

Digital Tools as Solutions: Interconnecting the Lab of the Future



In the dynamic landscape of life science research, scientists turn to digital hardware and software that improve upon existing laboratory processes.

Researchers working in a 21st century life sciences laboratory face abundant technological opportunities, but also a collection of challenges. As the research setting continues to transform into a hybridized hub of automation, large scale discovery, and broadening expertise, digital tools are needed to overcome obstacles standing between the lab of the present and the lab of the future.¹

Pain Points in the Present

The advent of higher throughput methods and newer technologies enables more scientists to investigate previously unanswerable research questions, but experimental reproducibility, administrative challenges, and information silos are common pain points that hinder progress.^{1,2}

Reproducibility is crucial in scientific research. Despite this, scientists face widespread difficulties reproducing experimental findings, which wastes time and resources. Many factors contribute to irreproducibility, including an ever-evolving life science research landscape and a lack of standardized workflows, both within laboratories and between research groups.²

Instrumentation, protocol, and training variability exacerbates reproducibility challenges.² “The lab is a very heterogeneous space, where people interact with more than 10 different types of instruments every day,” said Marco Ravot-Licheri, head of Digital Life Sciences Business at Tecan, who develops and implements digital strategies for life science research. “At the moment, these instruments are not always fully integrated, and people have very different ways of operating them.” Even when researchers in one laboratory have access to the same instrumentation as another, differences in instrument upkeep and



Marco Ravot-Licheri drives digital strategies for life science applications at Tecan.

IMAGE PROVIDED BY MARCO RAVOT-LICHERI

operation contribute to both irreproducibility and administrative burden.^{2,3}

Scientists continue to work towards standardized experimental design, data analysis, and transparent processes, but information silos often get in the way of these efforts.^{3,4} For example, drug discovery and development increasingly relies on large and exclusive datasets and insular process management systems. This creates a closed research ecosystem that does not reach its full discovery potential.⁴

Moving Towards a Lab of the Future

These hindrances are interconnected, and addressing one challenge ultimately feeds into solving another. To this end, digital tools for life science research encompass both hardware and software solutions to a variety of common challenges.⁵ The concept of the Lab of the Future emphasizes integrating data and digital solutions, such as automated workflows, laboratory connectivity, and information management, to create open ecosystems that benefit collective research breakthroughs.⁶ “An open ecosystem enabling all instruments to be interconnected is the key to bridge across current data and process silos. This is a fundamental enabler to make automation simple and unlock new discoveries,” said Ravot-Licheri.

Enhancing experimental reproducibility

Digital solutions that incorporate the strengths of artificial intelligence (AI), data science, connectivity, remote control solutions, and cloud-based platforms improve reproducibility within and between laboratories.^{7,8} These technologies help scientists standardize protocols, automate workflows, and monitor experiments in real time with less manual dependence, improving consistency across workflows. Intuitive user experience to operate lab instrumentation coupled with integrated data records allow researchers to easily perform, record, and share detailed experiments, further facilitating transparency and reproducibility.^{8,9}

Breaking down information silos

Scientists use digital tools such as integrated data management systems to improve crosstalk within and between research teams. For example, cloud-based systems help researchers store and share data virtually, integrating experiments, analyses, and data curation platforms for better access and enhanced efficiency.^{6,7} Furthermore, scientists can use AI approaches such as machine learning to analyze, sort through, and clean up vast datasets, accelerating the discovery process.^{6,10}

Streamlining administrative processes

Researchers can lower administrative burdens with digital regulatory documentation, automated training processes, and smart laboratory equipment for predictive maintenance.^{7,11} These tools free up valuable laboratory time by streamlining administrative aspects of the scientific process.

“Starting from a seamless setup that significantly lowers the barriers to access the lab, to intelligent



Intuitive data management tools improve reproducibility and help create an open ecosystem.

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automation that minimizes the errors and ensures full reproducibility of experiments, insightful analytics that really help scientists make the most out of the lab experiments, and all the way to predictive maintenance to make sure that the instruments are always up and running,” said Ravot-Licheri. “All of this, in the Lab of the Future, is interconnected.”

Digital Analytic Tools that Make Lab Automation a Reality

Automating hardware in the Lab of the Future depends on digital analytic software, such as Introspect™ from Tecan. This powerful laboratory management software increases instrument productivity and enables scientists to remotely monitor their devices. “With Introspect, we started our exciting digital journey. It is a tool that provides actionable insights on how to increase the overall equipment effectiveness,” said Ravot-Licheri.

Ravot-Licheri likens Introspect to a fitness application for the lab; instead of monitoring the number of steps someone takes or calories burned, Introspect allows scientists to monitor the needs of their instruments in real time. “I can use a fitness app to see whether I am training correctly, overtraining, or undertraining. Introspect follows the same concept but for the fleet of instruments in the lab,” he explained. “You can see your level of health in terms of, am I really utilizing it enough? What’s the quality of my work, or what’s the actual performance of the instrument? What can I do to prevent “injuries” or, applied to the lab, how can I prevent errors?”

This software incorporates AI-based data science and increased usability to improve laboratory management across different types of industries, including pharmaceutical, biotechnology, and clinical

diagnostics. Scientists use Introspect to access data-driven insights on smart devices, such as laptops or cell phones, which makes this software a go-to digital tool for laboratory managers and operators trying to improve administrative processes and instrument standardization.

Digital Tools of the Future

In the Lab of the Future, digital tools will unify instrument operation and data management by connecting every scientist involved in a project. Building on the success of Introspect, Tecan is moving in this direction with LabNavigator™, a single pane of glass for operating and programming workflows that bridges the gap between manual and automated processes.

“It is really about simplifying the way to perform an end-to-end process,” Ravot-Licheri said. “If you think about what happens in the lab today, you have some manual steps, then you have some automation steps, and then you have some additional steps. Currently, all of this is very siloed. With this tool, all steps are easily followed from a single interface. This allows the experts to work only once to set up the workflow and then to multiply their impact by enabling novice lab operators to make an impact from day 1. What’s more, this is about getting things right, by enabling error minimization, higher reproducibility, and detailed tracking.”

LabNavigator is an intuitive interface that enables scientists to operate and program experiments across multiple devices and manual steps, for better productivity and reproducibility. “Imagine getting into a lab and receiving a tablet with all the instructions needed, guided with pictures, videos, clear explanations, clear physical orientation in the lab, as well as the possibility to run instruments in a vendor-agnostic way from this intuitive platform,” said Ravot-Licheri.

Instead of having to learn several different interfaces, researchers can perform every aspect of process management from this simple device, making it easier for scientists to contribute to multiple research teams and collaborate more effectively, moving further toward an open ecosystem laboratory.

Walk the Talk: Putting Digital Tools into Practice

Digital software and hardware for life science breakthroughs such as Introspect and LabNavigator

are conceptualized, tested, and brought to fruition at the House of Life Science Lab, a multifunctional innovation space that brings together cross disciplinary teams of biologists and engineers. The House of Life Science Lab embodies what scientists do best: identifying a problem or research question, investigating the root of it, and building solutions.

“At Tecan, we want to walk the talk. A lot of the ideas behind our digital products came from researchers, from our customers, and from scientists working at the House of Life Sciences Lab,” explained Ravot-Licheri. “Starting from, what’s the pain point of the scientist? Then developing the technology to solve it, rapidly prototyping it, and putting it in the actual hands of the scientists.”

Researchers in this real-life lab perform a variety of multi-omics applications, ranging from liquid biopsy assays to cell line development and beyond. Along the way, they test and showcase the power of digital laboratory tools that reimagine what is possible, both in the future of life science research and in present day discovery.

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