LIMS vs ELNs

arch enemies or best of friends?

Since the first appearance of laboratory information management systems (LIMS) in the late 1960s, this technology has become commonplace in many, if not most, research and commercial laboratories. This considerable development in LIMS is in response to the increasing demands placed upon the management of data. Furthermore, partnering and product line extensions are becoming more prevalent, as LIMS vendors strive to maintain their presence. In this article, we explore how the current LIMS are evolving to meet an increasingly demanding customer base, and how they plan to co-exist with other popular laboratory data management utilities.

By David Morris

One of the many challenges that biopharmaceutical companies face is improving the throughput of drug discovery; information technology is an essential component of many aspects of this research, dramatically enhancing efficiency and productivity in this area. However, in most labs the crucial experimental layer between raw scientific data and business context is served by the paper lab notebook, which is a major bottleneck between the two. Time is spent on non-productive activities, such as manual data transcription, merging data from various sources for analysis, and writing reports and notebook entries. In essence, the scientist has become the 'data integrator', performing tasks that take time away from designing and performing experiments. There are a number of reasons for this inefficient use of valuable resources, but the large number of independent informatics systems and paper laboratory notebooks are primarily among them.

The past 50 years has seen LIMS widely adopted in application areas as disparate as pharmaceutical development through to diamond mining and forensic science. The ability of LIMS to link specific information to samples and projects has made them particularly popular in the QA/QC environments. Parallel to these custom-built LIMS implementations, efforts were made to create commercial proprietary LIMS, often developed by analytical instrument manufacturers. These commercial systems, while typically developed for a particular industry, such as the pharmaceutical industry, still required considerable customisation to meet a specific laboratory's needs. In particular, laboratories often require very specific format and reporting requirements. Yet, such demands for customisation increase the cost of the commercial LIMS and can extend the implementation time.

However, the data management landscape is constantly changing. As potential customers become more knowledgeable, and technologies produce more volume and context, the appetite for multiple systems support is reduced. As a result of this, combined with the universal need for time savings and productivity increases, vendors have had to respond accordingly. The last decade has seen a dramatic change in not only the way data is managed, but also the way data is regarded in the laboratory. Time is money, but so is data. Thus, due to these increasing demands placed upon the management of data, LIMS have had to evolve accordingly.

For many years, LIMS has been used to help manage R&D information with final experimental

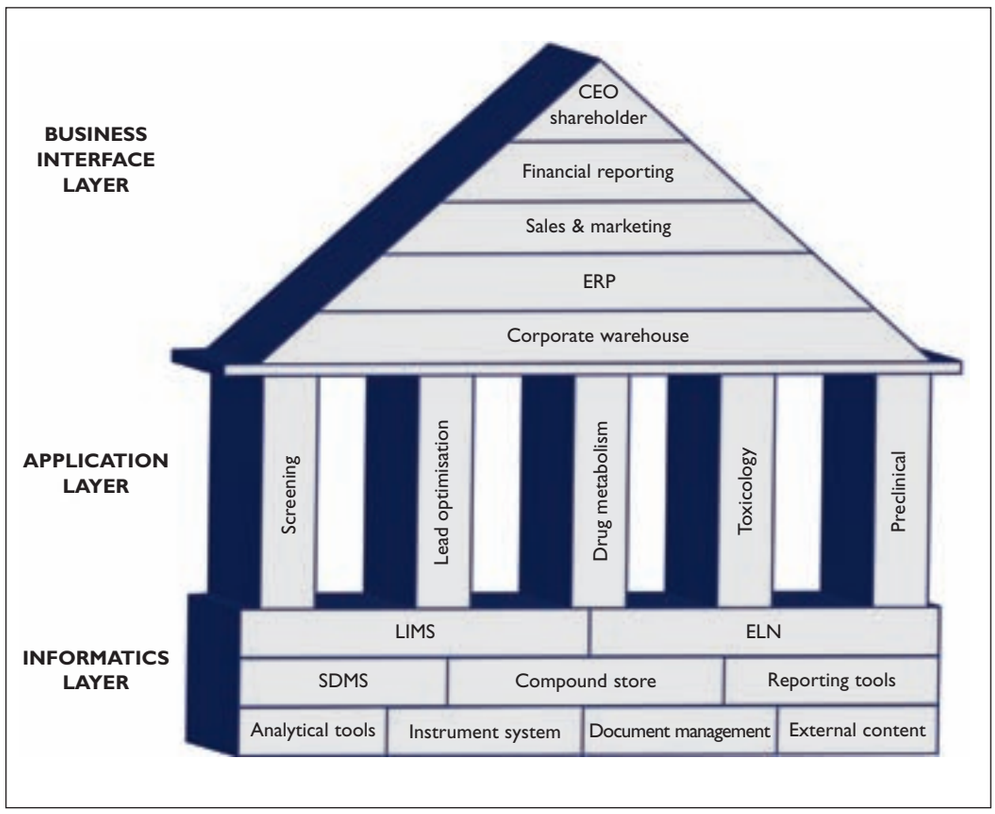

Figure 1: Integrating LIMS and ELNs can provide a platform to manage R&D and instrument data across departments, making information accessible throughout an organisation

results being entered into paper notebooks. LIMS is an excellent tool to manage structured information that is generated in the laboratory, search results for specific tests or gather information on samples and studies. However, the majority of recorded information in drug discovery and early stage development is often unstructured, such as documents, notebook pages, sequences, molecular models, spectra and images. These datasets are generally not suited to a structured LIMS database. In addition, the managed workflow capabilities of many LIMS are often too rigid to be useful for many research organisations, especially in early discovery. The need to protect, preserve and share R&D knowledge has lead to resurgence in the use of electronic laboratory notebooks (ELNs).

Complementing LIMS with ELNs

ELNs are relative newcomers on the data management scene, and have changed significantly since they first started claiming to replace paper records in the laboratory. The use of ELN technology has risen sharply in the past four years to become a mainstream laboratory informatics platform in biopharmaceutical companies. Over a quarter of the potential laboratory market has now implemented (or is in the process of implementing) an ELN in at least one department. Biopharmaceutical organisations continue to lead in both the installed base and demand. Year on year growth is still above 20%, making ELN one of the fastest growing informatics technologies. Like LIMS, ELNs are now used in a variety of application areas ranging from pre-clinical biology through to food and beverage and cosmetic companies. Drug metabolism, pharmacology and pharmacokinetics departments indicate very strong interest in order to automate manual spreadsheet processes. Drug discovery research continues to dominate the number of ELN installs, predominantly for synthetic chemistry reaction planning and experimental documentation. However, this segment is highly penetrated; stronger growth over the next few years will come from other domains, such as biology, which offers a greener field of opportunities. Indeed, the largest potential area of expansion for ELNs is in analytical chemistry, which naturally spans R&D, quality and service laboratories.

An ELN can be defined as 'a secure system assembling scientific content from multiple sources related to each other, allowing for contextual

annotation, and packaging it in a legally acceptable document to be searched, mined and collaborated'. Starting out as eco-friendly ways to reduce the amount of paper a laboratory consumes, high-end ELNs are now considered much more than simple replacements to paper lab notebooks, incorporating complex workflow support, web services, digital and electronic sign off, analysis and reporting capabilities. These systems have not only led to increases in laboratory efficiency and improved leverage of institutional knowledge, but also to enhanced protection of intellectual property (IP). Based on technology that manages the underlying electronic records, ELNs can provide the access security, version control, record authentication and automated time stamping that their paper forebears cannot. ELNs provide the final repository of data and information that is used to support a patent and protect intellectual property, and complement the traditional use of LIMS in R&D.

A perfect ELN system should capture all the information that a scientist generates and store it in an open format that enables easy, controlled access. By providing a central searchable location to store all the information, data and IP generated from a scientist's workflow, an ELN solution allows 'know-how' to be disseminated easily through an organisation, as new procedures are implemented centrally and viewed immediately by users. Thus the laboratory notebooks of any organisation can become what they were intended to be: a data resource for decision making, IP security and learning.

With the rising popularity of ELNs and their growing functionality and applicability, is the distinction between where LIMS ends and ELN begins becoming blurred? Partnering and product line extensions are becoming increasingly prevalent, as LIMS and ELN vendors strive to meet a more demanding data management consumer.

LIMS versus ELNs

Although LIMS systems have extended their functionality to address the diverse requirements of many industries, the basic LIMS concepts and workflows have not changed significantly. Typically, the user must follow a pre-defined rigid workflow enforced through the LIMS, allowing an organisation to track samples and compile reports of data generated against samples or batches. However, LIMS cannot easily store relevant data alongside the test results, lacking the ability to capture 'context'. Many organisations now require a single corporate data repository to electronically store all their scientific data, usually in LIMS, scientific data management systems (SDMS), document management systems, corporate warehouses and file stores. In accommodating this need, ELNs are being heralded as the next generation of LIMS.

Both LIMS and ELNs claim flexibility, both save time and money, and both are central to data management requirements. Discussion forums are full of definition and counter definition regarding what they are and what they do. The ELN- and LIMS-centric views of the data management landscape perhaps make a unifying definition difficult, yet not impossible. But all generally agree that LIMS and ELNs are different yet converging technologies.

Michael Elliott, CEO of Atrium Research and Consulting LLC, a leading authority on data management, explains the differences between the two technologies. "The chief differentiator is that LIMS tends to be workflow-centric, following a specifically defined process. That is one reason the technology has failed in discovery. ELNs tend to be more 'ad hoc' and 'personal' to the scientist, since it adapts to individual ways of working, while LIMS workflow tends to be structured by management and IT and therefore, less adaptive."[1]

The ability to set workflow at management level makes LIMS ideally suited for regulated environments, where workflows must be strictly adhered too. Conversely, this rigidity is not suited to research and discovery environments, where workflows and types of data can change. Structured data that exist in QA/QC environments or manufacturing is well suited to processing by LIMS. Unstructured data that is commonplace in research environments, and the need to adapt workflows accordingly, is better handled by an ELN system.

The fact that these systems, while sharing some of the same language in their respective descriptions, perform different functions within the laboratory and manufacturing environments, has prompted vendors of both solutions to adopt new strategies to provide a complete solution. Recently, STARLIMS introduced an ELN of its own to complement its LIMS and SDMS offerings. This introduction is focused on the replacement of the paper lab notebook and support for QA/QC workflows, an area where LIMS systems have always been particularly strong.

"The use of a common technology eases the support issues associated with multiple systems and the unified approach means that there is no need to develop costly interfaces between the various products; interfaces which typically require testing, validation and possibly updating as new versions are released," says Dr Simon Wood, Executive

Director of Marketing and Education at STARLIMS. "By developing a unified laboratory informatics architecture that meets the major data and information management needs, STARLIMS is helping laboratory-based organisations meet many of the challenges facing them today. Furthermore, by removing the traditional barriers between types of laboratory data, it eliminates multiple searches and 'lost data', and ensures that users throughout the organisation have timely access to the data they need to make informed decisions, maximising the value of information resources."

Conversely, Thermo Fisher Scientific is committed to providing comprehensive informatics solutions in partnership with other industry leaders, so that the appropriate tools are available for the specific needs of any application. Its Thermo Scientific Watson LIMS™ is widely used in the preclinical area of bioanalytics, currently boasting 18 of the top 20 pharmaceutical companies as users. An established user of LIMS from Thermo Fisher Scientific, the Veterinary Laboratories Agency (VLA) is an executive agency of the Department for Environment, Food & Rural Affairs (Defra) in the UK. For more than 100 years, the VLA has been delivering research, surveillance and laboratory services for animal and public health. The VLA currently employs the Thermo Scientific SampleManager LIMS™, which is fundamental to providing high-volume laboratory testing, surveillance and disease outbreak capabilities.

The flexibility offered by a highly configurable LIMS is critical in support of rapid scaling-up of laboratory throughput during disease outbreaks such as Foot & Mouth, Bluetongue and Avian Influenza. Commenting on the need to transfer the benefits of LIMS to the less rigid workflows of the Agency's research activities, Terry Stacy, IT Manager at VLA, said: "VLA's evaluation of ELNs indicates products such as IDBS E-WorkBook can fill this gap and offer an intriguing informatics solution to research scientists. However, the ultimate challenge remains to integrate the technologies to provide Agency-wide, auditable sample tracking from our routine and outbreak surveillance testing through to a wide range of scientific research on veterinary diseases."

It is apparent that both LIMS and ELNs are evolving to meet an increasingly demanding customer base, but it still remains to be seen how they plan to co-exist or not. The changing landscape is also reflected in the customer engagements seen by ELN vendors. Integration has always been important, but perhaps now more than ever. IDBS is currently working with a number of large pharmaceutical and biotech customers on multi-site ELN implementations.

One recurring requirement is the exchange of information with incumbent LIMS systems, as Dr Paul Denny-Gouldson, Product Manager for the E-WorkBook suite at IDBS, explains. "Customer expectation has changed significantly over the past few years. Providing a replacement for paper or an IP archive with a single domain-specific technology is no longer sufficient. Customers expect compliance support, analytics, task flow management, integrated searchability across all data and IP control under one umbrella. In addition to specific extensions to cater for application areas, customers demand seamless integration with existing and future instrumentation, data analysis tools and a wide range of data stores including LIMS.

"Organisations require the flexibility to rapidly define and optimise workflows, which may include passing tasks to domain-specific LIMS and receiving data in return, then the ability to rigorously lock them down. Particular examples of this are in pre-clinical safety/DMPK evaluation and process development, where data collected may be both quantitative and observational and high levels of data control are required. The customer's view is becoming less focused on what a product is called, and more to do with what value that system delivers in demonstrable ROI, ease and speed of deployment and the provision of context-rich data. E-WorkBook Suite, with chemistry and biology extensions, provides data management, analysis and workflow control for ROI in research and development environments."

Product line extensions, partnerships and improved integration all help enhance the end user experience, by accessing data, turning it into knowledge and ultimately making decisions upon it, in a timely, efficient manner. So why is there such confusion between LIMS and ELNs? As mentioned previously, part of the problem could be the shared language used by ELN and LIMS vendors. Take 'data management' as a start point – this can mean many things to many different people. Terms like 'searching' and 'reporting' perhaps need to be better qualified so users understand what they are being offered. Both systems have been, and will continue to be, successful because they add context to data.

Conclusion

Changes are evolving to remove the barriers between the various structures of information that have propagated in the last decade. The laboratory

References

1 Elliott, M. Electronic Laboratory Notebooks: A Foundation for Scientific Knowledge Management. Edition I; Atrium Research & Consulting LLC; Wilton, CT, USA (2004).

is not unlike many other business environments that are supported by information technology, and there are common difficulties in the implementation of an information system in all industries. Given the wide range of laboratory types and operations, it is difficult to make any clear evaluation of the technologies without considering how they might be used.

While there are still major areas of overlap between ELN and LIMS, in general the difference can be summarised as LIMS are better for managing structured information and ELNs are better for more disparate, unstructured information. Some labs need a traditional LIMS, others a flexible ELN. Thus, the overlap between ELNs and LIMS is inevitable, as each has expanded their feature sets into each other's spaces.

However, the market for ELNs is dynamic and has grown beyond the early adopter stage to become a mainstream informatics necessity, and the benefits and competitive advantages are being realised by those who have made the investment. However, ELN, LIMS, SDMS, Enterprise Content Management (ECM), or any other technology category acronym is not the solution to all data management challenges in the laboratory. Based on the current evolution of the market, each technology has its place and so careful attention must be paid to the definition of your laboratory informatics strategy, process analysis, project planning and change management to ensure project success. DDW

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