Considerations in selecting a laboratory information management system (LIMS)

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As a laboratory grows, it faces the dilemma of accurately and quickly processing overwhelming amounts of data for the tests performed and keeping ahead of its competitors by utilizing the latest technology to enhance laboratory performance and increase profitability.

It is important to select a database engine that is not proprietary and that will have a clear migration path as the technology evolves, which will protect the investment.

LIMS are database applications that are used to store and manage information associated with the laboratory, such as customers, sample matrix, tests, results, methods, parameters, bottle types, employees, control limits, passwords, etc. In choosing a LIMS, many questions arise, including selecting the appropriate database engine, ease of use of the LIMS software, quality of the vendor's technical support and training programs, and utilization of existing hardware or software. Other factors include flexibility in making changes to the system as the laboratory's demands change, the user interface, vendor expertise, and, of course, budget. Open Database Connectivity (ODBC) is a database standard that provides the ability to link the LIMS with different databases (such as accounting, SAP, ERP [enterprise resource planning], etc.). It is important to select a database engine that is not proprietary and that will have a clear migration path as the technology evolves, which will protect the investment. There are basically three types of database engines: proprietary (which are not ODBC-compliant); ISAM (Indexed Sequential Array Method), such as Access (**Microsoft Corp.,** Redmond, WA), **Paradox** (Scotts Valley, CA), and FoxPro (**Microsoft**); and SQL (Structured Query Language), including SQL Server (**Microsoft**), **Oracle** (Redwood Shores, CA), **Sybase** (Emeryville, CA), and others.

Additionally, consideration needs to be given to the success and ease of implementation of the LIMS. It is important to select a system that will fit the laboratory's data management needs with minor modifications. However, there are certain core features that all LIMS and LIMS buyers should be aware of and understand (*Table 1*).

Many laboratories are migrating from paper logbooks to spreadsheets on a PC to track their samples. This is a great first step; however, once the database grows, it is increasingly difficult to interact with the spreadsheets and a relational database is often the answer. In selecting a LIMS, it is necessary that the LIMS matches the current sample flow of the laboratory, that the system is flexible to accommodate change, and that the vendor has an upgrade path available as the laboratory grows.

As the laboratory's data management needs and reporting (fax, e-mail, electronic data deliverables) expand, the LIMS should

Table 1

Typical LIMS functionality

Typical LIMS functions/modules	Description
Sample tracking	Allows laboratories to track their samples through different departments in the laboratory with a computer-generated unique sample identification number and provides a complete chain of custody.
Data entry	Allows analysts to enter results into the LIMSand to assign QC run batches. Reporting to clients via fax, e-mail, or a hard copy.
Sample scheduling	Automatically logs in samples, receives them into the laboratory, prints labels, and assigns the tests for projects on a routine basis.
QA/QC	Allows users to generate control charts and view trend analysis graphs. Control charts can encompass blanks, duplicates, spikes, surrogates, standards, etc.
Electronic data transfer	Allows automatic transfer of data from analytical instrumentation into the LIMS. In Increases productivity and greatly decreases the potential for transcription errors.
Chemical and reagent inventory	Functionality that tracks the purchase and usage of supplies in the laboratory and manages lot and order numbers, shelf life, costs, etc., assisting in supply management.
Personnel and equipment management	Allows users to track employee training records for ISO and NELAC purposes and also track instrument calibration, repairs, costs, monitor trends, etc.
Maintenance	A function that allows the database administrator to manage the database, keeping track of client lists, employees, tests, methods, parameters, permissions, priorities, etc.

accommodate this expansion with a clear migration path so that none of the customizations previously made are lost. The LIMS may also need to interface with other databases, such as accounting, inventory, or material safety data sheet (MSDS), which increases the importance of selecting a system that is ODBC compliant with a solid database design.

LIMS selection considerations include:

- Database engine (ISAM, SQL, proprietary) choices
- System features to match user requirements
- Current hardware and software available in the laboratory
- Ease of use, on-line help, technical support, training, and upgrades available for the vendor
- Flexibility to accommodate a changing laboratory environment
- Cost/ROI (return on investment) considerations.

If the above criteria are examined, the database choices are much easier to make than they used to be. Most laboratories align themselves with database market leaders such as **Microsoft** and **Oracle.** Users need to define their system requirements by meeting with key laboratory managers and staff to determine which areas of the laboratory require improvement and to discuss areas that would benefit from automation. Many laboratories have made significant investments in hardware and would like to leverage those investments, if possible, to utilize the existing hardware for the LIMS. However, it should be noted that although this sounds reasonable, sometimes it is more cost effective to invest in hardware upgrades or a replacement. When learning any new software product there is a learning curve. Be sure that the software selected is intuitive and easy for the analysts to learn. It is also critical to select a LIMS vendor that offers training programs and superior technical support. The LIMS should allow users to make changes to accommodate the way in which the laboratory does busi-

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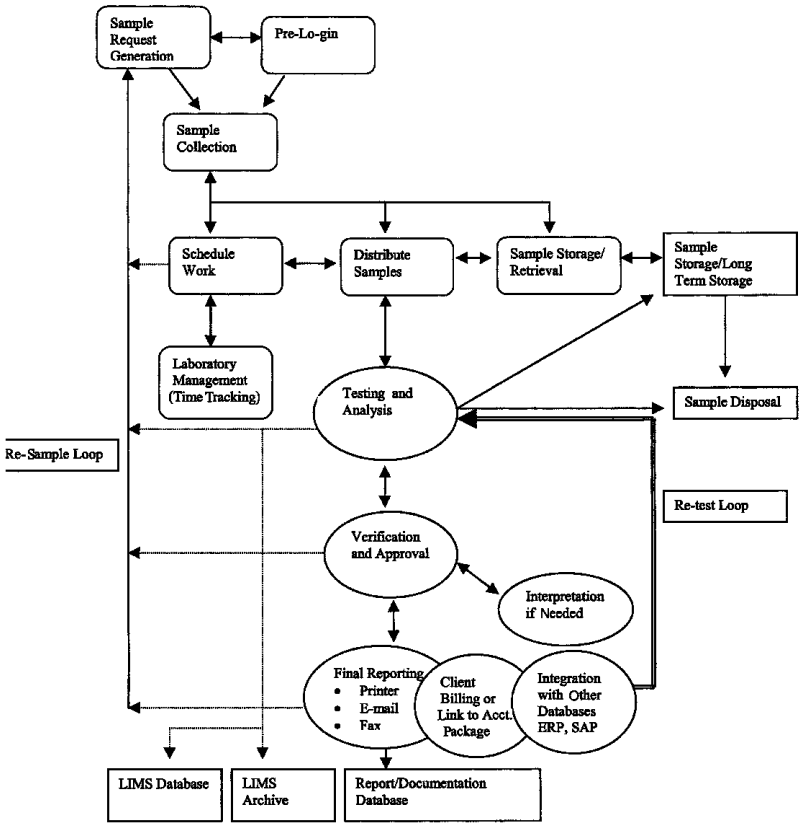

Figure 1 *Schematic representing typical LIMS workflow.*

ness. For example, the LIMS should allow users to change field names on-screen to terminology that is familiar in their laboratory. Reports should be easily modifiable and end-users should be able to incorporate new screens into the program to accommodate special projects or new functionality. Finally as in any business, the laboratory owner must consider the return on investment for the LIMS. By transferring mundane tasks to the LIMS, the analysts are available to analyze additional samples and work on method development.

Laboratories are in the information business. Those that can deliver quality information to their clients ahead of their competitors will emerge as market leaders. Before selecting a LIMS it is important to have a clear understanding of exactly what the laboratory's data management requirements are, in addition to the benefits that the laboratory can expect to gain from a LIMS and automation. *Figure 1* displays sample flow through a typical laboratory.

It is also important for laboratories to have a clear understanding of the current operations and where they will receive the largest return on investment. Once the laboratory has established a shopping list of system requirements, it is important to evaluate systems based on requirements via live demonstrations and a question-and-answer session.

Perhaps the most common reasons for acquiring a LIMS are to decrease turnaround time, enhance reporting, and to improve overall data quality. Turnaround can be greatly enhanced with a rapid sample log-in process. A LIMS analyst can pull names from a client list with client-specific pricing and QC already set up; thus, this information does not have to be reentered each time. With a LIMS, not only can samples be logged in faster (bar codes can also be utilized), but there is complete chain of custody and a full audit trail, and worklists can be generated as well as backlog and production reports. The laboratory manager can determine a sam-

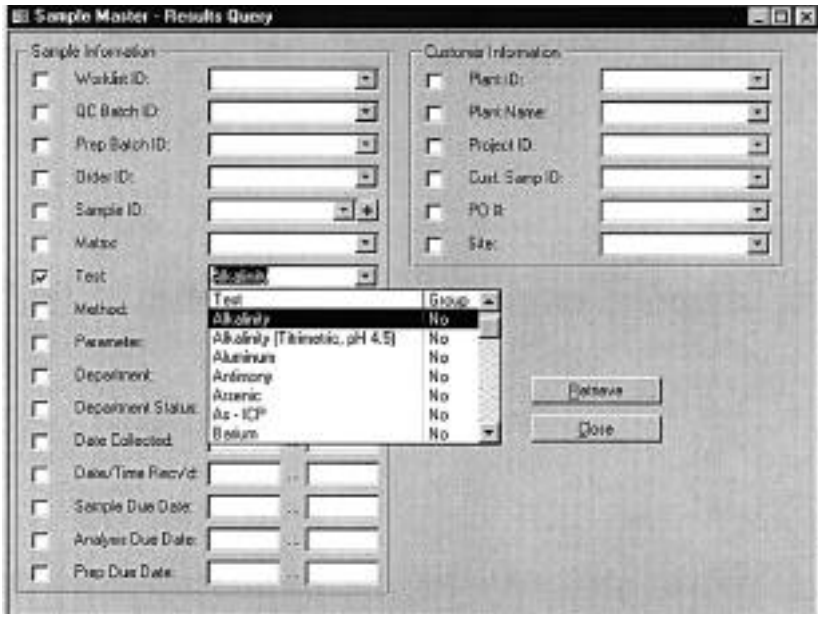

Figure 2 *Sample Master results query.*

ple's status at any time without running through the laboratory from department to department to find the sample. After sample log-in, the area often requiring the greatest improvement is reporting and the ability to automatically generate reports from the LIMS. These reports (such as Certificates of Analysis, result reports, etc.) can be autofaxed, autoprinted, auto-e-mailed, or displayed on a Web site in read-only format. The Internet is also revolutionizing laboratory e-business; results can be e-mailed to clients, worklists to employees, as well as out-of-specification warnings to employees, at minimal cost and with great speed.

A LIMS can also significantly enhance data quality by verifying data format, providing an audit trail, reducing data entry errors, decreasing data search time, and limiting users to selecting a test or method from a pull-down list (helping to ensure a "clean" database, i.e., no multiple spellings for the same test, matrix, or method) (*Figure 2*). Automatic calculations limit checking upon data entry, and data validation together with instrument integration greatly increase productivity since analysts do not have to hand-enter results from the instruments into a spreadsheet or report. This also decreases transcription errors and improves data quality.

A successfully implemented LIMS will increase laboratory productivity, improve data accuracy, and increase the laboratory's overall effectiveness. A LIMS can organize all the information that is pertinent to the laboratory and allows for rapid data retrieval and reporting. It also allows data to be accessible to others, promoting collaboration among different departments. In addition, many laboratories utilize either a local or wide area network that allows users to share network printers and information. Most LIMS are set up in a true client/server configuration (*Figure 3*). In this configuration, the database tables reside on the server and the graphical user interface resides on the client machines. The advantage of this configuration is that data processing occurs on the server.

A LIMS can be a powerful tool that gives the laboratory a competitive advantage over other laboratories, saving time and money. Benefits of LIMS implementation include faster turnaround times, automation, increased productivity, higher quality of data, electronic reporting, and integration

Figure 3 *Typical LIMS client/server configuration.*

with other enterprise databases. With the decreasing hardware and software costs and growing acceptance of the Internet, the time for laboratories to move from paper tracking systems to a LIMS has never been better. Not all laboratories operate in the same way, so it is extremely important that a LIMS match the laboratory flow and have the flexibility to accommodate future changes in laboratory operations.

Additional reading

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