

Automated
Digital Lab

Guide to achieving an automated digital lab

Insights and solutions
to drive productivity

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Introduction

One of the most significant transformations in modern laboratory operations is the shift from manual, disconnected processes to integrated, digital, and automated workflows. This evolution represents a fundamental change in how scientific work is conducted, documented, and leveraged for discovery.

Traditional laboratory practices, built on paper records and standalone instruments, served science well for decades. However, as research demands intensify and regulatory requirements become more stringent, the limitations of these approaches have become increasingly apparent. Manual data transcription introduces errors, disconnected systems create bottlenecks, and paper-based documentation struggles to meet modern compliance standards.

In response to these challenges, the need for automated digital lab transformation has become increasingly essential, offering a path to reshaping laboratory operations across pharmaceutical

development, biotechnology research, and clinical diagnostics. By embracing digital infrastructure and laboratory automation, organizations can achieve unprecedented levels of efficiency, reproducibility, and scientific impact. These integrated systems reduce manual intervention, eliminate data silos, and enable laboratories to operate with the speed and precision that contemporary science demands.

This eBook explores the journey to automated digital science and provides practical guidance for laboratories at every stage of digital maturity. It examines the forces driving digital transformation, presents a clear framework for assessing your laboratory's current capabilities, and offers actionable strategies for progress. Whether you are just beginning to digitize core workflows or advancing toward fully intelligent automation, this guide provides the insights needed to navigate change effectively, select appropriate solutions, and build partnerships that accelerate your laboratory's evolution.



The case for the automated digital lab

The pressure has never been greater

Breakthrough discoveries are happening at an accelerated rate. Advances in genomics, cell therapy, precision medicine, and artificial intelligence (AI)-driven drug discovery have compressed elements of scientific exploration that once took decades into months. Yet at the same time, the cost and complexity of bringing new therapies to market continues to rise. Despite unprecedented scientific insight, productivity in drug development has declined over time—a challenge often described as Eroom's Law.¹

This paradox defines the modern laboratory environment: scientific possibility is expanding, but operational, regulatory, and economic pressures are intensifying. More data is generated than ever before, yet translating that data into approved, scalable therapies remains slow and costly. Laboratories are not constrained by imagination; they are constrained by fragmentation, manual workflows, disconnected systems, and the growing burden of compliance.

Across the scientific industry, labs are shifting from disconnected instruments and manual processes to fully integrated digital environments. In these modern labs, AI is becoming a partner at the bench, elevating decision making and accelerating insight generation. Orchestrated digital workflows and automation free scientists to take on higher-value tasks by removing repetitive, method-driven work.

This automated approach is rapidly becoming standard practice across pharmaceutical development, biotechnology research, and clinical diagnostics. The question is no longer whether to embrace digital transformation and lab automation, but how to effectively use solutions that let a lab reach its potential and establish a sustainable, and scalable rhythm of innovation.



With aging populations globally and chronic disease incidence projected to rise

**>20%
by 2030,**

growing numbers of clinical samples will overwhelm traditional manual processes.²



**More
than half**

of preclinical research is unreproducible, highlighting the critical need for digital systems that eliminate variability.³



With

**43% of
pharma
companies**

struggling to find digitally skilled talent, laboratories can't rely on hiring alone, making user-friendly automation essential for bridging the capability gap.⁴

The forces driving change

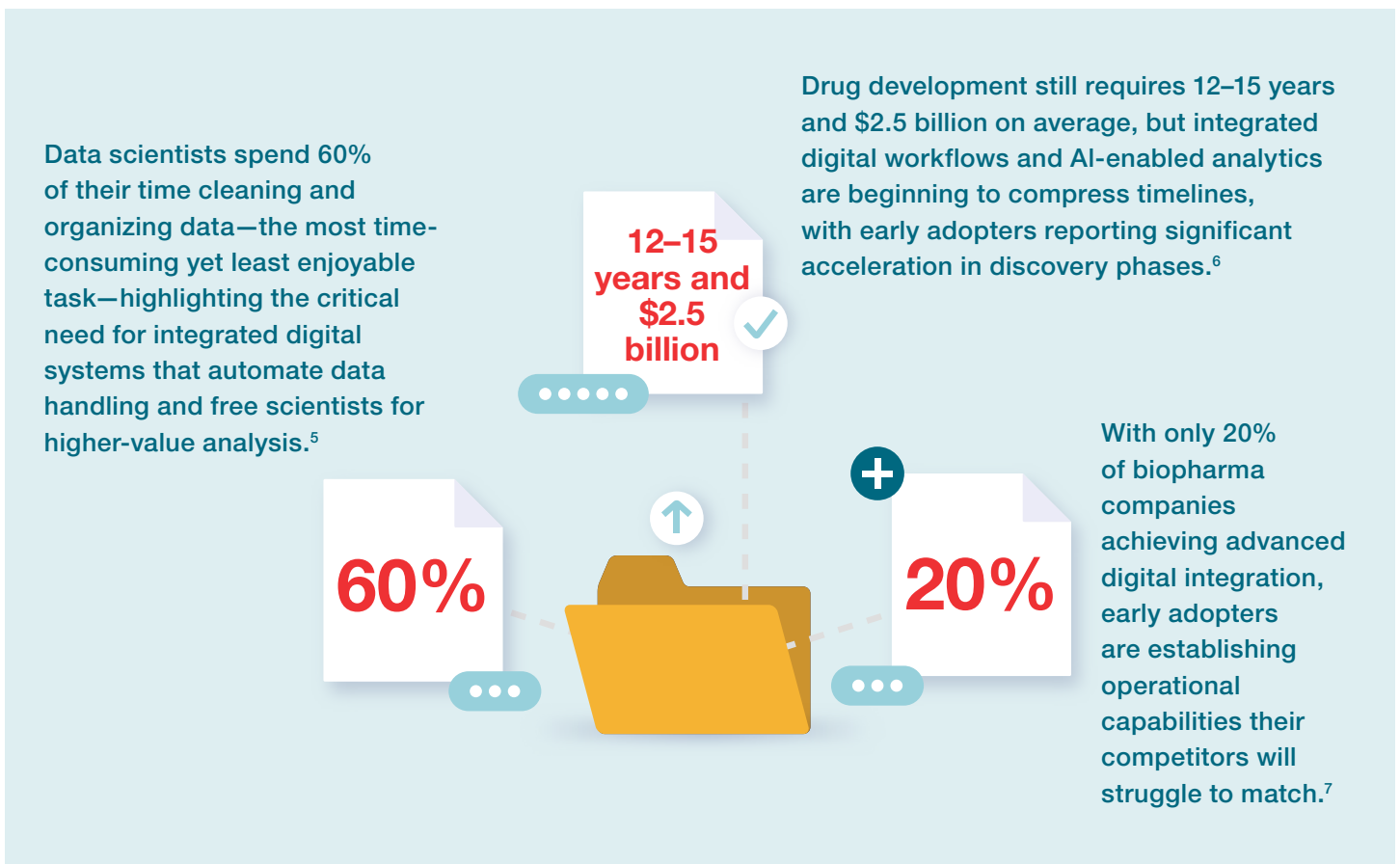
The laboratory landscape is being reshaped by advances in technology that demand a fundamentally different operational approach. Understanding this landscape is essential for any organization, regardless of where it is on its digital journey.

Laboratory workloads continue their exponential growth as precision medicine, high-throughput screening, and multi-omics approaches become standard practice. Manual workflows that once handled hundreds of samples now face thousands—or even tens of thousands—creating bottlenecks that slow scientific progress. As a result, scientists spend valuable time on repetitive tasks instead of applying their expertise to complex problem solving and experimental design.

But volume isn't the only challenge. New analytical approaches are required to match the complexity and richness of modern datasets. This is where AI and machine learning are pushing the boundaries of what is possible: identifying patterns across complex datasets, flagging anomalies before they propagate through workflows, and generating insights that would be impossible to detect manually. Successful labs aren't just processing more samples, they're leveraging AI to extract more value from each sample, transforming raw data into actionable scientific knowledge with unprecedented speed and accuracy.

Data integrity has also become a worldwide focus for regulatory agencies, with requirements becoming increasingly stringent for complete traceability, electronic audit trails, and robust quality management systems. Traditional paper-based systems and manual documentation create inherent risks, including transcription errors, incomplete records, difficulty reconstructing timelines during audits, and challenges demonstrating data provenance. The solution lies in interoperable systems that allow data to flow seamlessly across the entire laboratory ecosystem—from experimental design and execution to analysis and reporting—creating the digital continuity that regulators increasingly expect.

Talent constraints are also accelerating the adoption of automation; experienced laboratory scientists are in high demand across all sectors. Training takes time, retention requires engaging work, and losing institutional knowledge creates operational risk. Forward-thinking organizations are responding by deploying automation and digital solutions that handle repetitive tasks, freeing scientists to focus on higher-value work requiring human judgment and creativity. When routine operations run automatically, scientists can dedicate their time and cognitive energy to experimental design, data interpretation, problem solving, and the creative thinking that drives breakthrough discoveries.



What digital transformation delivers

When a lab embraces digital science and automation strategically, the benefits cascade across every dimension of operations. Perhaps the best way to understand the impact is to see it through the lens of a typical lab day.

Imagine arriving at your lab in the morning to find that overnight, while you slept, robotic systems processed 2,000 samples through a complete analytical workflow. The data is already in your electronic laboratory notebook (ELN) or laboratory information management system (LIMS), quality checks are complete, and results are waiting in your dashboard, all before you've taken a sip of your morning coffee. This scenario isn't aspirational, it's the reality in today's automated, digitally transformed lab.

Automated systems run continuously, processing samples around the clock without fatigue, delivering results with faster turnaround times that accelerate research timelines and improve service delivery. Robotic platforms execute protocols with unwavering consistency and speed that surpasses manual operations, eliminating the variability introduced by different operators or shifts. Meanwhile, workflow scheduling software optimizes equipment utilization to ensure that expensive instruments operate at peak efficiency while minimizing idle time. The cumulative effect is a laboratory that accomplishes dramatically more with existing resources, meeting growing demands without proportional increases in staffing or space.

However, automation alone does not deliver transformation if it operates in silos. True performance gains emerge when instruments, software platforms, robotics, and data systems are integrated into a coordinated digital ecosystem. In a fully connected laboratory, data flows seamlessly from experimental design to execution and analysis. Workflow orchestration software initiates runs, verifies reagent and consumable availability, schedules work across instruments, and directs the robotic movement of plates and samples between systems. Results are aggregated automatically into centralized dashboards and ELNs or LIMS environments, creating a unified, traceable data record.

When this digital continuity is established, data does more than report outcomes—it informs the next action. AI-enabled analytics can identify patterns, optimize parameters, and recommend subsequent experiments, creating a feedback loop that continuously improves performance. The lab evolves from a collection of capable technologies into an intelligent, self-optimizing system.

Manual processes introduce variability that even the most skilled scientists cannot eliminate. Human factors like fatigue, distraction, and subtle differences in technique all contribute toward inconsistencies that accumulate and can compromise data quality. In fact, more than half of preclinical research proves irreproducible, representing not just scientific setbacks but also billions of dollars in wasted resources.

Digital systems eliminate this variability by executing protocols identically every time, with precision that human hands cannot match. They support quality by design, automatically capturing comprehensive metadata, maintaining complete audit trails without additional effort from scientists, and flagging anomalies in real time before they propagate through downstream processes. This built-in quality infrastructure not only improves scientific rigor but also simplifies regulatory compliance by ensuring that all required documentation exists and is readily accessible.

Digitally connected workflows also facilitate collaboration across teams and disciplines by making data immediately accessible, searchable, and shareable. Researchers can build on each other's work more easily, identify patterns across datasets, and make connections that might otherwise remain hidden in disconnected systems. Innovation flourishes when brilliant minds spend their time thinking rather than transcribing.



A journey, not a destination

The transformation into an orchestrated digital lab isn't a single destination—it's a journey that unfolds in stages, with each laboratory progressing at its own pace based on unique goals, resources, and scientific priorities. A small academic research lab faces different challenges than a large contract testing organization. A biotech startup has different needs than an established pharmaceutical manufacturer with legacy systems and established workflows.

Every lab sits somewhere along a maturity continuum, from foundational digitization to fully intelligent, AI-enabled automation. With the appropriate roadmap and the right portfolio of solutions, every lab can progress at the pace that makes sense for their needs. This allows them to build capability incrementally, reducing risk through phased implementation. Organizations learn from each stage, adjust strategy based on results, and maintain operational continuity while evolving capabilities.

The automated digital lab isn't a distant vision reserved for the largest, most well-resourced organizations; it's a practical reality that laboratories around the world are building right now, regardless of size or sector. These labs are demonstrating that thoughtful investment in digital infrastructure and automation delivers tangible returns: faster time to results, higher data quality, improved compliance posture, better resource utilization, and enhanced scientific productivity.

The question isn't if or when your lab will make this journey, but how to navigate that change in a way that maximizes benefit while managing risk and maintaining focus on your core scientific mission.

Where does your lab stand today on this journey? In the next section, we'll introduce a clear framework for assessing your laboratory's digital maturity and help you discover the next steps to take on your own digital transformation journey.

Where does your lab sit on the digital maturity curve?

The BioPhorum Digital Plant Maturity Model (DPMM) 3.0 provides a practical, industry-recognised framework for evaluating digital readiness across biopharmaceutical manufacturing. From paper-based processes to fully automated, data-driven operations, the model helps organisations identify where they are today — and chart a path toward automated digital lab transformation.

[Learn more](#)

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Discover your lab's path to digital transformation

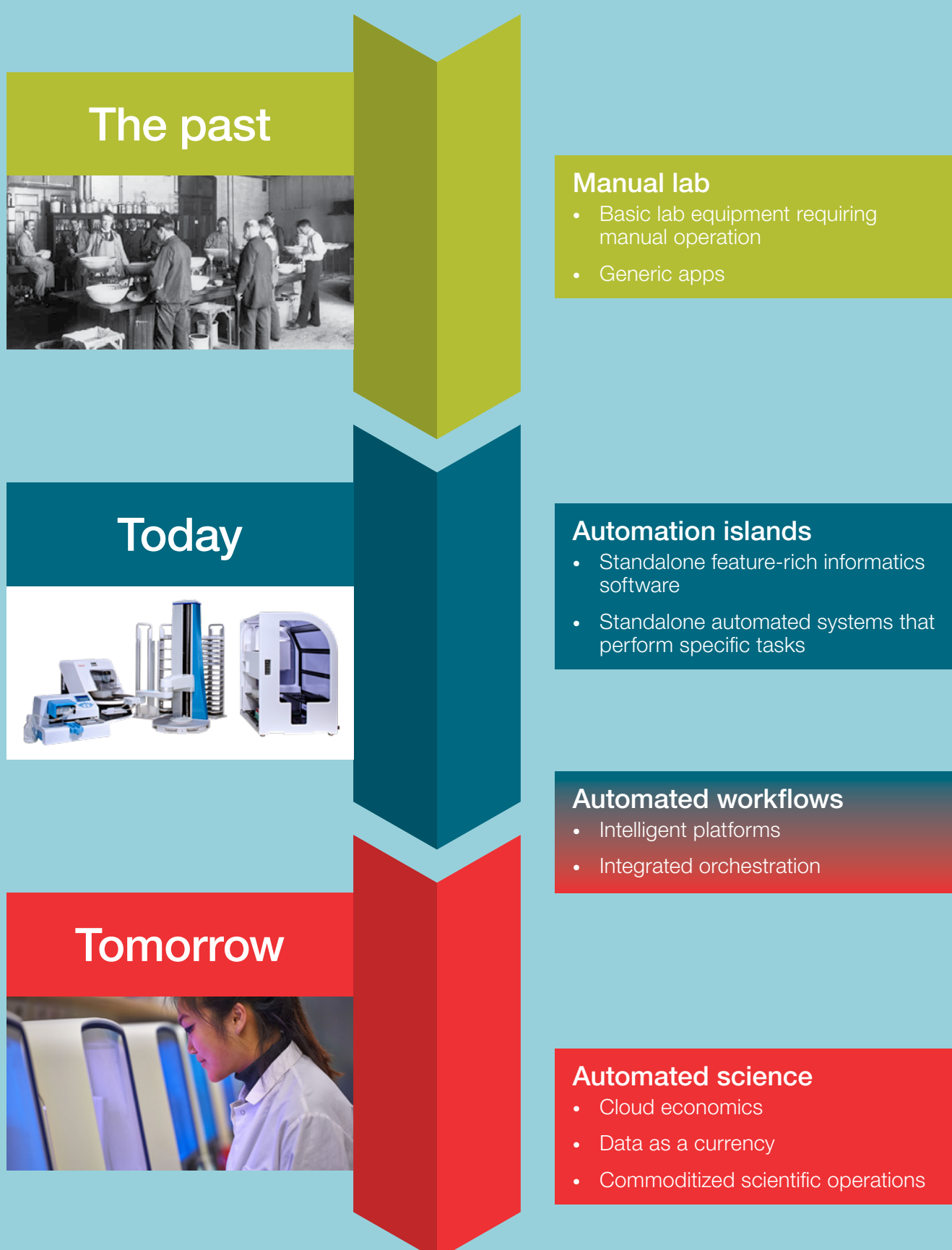
The journey to the automated digital lab



The pace of scientific discovery has increased rapidly, but this acceleration creates a fundamental challenge: how do labs keep up?

From manual processes to fully digital workflows, labs progress through distinct stages of digital maturity. It's a journey that every lab is already on, whether they realize it or not. Each stage brings new capabilities, new efficiencies, and new opportunities to accelerate science.

Science is accelerating



A vision of the automated digital lab

The automated digital lab isn't a distant vision; it's a practical reality being built today by labs around the world. It's characterized by connected systems, orchestrated workflows, and intelligent automation that scales with your science.



The building blocks of transformation

As labs advance toward more connected and automated operations, the way data moves through the lab becomes increasingly important. Most organizations progress toward more structured and interoperable data, which naturally supports better orchestration and future AI capabilities—even if full FAIR alignment remains an ongoing journey.

Successful labs typically integrate capabilities across six interconnected areas:

Resource optimization

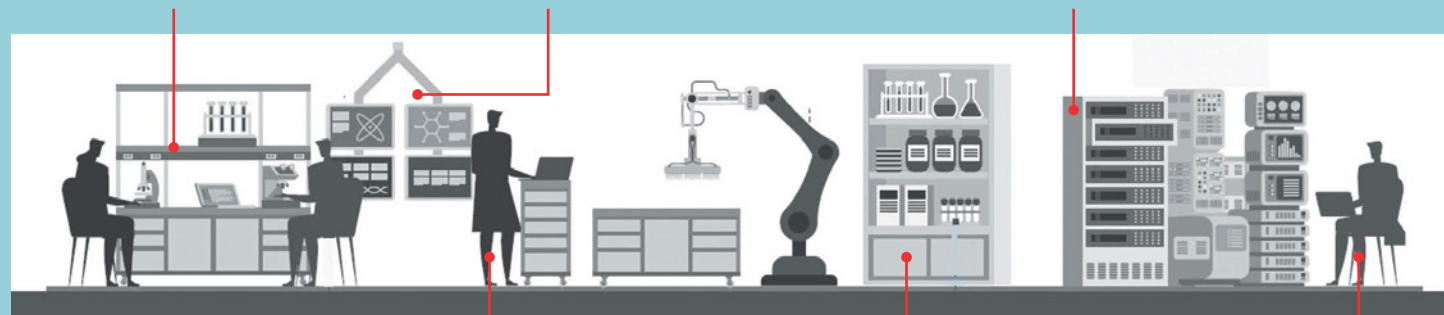
Digital tools and workflow design that maximize asset and staff utilization, unlocking efficiency gains over time.

Lab control tower

Centralized visibility and real-time monitoring that enables proactive management rather than reactive problem solving.

Data foundation

Connected systems that capture, integrate, and preserve data with full traceability, creating the single source of truth that enables everything else.



Automated science

Physical automation that handles repetitive tasks with precision and consistency, delivering productivity gains versus manual workflows.

Lab orchestration

Connected systems that link people, data, and instruments for faster decision making and shorter cycle times.

Intelligent infrastructure

AI-enabled systems that generate insights, optimize processes and enable self-optimization, but only when built on connected, quality data. As AI adoption increases, the value of having better-structured, more interoperable data becomes increasingly evident—even small improvements here can accelerate downstream automation.

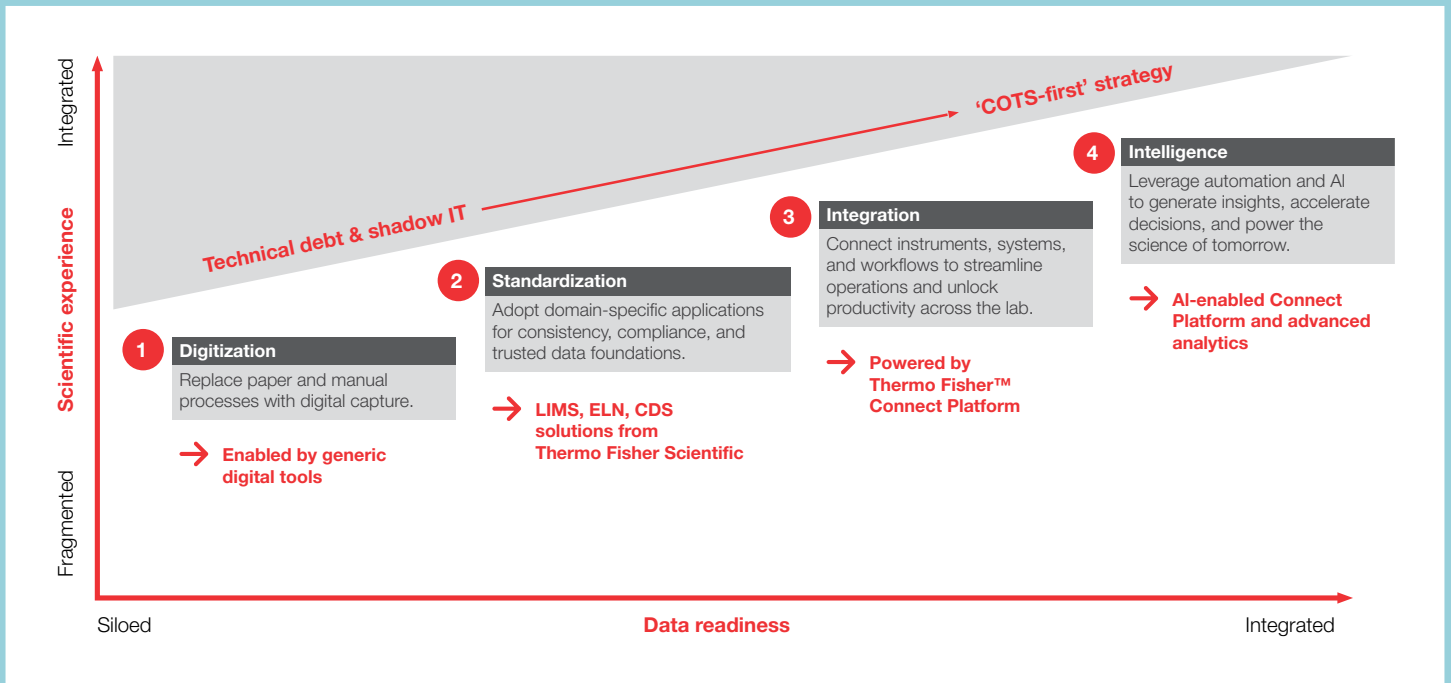
The stages of digital lab maturity



Every lab moves to its own rhythm along a continuum, from fully manual to fully automated digital operations. Understanding where you are and why progression matters is the first step toward meaningful change.



Many labs still rely on generic tools, custom applications, and in-house workarounds. This creates technical debt and shadow IT—systems that work but are brittle, slow, and difficult to scale. As labs add more point solutions (LIMS, ELNs, CDS), complexity often increases rather than decreases. This means scientists spend more time on administration and less time on the science that matters. It also makes it harder to maintain consistent, reusable data across systems—one of the quiet challenges labs encounter as they move toward more automated and AI-enabled environments.



Progress happens when labs adopt a commercial-off-the-shelf (COTS)-first strategy. This relies on purpose-built platforms that are integrated, validated for compliance, and ready to scale. This approach improves data readiness, allowing information to flow in real time. It also naturally improves data consistency and interoperability, which pays dividends later when labs begin orchestrating workflows or applying AI.

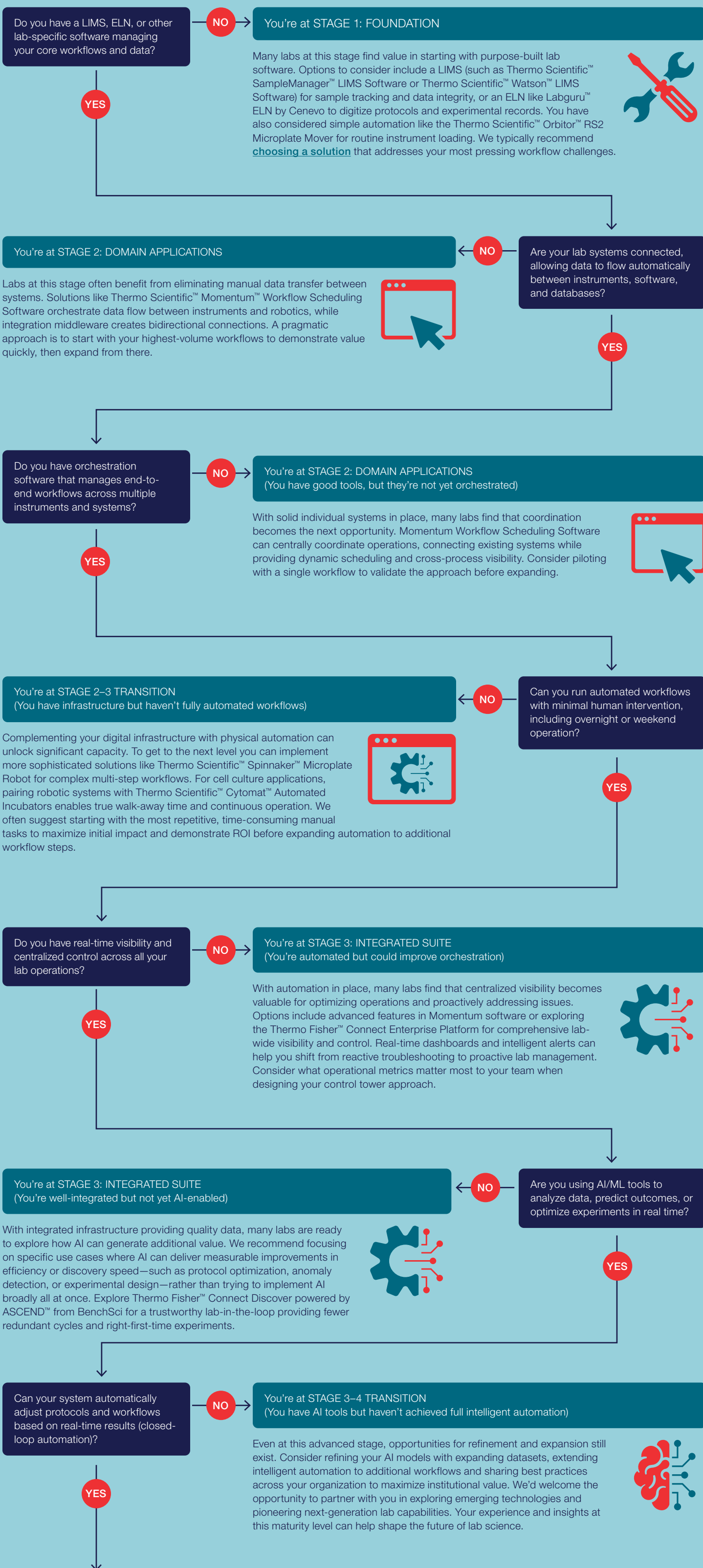


As labs move through this continuum, they unlock AI-enabled insights and experience the power of true automation. This allows you to build an intelligent, increasingly self-optimizing lab. Progress doesn't require massive transformation overnight. It happens through thoughtful, strategic moves that build capability over time.

Stage	Where you are	Technologies in use	What you can achieve
FOUNDATION 	<ul style="list-style-type: none"> Your lab operates primarily through manual processes with basic digital tools 	<ul style="list-style-type: none"> Generic productivity tools (Excel, Word) Standalone instruments with local data storage Email for communication and coordination Paper-based SOPs and batch records 	<ul style="list-style-type: none"> Execute routine testing and experiments Maintain basic records of work performed Meet fundamental regulatory requirements Operate flexibly with small teams
DOMAIN APPLICATIONS 	<ul style="list-style-type: none"> Your lab has implemented standalone automation for specific tasks using purpose-built software to automate key workflows 	<ul style="list-style-type: none"> LIMS for sample management and tracking ELN for electronic record-keeping Chromatography data systems (CDS) Standalone automation for specific tasks Workflow scheduling software 	<ul style="list-style-type: none"> Track samples systematically with barcoding Maintain electronic records with audit trails Generate compliance-ready reports Automate specific instrument operations Reduce data entry errors within each system
INTEGRATED SUITE 	<ul style="list-style-type: none"> Your lab has achieved meaningful integration across digital and automation systems 	<ul style="list-style-type: none"> Integrated LIMS, ELN, and specialty applications Lab automation platforms with multiple instruments Middleware or orchestration software Connected instruments with bidirectional data flow Centralized scheduling and resource management 	<ul style="list-style-type: none"> Run end-to-end automated workflows with minimal intervention Track samples and data across the entire lab lifecycle Generate real-time dashboards and analytics Manage resources and schedules dynamically Demonstrate compliance with complete digital records
INTELLIGENT SUITE 	<ul style="list-style-type: none"> Your lab operates as a fully connected, intelligent ecosystem 	<ul style="list-style-type: none"> AI-enabled lab operating system Advanced analytics and predictive modeling Digital twins for process simulation Agent-based automation Real-time optimization algorithms Cloud-based computing and data infrastructure 	<ul style="list-style-type: none"> Generate novel scientific insights from integrated datasets Optimize experiments automatically based on real-time results Predict outcomes and adjust protocols dynamically Scale operations efficiently with minimal manual oversight Accelerate discovery through AI-assisted design

Discover the right solution for your lab

By now you're probably wondering, how does my lab measure up? The assessment below is designed to help you identify where your lab stands today and discover the next steps on your digital journey.



Congratulations – you have an intelligent suite and are at the cutting edge!

Connecting AI insights back to workflow execution represents an advanced capability that requires thoughtful integration. This may involve custom integration between your analytics tools and orchestration software, or exploring platforms like the Thermo Fisher™ Connect Platform, which offers AI-enabled decision-making capabilities. This can also include hardware upgrades such as the Thermo Scientific™ **Autonomous Mobile Robot**, which brings mobility to lab automation, enabling autonomous transport of labware between workstations, rooms, or even floors.

Given the complexity, many labs find value in starting with pilot projects in controlled environments to develop expertise and validate the approach before expanding to more complex applications.



Tools for the automated digital lab



Understanding your lab's current capabilities is just the beginning. The next step in your digital journey is equipping your team with tools that drive progress. Automation is changing the game—enhancing reproducibility and freeing scientists to focus on high-impact work. Thermo Fisher Scientific's suite of automation solutions helps labs orchestrate their workflows with speed and flexibility, accelerating the path from idea to outcome.

Explore the Digital Science & Lab Automation portfolio of software, robotics, and collaborative platforms designed to seamlessly integrate into your workflows and transform your lab.



Robotic movers

Robotic movers handle repetitive sample logistics, allowing you to focus on what matters most.

Thermo Scientific™ Spinnaker™ 3 Microplate Mover Robot

This advanced benchtop robot uses vision-based position teaching to precisely handle and transport microplates between instruments and storage. Designed for scientists at any experience level, it fast-tracks your path to results by eliminating handling errors and creating effortless collaboration between you and automation. The result: greater confidence, reduced effort, and faster science.



Thermo Scientific™ Autonomous Mobile Robot (AMR)

The AMR leverages advanced robotics to navigate complex laboratory landscapes, transcending traditional benchtop robotic systems. Combined with the Spinnaker 3 Microplate robot, it smoothly transports samples between instruments, boosting throughput and keeping your lab running at peak efficiency.



Thermo Scientific™ Orbitor™ RS2 Microplate Mover

By interfacing directly with your laboratory equipment, this microplate mover rapidly transports microplates between instruments with seamless precision and intelligently tracks every plate location. This reliable, error-free automation keeps your science moving forward.



Collaborative platforms

Collaborative laboratory automation platforms connect robotic systems, instruments, and software into a flexible, modular environment that can be quickly reconfigured and scaled as workflows evolve. Unlike fixed automation setups, it enables shared instrument access and walk-up usability, allowing scientists to efficiently use and adapt automation without rebuilding infrastructure.

Thermo Scientific™ Aloft™ Collaborative Laboratory Automation Platform

Build the lab of the future with a modular platform designed for element-level standardization. Discover flexibility without the hassle by reconfiguring the platform as your needs change.



Thermo Scientific™ inSPIRE™ Collaborative Laboratory Automation Platform

The world's first collaborative lab system combines intuitive touch control and a flexible, modular design to streamline automated workflows. Designed for labs that demand versatility and speed, the inSPIRE platform empowers your team to move faster and adapt to evolving needs.



Thermo Scientific™ SmartCart™ Docking Solution

A lightweight docking solution that moves devices and samples with ease, creating flexibility for labs to reconfigure workflows as research advances. Streamline your processes, reduce downtime, and gain the freedom to design your lab around your priorities.



Automated incubators

Speeding up research while ensuring reliability in standardized workflows can be challenging, but automated incubators make it possible! Spanning 4 °C to 70 °C and multiple capacities, our diverse selection of Cytomat models maintains consistent conditions for cell cultures, expedites workflows, and scales experiments without added complexity.

Thermo Scientific™ Cytomat™ Automated Incubators and Storage Systems

These automated, robot-accessible incubators provide precise control of temperature, humidity, and CO₂ for high-throughput cell culture and assay workflows, while enabling seamless integration, rapid plate access, and stable conditions to reduce contamination and variability.



Laboratory orchestration

For labs ready to go further, the Connect platform orchestrates operations, transforming workflows into a single high-performing system. More than just a tool, the Connect Platform serves as the blueprint for our future software portfolio, guiding the next generation of our integrated digital solutions.

Thermo Scientific™ Connect Enterprise Platform

A secure AI-enabled platform that orchestrates all your instruments, software, and data into one unified workflow, giving you real-time insights for smarter decisions.



Thermo Scientific™ Connect Discover Software

Developed in partnership with BenchSci, this AI-powered tool improves experimental design, reagent selection, and overall R&D productivity to support preclinical and translational research.



Laboratory software

It's not just about automation – capturing, organizing, and tracking data across every step of the workflow is essential. Together, our laboratory information management system (LIMS) and electronic laboratory notebook (ELN) solutions provide the foundation your lab needs to leverage AI and advanced analytics down the line.

Thermo Scientific™ Momentum™ Software

This automation scheduling software enables you to intuitively create, design, and modify complex automated workflows for a broad range of applications. It enables end-to-end data integrity, real-time decision making and on-the-fly workflow adaptation.



Thermo Scientific™ SampleManager™ LIMS Software

This LIMS is a complete informatics solutions for manufacturing quality control and process development. It helps labs improve compliance, efficiency, and decision-making through automation and connected data management.



Thermo Scientific™ Watson™ LIMS Software

A trusted digital backbone, managing biological labs worldwide for over two decades. Its success stems from ensuring compliance and traceability while providing efficient and standardized reporting of results. Watson LIMS gives you the confidence to focus on science, not paperwork.



Labguru™ ELN by Genevo

Created by scientists, this ELN helps researchers plan, record, and manage experiments with ease. By providing a structured platform to centralize your data, it enables seamless collaboration, full visibility across projects, and simplified research.

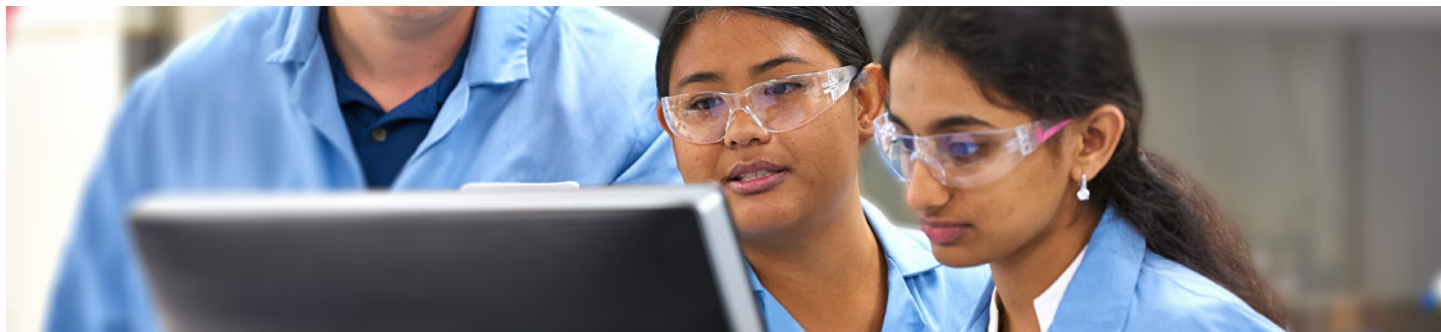


[Explore the full suite of digital solutions here](#)

Unlock the power of successful partnership

The path to automated digital science isn't just about technology—it's about finding the right partner to walk alongside you. As laboratories face increasing demands for efficiency, compliance, and innovation, the partnership you choose is just as critical as the tools you use.

What makes an ideal partner?



What Thermo Fisher brings to your lab

We provide the digital backbone	Comprehensive lab automation solutions	'Collaborate to differentiate' approach	Global support infrastructure
From LIMS and ELNs to the Connect Platform, we transform data into decisions. With over 30 years in lab automation, we offer more than just tools—we provide a steady hand in regulated environments.	Our automation portfolio includes robotic movers, collaborative platforms, workflow scheduling, and automated incubation systems—all designed to integrate seamlessly. In short, whatever puzzle your lab presents, we have the pieces—and they're built to work in harmony from day one.	We believe in partnerships built on trust, shared accountability, and clearly defined outcomes, so you're never navigating challenges alone. Our ecosystem model brings together providers, partners, scientific users, and business stakeholders to ensure solutions deliver real scientific impact at the scale you need.	With 2–4 hour support response times, global technical offices, regulatory compliance specialists (yes, we speak FDA), and local language support, we ensure your systems stay operational and optimized.

A great partnership isn't just talk, it will deliver:



Accelerated innovation

Rapidly turn data into decisions using integrated digital and automation solutions



Enhanced reproducibility

Reduce variability and increase confidence in your results



Operational efficiency

Free your team from routine tasks to focus on discovery



Future-ready infrastructure

Build laboratories that scale with your ambitions



Measurable ROI

Experience higher throughput, reduced costs, and faster time-to-insight

The future of laboratory science is automated, digital, and collaborative. But transformation doesn't happen overnight—it's a journey that requires the right vision, the right tools, and the right partner.

We're ready when you are. Our experts would love to chat about your journey to laboratory excellence.

Resources



The latest automation tools

Explore a full suite of tools to support you no matter what your automation needs are, from instrument loading to full end-to-end automation, and regardless of your application.

[Learn more](#)



Powering biopharma innovation at lab level and at scale

Explore how automation is transforming scientific operations at every level. From hands-on robotics that accelerate individual experiments to enterprise-wide platforms that process thousands of samples each month.

[Learn more](#)

 Learn more at thermofisher.com/digitalsolutions