ARTICLE

What Are the Key Features of a GC Smart Connected Lab?

Introduction

"Smart" devices and technologies are woven throughout our daily life where they wirelessly automate daily tasks and connect people around the world. From banking to personal communication and beyond, app-driven smart technology is readily available to everyone.

The laboratory world is no exception. Laboratory managers are trying to decipher how they can implement the smart strategies of Industry 4.0 in their labs in order to gain the advanced efficiency, productivity, controls, and data power it enables.[1,2] In other words, how can their lab become a Laboratory 4.0 operation?[3]

Interest in the potential of smart technologies was high before the pandemic hit in 2020. That interest changed to a necessity when businesses were faced with the need for remote and automated operations in order to maintain business continuity. Businesses that have embraced smart operations are seeing substantial improvements in productivity, efficiency, and operating costs.

Smart devices and processes are being introduced into laboratories at an increasing rate, including the following:

- Smart devices that can be pre-programmed to perform automated tasks on a specified schedule.
- IoT systems that connect all instruments and software within a workflow.
- Wireless control of smart devices and IoT systems via web apps for computers and mobile devices.

INDUSTRY 4.0

Industry 4.0 is the term used for the 4th industrial revolution that began in the first and second decades of the 21st century. Those years saw unprecedented advances in computing power and internet connectivity. Manufacturing industries use those advances to transform their operations through highly-automated and interconnected processes that increase efficiency and output. Such operations are often referred to as "smart" manufacturing because they seamlessly connect physical machinery, software, and cyber networks to form a fully-integrated Internet of Things (IoT).

Although the initial focus of Industry 4.0 was on manufacturing, other businesses have begun adopting those Industry 4.0 strategies that are applicable for their operations. Laboratory 4.0 is on the increase across the many different types of laboratories operating today.

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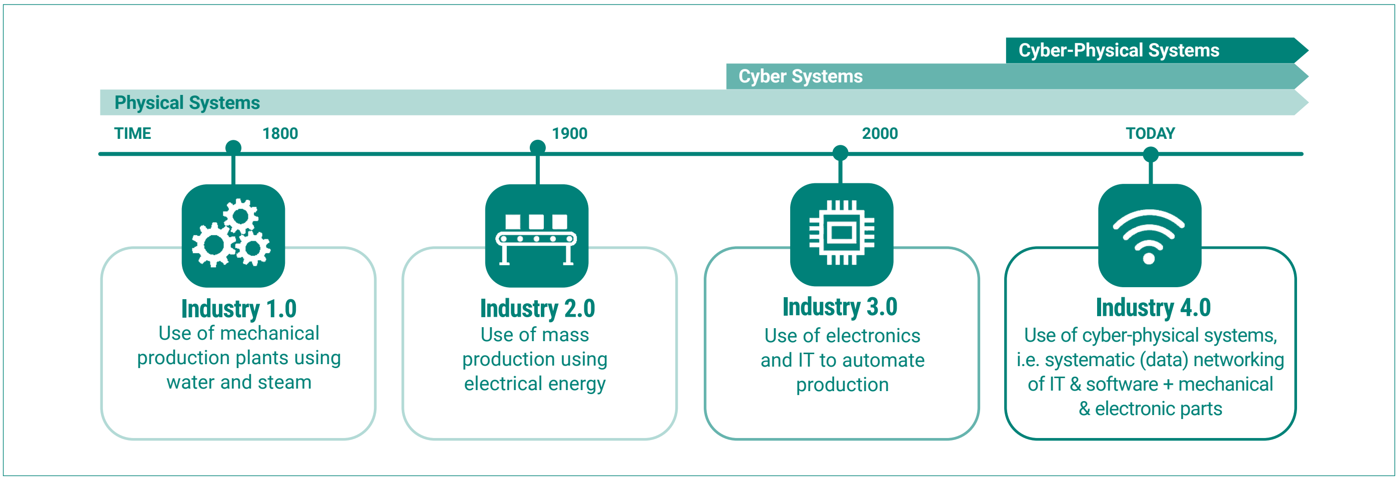


These smart strategies enable laboratory staff to remotely monitor and control their workflows, access data, and proactively address instrument maintenance needs. In return, they enjoy reduced errors and instrument downtime, more robust data analysis capabilities, compliance with data management regulations, and many other benefits that come with Laboratory 4.0.

For lab managers, the question that naturally arises is, "how do I merge the advantages of connected smart labs with established analytical techniques?" For gas chromatography (GC) labs in particular, even though GC has been an established analytical technique for decades, it can be seamlessly transitioned into a smart workflow that can lead the way in a lab's transformation into a Laboratory 4.0.

This article reviews the application of smart technologies in laboratories and demonstrates how PerkinElmer is helping lab managers drive digital enablement, process automation, and the creation of a culture of technology adoption throughout their labs.

Features of Laboratories 4.0	
Digital enablement	Remote control
	Multiple access points to analytical workflow
	Harmonized and integrated data system
Automation	Minimize repetitive manual tasks
	Integrated data system control
Internal culture	Cultural change and change management
Technology adoption	Perceived usefulness (PU)
	Perceived ease-of-use (EOU)
	User interface
	User experience

Digital Enablement

Digitally-enabled labs take advantage of wireless devices and software apps to remotely monitor and manage their workflows. Physical tools are merged with digital tools to enable real-time data analytics and ongoing analysis verification while also being able to optimize the workflow and prevent unexpected instrument downtime. According to McKinsey an average chemical QC lab can reduce costs by 25-45 percent by becoming digitally enabled.[4]

To support the transition to digital-enablement for GC, the PerkinElmer™ GC 2400™ Platform features:

- PerkinElmer Simplicity Vision™: an app that can be used to monitor and control the workflow from any PCs or wireless device.
- Detachable touchscreen: a portable device that staff can use to monitor and control a GC 2400™ System or multiple systems, remotely from any location in the lab.
- PerkinElmer SimplicityChrom™ Chromatography Data System (CDS) Software: an intuitive data acquisition and analysis software package that can be used via the detachable touchscreen or the web app

Digital-enablement also includes managing and storing analytical information and data with the right tools. Laboratories use a plethora of software programs including the laboratory information management systems (LIMS), electronic laboratory notebooks (ELN), scientific data management systems (SDMS), and others. Using multiple software systems often results in redundant information storage and duplication of costs for adoption and maintenance. The recent trend, therefore, has been to harmonize multiple software systems to create a digitally-integrated approach that allows multi-user access. Although seamlessly integrating multiple software systems is the ideal approach, it can also be challenging to accomplish.

Examples of an effectively integrated software system are seen in the features of the GC 2400 Platform. The platform is controlled and managed by the SimplicityChrom CDS Software which enables:

- Multiple user accounts and profiles
- Each workflow directly managed by its analyst
- All workflows managed within the same system

This simplifies the administration process and mitigates many common IT challenges associated with multiple domains management.

Automation

Another important aspect of a digitally-enabled laboratory is maximizing task automation. Automated instruments and processes reduce errors that commonly occur in manually performed tasks. Additionally, automating repetitive tasks increases throughput and frees up time that analysts can spend on other important matters. It is not unusual for lab automation to increase productivity by 25% or more.[5]

For example, in GC workflows, sample preparation requires a substantial amount of time, which greatly impacts workflow throughput. The GC 2400 Platform uses fully automated sample preparation and the ability to use different autosamplers for different sample types. The PerkinElmer AS 2400™ Liquid Sampler maximizes automated sampling capabilities and can be readily exchanged on different GC 2400 Systems. The SimplicityChrom CDS Software auto-recognizes and auto-configures the different autosamplers, removing the need for manual intervention. Automation such as this not only increases productivity, it also allows for adoption of scalable solutions to match growing laboratory needs.

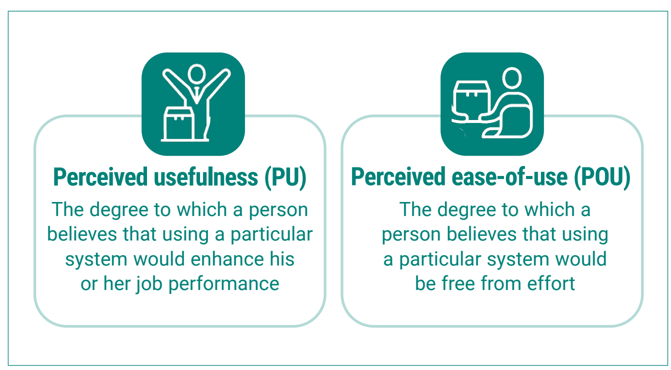
Another feature of fully automated workflows is the continuous monitoring and reporting of instrument performance and status. This allows potential issues to be identified before they become full-blown problems that cause instrument down time. An example of this type of automation is the GC 2400 Platform live status notifications. The notifications are provided on the Simplicity Vision web app, as well as on the hardware itself via lights and sounds. This accelerates the decision- making process for intervention and reduces down time. Use studies demonstrate this type of automation and connectivity reduce equipment breakdowns by up to 70% and lower maintenance costs by up to 25%.[5]

Internal Culture and Technology Adoption

Digital enablement and automation cannot be successfully implemented in the lab without the lab staff being open to its adopton and trained in its use. Indeed, a Laboratory 4.0 is impossible without a shift in culture. The research literature offers many insights on cultural change and change management. Here, we will focus on technology adoption challenges and strategies.

In 1962 Everett Rogers theorized that the adoption of a new product, service, or idea does not happen simultaneously across all people in a social system, where he recognized different characteristics based on the speed of adoption.

The Technology Acceptance Model is used to identify the different ways in which users come to accept a new technology.[6] According to the model, when faced with a new technology, users are influenced by two primary factors: perceived usefulness (PU) and perceived ease-of-use (PEU). Addressing these two considerations with respect to both the organization and the individual can help people develop a positive attitude toward a new technology.



Digitally-connected and automated labs have the opportunity to minimize the impact of change and ease the adoption process by insisting on instruments and workflows that have an intuitive user interface (UI) and user experience (UX). Recent advances in UI/UX design are meeting the demand for technology that is readily adopted and learned by final users. Such UI/UX create an optimal experience that enhances integration and eases its deployment and collaboration. They are also filling or eliminating skill gaps at the user level by easing the need for specialized skills and standardizing the reskilling/upskilling process.

Many studies have investigated the impact of the use of digital device on cognitive behaviors. Nathaniel Barr (Department of Psychology, University of Waterloo, Canada) and al studied the impacts of using smartphone technology and internet access on human cognition.[7] Across three studies, it was found that, when given reasoning problems, users who think more intuitively were more likely to rely on their smartphones for information. These findings might strengthen the theory that people increasingly tend to offload thinking to technology. Psychological researchers need to understand the increased connection of mind and media to adequately characterize human experience and cognition in the modern era.

The design of the SimplicityChrom CDS Software, for instance, is centered on the user experience. It offers a user-friendly iconographic interface that is intuitive and easy to learn, and both new and expert users can successfully create, implement, and manage full GC workflows.

Another consideration in technology adoption is the fact that not all users process or visualize data in the same way. Therefore, the SimplicityChrom CDS Software not only allows users to generate data tables and chromatographic peaks for a given analyte across multiple samples, it also allows the creation of customized layouts and workflows. This capability helps analysts identify trends in the data, and helps the lab increase productivity and reduce the cost of technology adoption.

Data tables and chromatographic peaks for a given analyte can be viewed across multiple samples to identify trends and save time. And since not all users process or visualize data the same way, SimplicityChrom CDS Software allows for the creation of customized layouts and workflows.

Conclusion

In this article we summarized the key factors of the Industry 4.0 concept and demonstrated how these principals could be brought to the analytical laboratory through the example of how the PerkinElmer GC 2400 Platform supports labs become digitally enabled, automated, and ultimately, more productive.

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