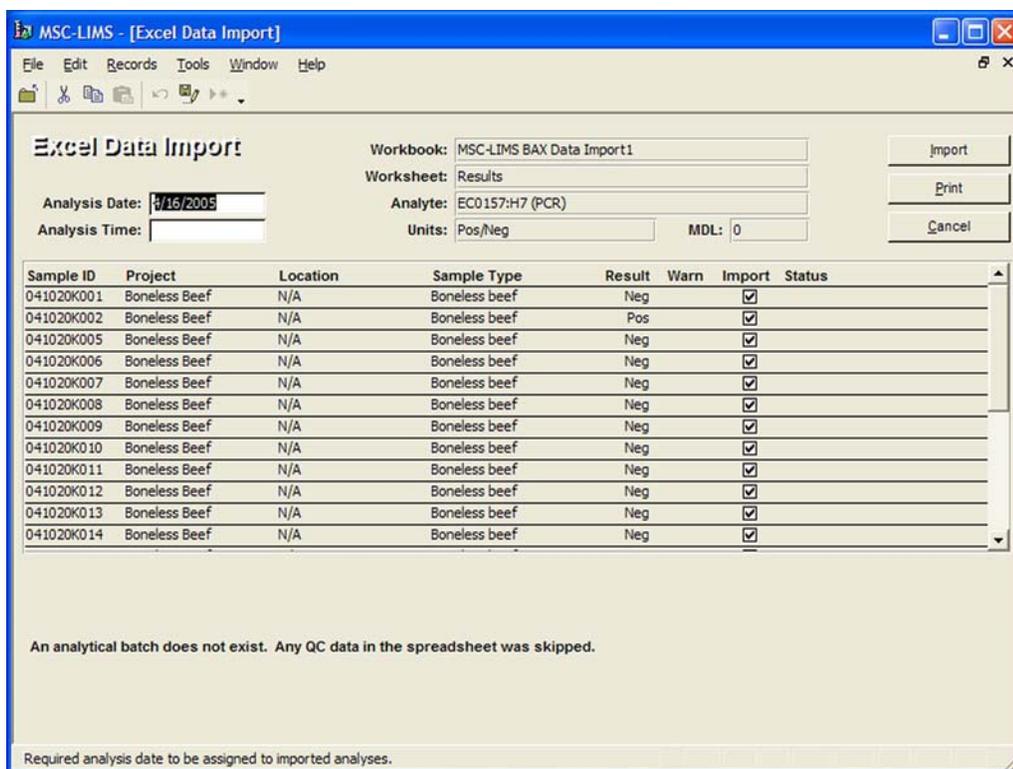
Figure 4 - MSC-LIMS' Excel Data Import screen

Implementation and Functional Advantages

O'Rielly found that implementing the new system proved simpler than she had anticipated. "When we first introduced LIMS to the lab we were somewhat concerned with the differing levels of computer literacy of the technicians. But our LIMS user interface is very straightforward, and there were very few problems."

Following installation and training, O'Reilly's team wrote a step-by-step training manual and continued their old paper system as well as the LIMS for several months. They gradually incorporated the LIMS' features into their day-to-day operations and are now fully automated, including proficiently utilizing the BAX interface and generating final reports.

O'Rielly values efficiency. "I am always looking for ways to streamline the operation. With the increased documentation required for accreditation, we now spend almost as much time filling out paperwork as we do microbiology." Fortunately, their confidence in presenting BAX results in the LIMS' pre-defined and user-defined reports has significantly reduced paper-handling time. "Generating reports is now significantly easier, less time consuming and less prone to transcription errors."

The difference between their former pen-and-paper system and the new automated system is "night and day," she said, recalling that "Often I spent several hours a day tracking down data to resend to a customer. I can now run a query on the computer for the specific information I require."

Know Any Good Shortcuts?

Collard is convinced that a well-executed interface is the most reliable method for sharing LIMS and instrument data. Rohrbeck concurs: "The simplicity of BAX® system files makes it fairly straightforward for developers to integrate them with an external system. For customers who require automated LIMS-type access, developers can work with a familiar, commercial interface rather than a proprietary API (Application Program Interface)."

Okay, but what if a lab has no LIMS? To this Rohrbeck responds that "customers without a full LIMS system can still use Excel to create custom reports and/or generate BAX® system data files. And we do have customers who read and write BAX® system files directly, without the use of Excel."

If the goal is simply to minimize data entry, Collard suggests yet another alternative: barcodes. "If technicians are able to generate a bar-code for each sample using a simple Windows barcode font, they may be able to read the encoded information directly into the BAX system using a keyboard-wedge barcode scanner." A keyboard-wedge scanner is an all-hardware solution that slips data into the flow between keyboard and computer, making scanned data appear as if entered at the keyboard.

Of course, a computer-generated bar code can only convey information that the computer possesses. And technicians utilizing the wedge configuration may still need to enter final test results directly into their LIMS at the keyboard. Still, that implies less typing, and careful attention to detail should help to minimize transcription errors.

Finally, Collard recommends that lab managers confer with their LIMS vendor and their DuPont Qualicon sales manager before embarking on any system alterations. Rohrbeck offered his assistance. "As a policy, we don't design specific implementations, but we assist customers with problems they encounter. "

Summary

"The LIMS/BAX interface is a solution to the problem of dual data entry," O'Rielly concluded, and noted that the LIMS-based solution helps insure the integrity of their operations.

Rohrbeck's experience at DuPont Qualicon bears witness to the benefits of integration. "For volume users, this can be a tremendous time saving. The import/export integration eliminates re-entering large quantities of data, thereby reducing the potential for manual entry errors. Also, results can be made available immediately to the entire enterprise."

From the LIMS perspective, Collard observes, "No one should have to manually replicate data entry *ad infinitum*. Not with the technology available today." The two Excel "middleware" templates are now available to all MSC-LIMS users. "DuPont Qualicon's BAX system is gaining in popularity, as are sophisticated LIMS. It is important that labs have access to the best tools to accomplish their tasks."

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