SPOTLIGHT feature

LIMS & Lab Automation

A three-step plan for digital transformation

Trish Meek, Senior Director of Product Strategy and Marketing, Thermo Fisher Scientific

Digitalisation and automation have rapidly accelerated the efficiency and quality of laboratories in recent years, driving them forward on their digital transformation journey. Advanced software and hardware technologies are being embraced across many sectors, and laboratories are continually adopting new instruments and methods for data acquisition, and implementing digital systems to streamline workflows.

The advantages of automating science are numerous, from increasing levels of throughput, streamlining workflows, minimising human error, and improving data quality, integrity and reproducibility. Automation can take place on any level, from simple tasks, like calibrating hardware systems, to the orchestration of complex, multi-part laboratory ecosystems. Advanced digital solutions like data management and analytics software, and automation hardware, such as robotics, are just some examples of the tools modern laboratories use to accelerate scientific progress as part of their ongoing evolution.

The importance of having a digital transformation strategy has been confirmed by a recent Accenture survey, which discovered that while 93% of chief scientific officers know transformation is imminent, only 20% feel prepared for this innovation [1]. So, even with a high awareness of the expected industry disruption, why do such a large proportion of senior scientists experience barriers to entry for digital transformation?

One of the biggest perceived issues is the possibility of disruption to workflows during implementation. While it is true that changing workplace practices can be challenging, there are proven step-by-step processes that support laboratories with this digital transition. These workplans hinge on solutions like laboratory information management systems (LIMS). LIMS play a pivotal role in digital transformation by integrating instruments for connected end-to-end workflows, automatically storing and tracking data, and helping to drive productivity through features such as maintenance planning. In essence, LIMS work as a digital science workbench around which automated hardware and intelligence systems can function.

In this article, we discuss the importance of digital solutions in driving automation, and the steps laboratories can take to progress their digital transformation journey. This includes the importance of connectivity, and how this can facilitate automated, end-to-end workflows and advanced analytics, allowing scientists to analyse data in ways that wouldn't otherwise be possible.

Digital systems: the spearhead of automation

Automated science is often regarded as being built on three foundational pillars:

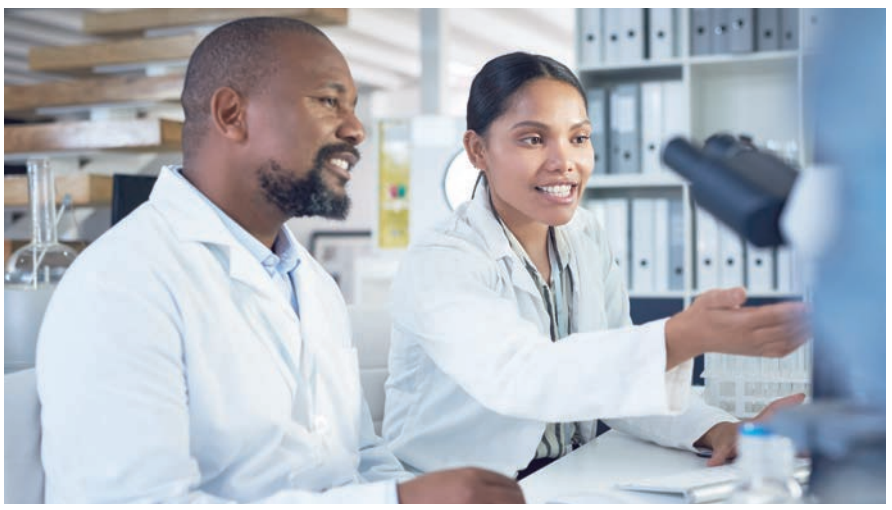
1. Physical automation. This involves all equipment and hardware with capacities for automation, including tools such as automated high-throughput screening devices and robotic sample handlers.

2. Data infrastructure. Digital solutions create an infrastructure that connects instruments with cloud-based technologies and centralised databases, allowing them to be accessed from multiple computing systems, smartphones and tablets. LIMS and electronic laboratory notebooks (ELNs) are dedicated software connectivity tools that enable the generation of standardisable, sharable data and ultimately provide the digital backbone for automated infrastructures. Additionally, digital systems can further increase automation through features such as automatic ordering of reagents and consumables.

3. Artificial intelligence (AI). Advanced software uses data science approaches like deep learning to analyse large volumes of data and generate insights that inform predictive science and intelligent workflows. Once fed enough data, AI can drive discoveries and push science to new levels.

While digital infrastructure is itself one of the pillars, digital solutions also play a pivotal role in connecting all three pillars together, helping to automate science by integrating instruments for connected end-to-end workflows. They act as the essential links between physically automated devices, the user and advanced analytical approaches, automatically storing and tracking data, and helping to drive productivity.

In particular, systems, such as Thermo Scientific SampleManager LIMS, help organisations to increase automation, and ultimately achieve digital transformation, by supporting laboratories to better connect instruments and data, and organise samples and associated information. LIMS software can manage standard operating processes for analytical instruments and collect large amounts of high-quality experimental and operational data automatically, securely storing it so it can be analysed manually or by deep learning algorithms. By improving connectivity and making data more easily accessible and shareable, LIMS software provides increased visibility and control over processes and improves capacity for automation, collaboration and intelligent data analytics.



Built-in data settings also ensure both experimental and operational data is compiled and stored in an organised manner, making it traceable, auditable and compliant with regulations. Furthermore, the gathering of operational data means LIMS can monitor laboratory systems in real-time and automate more processes, such as reagent stock monitoring and ordering, instrument calibration, and flagging when instruments need maintenance.

Collectively, digital solutions enable scientists to spend less time on menial tasks and more time utilising their specialised skillsets. When these systems are implemented, a platform is created for intelligent workflows to be built.

The three stages of digital transformation

But how do laboratories reach this stage of game-changing digital transformation? Every laboratory's transition process will be different, and projects aimed to integrate software and hardware systems often encounter challenges. For example, projects can see delays, high costs, and often result in disconnected user experiences and inconsistent audit trails. To avoid this, laboratory changes can be approached systematically based on their goals, resources and budget. While specifics may vary between organisations and laboratories, there are three key steps to implement a successful transformation:

1. Connect everything

The critical first step of digital transformation. It begins with connecting everything in the laboratory, including the instruments, consumables, people, workflows and data. Using informatics tools, like LIMS and ELN, laboratories can build a digital science workstation where data is findable, accessible, interoperable and reusable (FAIR) [2]. As well as working to drive data integrity throughout all processes, LIMS can be used to link up analytical instruments and other systems, like global manufacturing operations. By integrating all aspects of an organisation, from research to manufacturing and beyond, organisations can get a more holistic view of their operations and achieve increased process control.

2. Automate end-to-end workflows

The next step is implementing automated instruments and workflows, and connecting these systems into the digital laboratory. Laboratory automation is designed to maximise throughput, standardisation and reproducibility. By reducing manual tasks, automated systems decrease hands-on time and minimise potential human errors. When implemented well, interconnected automated instruments also enable laboratories to flexibly scale-up. Laboratories can start with standard journeys, like automating simple instruments and interconnecting benchtop instruments in a workstation. This can then be scaled-up to a larger transformative process that integrates and automates multiple instrument platforms and experiments to form an end-to-end connected workflow.

3. Utilise advanced analytics

Finally, integrating automated physical and digital platforms with tools and services like e-commerce and data analytics builds one intelligent ecosystem that provides predictive support for scientists. For advanced data analytics, this relies on artificial intelligence (AI) to analyse all the data created by the various automated solutions. For example, machine learning algorithms can create meaningful insight from data, while deep learning algorithms go further to generate more abstract information from that data. The more data that is inputted, the more trends are identified, meaning AI can be used to streamline operational processes and drive discovery. However, you need to be putting the right data in to get accurate results out, which is why effective data management and data integrity are so important.

A pathway to digital transformation

Many laboratories see digital transformation as a vital way to drive innovation and enable faster and more secure production routes, but also feel unprepared for this transformation, and find it challenging to overcome the barriers for successful implementation.

While every laboratory's digital transformation process is different, using common elements of these three stages can transform any laboratory, based on their goals, scope and budget. Enhancing productivity through connected laboratory pipelines can accelerate scientific output. A strong informatics infrastructure, including tools such as LIMS and ELN, can then be the foundation for automating individual or larger networks of instruments. In the end, after the steps to connect workflows and increase automation are implemented, laboratories can begin to consider implementing intelligent analytical systems, enabling scientists to utilise their data to its full potential and reveal insights that wouldn't otherwise be uncovered.

References

1. Disruption need not be an enigma, Accenture, February, 2018 [https://www.accenture.com/us-en/insight-leading-new-disruptability-index]

2. FAIR Principles, GO FAIR, [https://www.go-fair.org/fair-principles/]