Increasing User Adoption Rates and Realizing a Higher Rate of Return on a LIMS Investment

Improving the user experience for modern LIMS should increase adoption.

Introduction

In the world of scientific software, laboratory information management systems (LIMS) are prevalent and often disliked. In the 40 years since scientists began computerizing laboratory operations, automated workflows have increased throughput and data volumes. As a result, LIMS are now found in many labs while forcing changes in comfortable, paper-based routines. Yet in that time the interfaces and usability of LIMS have changed little. "LIMS carries a lot of baggage, and to many scientists is synonymous with rigidity, having to change what you do to work around or with the system, and having to get the information technology (IT) department involved whenever a protocol or study design changes," said Michael Elliott, founder, chief executive officer, and chief analyst at Atrium Research and Consulting, which provides analysis, coverage, and consulting in scientific informatics.

Several drivers present an opportunity for LIMS to substantially improve their image:

- Pressure from electronic laboratory notebooks (ELNs) and other scientific software.[2]
- Trends in consumer technology toward intuitive, touchscreen interfaces.
- Specialized clinical or regulated labs working in genomics, next-generation sequencing (NGS), and mass spectrometry that require LIMS functionality.

Usability is key to ensuring that LIMS are adopted and used. Three elements in particular can make the difference between a LIMS that is loved and one that languishes:

- Smart integrations with instrumentation and other software systems.
- Prebuilt workflows that support best practices and facilitate daily lab tasks.
- Logical, role-based, intuitive interfaces that serve as a resource to scientists and managers.

In this application note, Michael Elliott and two research scientists describe the traditional barriers to LIMS adoption and a vision of a modern LIMS that helps labs conduct better, faster, higher-quality science. "The primary benefit of implementing a LIMS should be around meeting a strategic goal, such as improving operational efficiency or data quality," Elliott explained. "How you do that should be paramount."

Rediscovering the Value of LIMS

The first commercially available LIMS was launched in 1982,[3] developed to automate the lab and omit what one commentator called the "clerical activities associated with the processing of analytical results" produced by lab instrumentation. At their core, most LIMS today still work effectively to help labs:

- Reduce manual tasks to reduce error rates and improve accuracy and quality.
- Connect electronic systems to speed data exchange and project turnaround.
- Improve access to experimental parameters, metadata, and results.
- Track and monitor resource use to report on and improve lab operations and productivity.[4]

These core value propositions are more important today as labs become high-throughput, high-volume testing centers, and are increasingly regulated. "I thought a LIMS was a great tool to introduce to the group and saw a real need for it given the scale of our customer load and the data and information we need to capture," said Kathleen Lundberg, LIMS administrator and project coordinator at the Center for Proteomics and Bioinformatics at the Case Western Reserve University School of Medicine.

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Unfortunately, as many of the original LIMS vendors began modifying existing legacy systems to support new methods and workflows, most notably in discovery research, they strayed from these core principles. Instead of retooling systems to match the requirements of new scientific areas, vendors added functionality driven by custom requirements. The result was bigger systems that were patched together loosely and illogically.

"We called our system FrankenLIMS," said Rob Hall, manager for the Bumgarner Lab at the University of Washington. Hall was describing a LIMS built by the biotechnology company where he worked before joining the Bumgarner group. "We didn't understand how hard it would be to build and maintain such a system," Hall said. LIMS need

to change as scientists redesign fields, reuse components, and create cross-references. "Ultimately," said Hall, "we were working around the LIMS to solve problems that the LIMS itself was creating."

Many commercial systems resemble FrankenLIMS, according to Elliott. That can change if vendors rethink the original LIMS value propositions from the perspective of two primary users in the lab: bench scientists and lab managers. "LIMS should be about doing something interesting with the data, not just shoving the data into the software," Elliott said. "Scientists and managers want to spend their time reviewing data and making decisions, not merging data, moving it around, and processing it."

Barriers to LIMS Adoption

However necessary a LIMS might be, they can be difficult for organizations to adopt. One barrier is systemic. Many research organizations lack the resources to assess their existing processes and educate themselves about how LIMS can help. "How do you choose a system when you're caught up in the daily grind of running a lab?" Hall said. "You may have in place some basic informatics system that works. However, you can see down the line that when you add machines or change workflows, it won't."

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There is also the LIMS reputation problem, which can intimidate even the most interested lab. "LIMS are viewed as a pain to install, get running, and get people to use," Hall added. "In addition to overcoming the inertia associated with changing a known workflow, you're worried that you'll be getting this big LIMS octopus that is going to come in and take over everything."

Scientists tend to resist using LIMS for two related reasons. First, LIMS are perceived as rigid and inflexible. Scientists assume that modifying a workflow or protocol requires at best tweaking the programming, and at worst a complete overhaul of the system. "LIMS means rigidity to many organizations, having to change everything you are doing to work around the system, and when a protocol or study design changes, having to call in IT resources or vendor staff to build custom code," Elliott said.

The second reason scientists resist lab management systems is the perception that they slow lab work. Bolted-on functionality and poorly executed integration leads to overly complex and often illogical workflows and user interfaces. The typical LIMS user interface does nothing to streamline interactions or guide scientists through work. Many user interfaces seem to reveal the entire system to users, probably because functionality has simply been added without regard to which users need it. The result is often a maze of screens that

scientists must navigate to complete routine tasks. "It's not uncommon to start with one screen to design an experiment, move to another screen to interface with an instrument, and then open a third screen to pull data from multiple instruments together," said Elliott.

Hall remembered how he dealt with FrankenLIMS as a bench scientist. "Lab scientists have to get through a certain number of samples or protocols in a given amount of time, so if we can cut corners, we will," he said. "I would do my work and then go back to the LIMS when I had a break and enter my data. Which of course meant I'd forget exactly what I did or I wouldn't have what I needed for a given field. It was a mess."

Given experiences such as those described by Hall, many organizations use adoption by edict, where managers tell lab staff they are required to use the system. For example, Lundberg explained that her lab mandates LIMS use by requiring a LIMS-generated driver file to run experiments. Such tactics may ensure compliance, but they do little to improve reputation of LIMS. "Wouldn't it be better if, instead of being burdensome and intrusive, LIMS could take the drudgery out of doing lab work?" Elliott asked. "That they could aggregate data easier or faster, assist with planning complex tasks, and provide new insights that would make scientists want to use it?"

Improving the LIMS Experience to Increase Adoption

The primary barriers to LIMS adoption—slowing down lab work, inflexibility, difficulty of implementation—can be overcome by a focus on usability. In moving LIMS from analytical labs to various research workflows, many vendors forgot about the end user, said Elliott. "Scientists are concerned with questions like 'Where's my sample?' 'What work do I need to do on it?' and 'How do I get the results of that work into a report?'" Elliott explained. Scientists could also benefit from a way to answer other questions, such as, "What jobs are pending?" "Which samples didn't pass QC?" or "Which samples do I need to escalate to the lab manager?"

Innovations in software interface development and design provide an opportunity for LIMS vendors, particularly those introducing LIMS to emerging research areas such as genomics, clinical research, or translational medicine. "These workflows are still evolving, so vendors have a real chance to get out in front of that and define optimal workflows based on industry best practices and standard operating procedures," Elliott stated.

Using modern interface design principles, vendors can implement LIMS best practices in ways that guide rather than restrict. Workflow intelligence in a LIMS should be able to predict next steps based on action by the scientist. When a certain type of sample is entered, for instance, a LIMS might display logical next steps in a workflow. In addition to moving scientists along a narrow path, a critical factor in regulated clinical labs, LIMS can also monitor and record when and who accomplishes tasks and consumes resources. In this way, a LIMS

can aid scientists in their work and provide managers with ways to track overall project progress and lab productivity.

Fulfilling these roles requires LIMS to capture information automatically rather than relying on scientists to enter it after the work is completed. "As a scientist, I hated entering information in the LIMS," Hall said. "However, as a manager, I want to track each and every one of those fields so that I can find the often minute difference in a large sample set or answer questions about how many samples we are running, whether we are running at capacity, and which of my research associates are doing what," said Hall. Ideally, LIMS should be able to capture information automatically while applying group characteristics to samples in the same collection. Research can become faster and less error-prone by automating tasks. LIMS can streamline these tasks by smart integration with barcode readers, robotics, supporting lab instrumentation, and lab software such as patient information systems and analysis tools. Presets or drop-down options within a LIMS interface can also facilitate up-front data entry, experimental set-up, and execution of complex tasks.

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LIMS can also shift from hindering to helping. "The interface should provide a limited, logical menu of options that are descriptive of the work a scientist wants to do," Hall stated. Given the role of tracking end-to-end work in a lab, LIMS are well positioned to provide a window into lab operations. Scientists could open the LIMS and immediately see what work is in progress, what needs to be set up, and which results are ready to report. "Scientists don't care about the nuances of the various technologies involved—and they shouldn't have to deal with that," Elliott said. "They want everything on one dashboard and an interface that stays the same whether they are queuing up data, running an experiment, pulling data back into the LIMS, or reporting results. If a LIMS can do something compelling, like highlight outliers or flag out of spec stuff so that I don't have to hunt for it, that's even better," said Elliott. Supporting standard workflows is important, but because research processes and best practices continually change, developers must learn from LIMS history and provide easy ways for labs to configure and adjust the system over time. Configurable interfaces can help scientists tweak the LIMS to accommodate their personal style or role within an organization. Industry-standard application programming interfaces (APIs) can

empower labs to customize and extend the LIMS should scientists need to deviate from a standard workflow or install lab-specific requirements or integrations.

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In addition to making LIMS easier for labs to implement and scientists to adopt, LIMS vendors should provide support to labs as they evaluate their processes and install a system. "Implementing a LIMS is ultimately about changing business processes, so it's a much bigger task than simply installing a system," said Elliott. Modern LIMS vendors should provide dedicated project management teams to ensure that a lab is able to implement its selected system quickly and painlessly.

Conclusion

In most cases, modern LIMS differ little from those introduced 40 years ago, which explains their poor reputation among users. The primary reasons scientists resist using LIMS is that they are complicated, inflexible, and a hindrance to lab work. Modern research workflows require continual updates to this vital scientific software. Interfaces should be designed from the perspective of the scientists who execute the work or the managers who monitor overall lab operations and track productivity. Prebuilt workflows and integrations enabled by industry-standard APIs can enable labs to codify best practices, incorporate specific functionalities, automate processes, and streamline routine tasks. By focusing on improving the user experience, LIMS can become systems that facilitate, rather than inhibit, research and clinical lab work.

Learn More

To learn more about BaseSpace® Clarity LIMS, visit: www.illumina.com/products/by-type/informatics-products/basespace-clarity-lims.html.

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