

# Enabling Verifiable Science Through Smart, Connected Lab Devices

labcompare.com/10-Featured-Articles/350675-Enabling-Verifiable-Science-Through-Smart-Connected-Lab-Devices

Tuesday, June 5, 2018

Tiphaine De Jouvencel

## Featured Article

In modern academic and industrial laboratories, data can live in many places and exist in various forms, ranging from observations written in a lab notebook to massive amounts of raw sequencing data stored digitally. Having all of this data floating around can create an organizational nightmare for the researcher. In addition, tracking and compiling data across different places and forms can be extremely time-consuming.



The way scientists and research groups manage data has remained relatively rudimentary. Take, for example, the practice of recording and storing data in paper notebooks, a form that is not equipped to handle today's growing amount of digital data. In addition, many scientists may retrieve and store data from multiple instruments using a portable USB drive, which is prone to the same problems. With these methods, data sharing can also become complicated. Physical copies have to be made and distributed, or electronic copies e-mailed. This process is not particularly conducive to collaboration, a critical part of science.

Storage of data in these insecure and decentralized formats has become a growing concern for scientists. Reproducibility issues are evident throughout the field, and scientists are finding it challenging to replicate studies published by colleagues, collaborators, and in some cases, their own labs. Other factors that come into play are inconsistent laboratory technique, inadvertent errors in manual processes and recordkeeping, and selective data reporting.<sup>1</sup>

Although many scientists have been citing comfort with their current work habits and cost as primary reasons for not upgrading technology, several potential solutions exist and are currently being developed into commercially available or open-source products. The use of these products could significantly streamline several steps in the scientific process and improve the generation of reliable data and the ease with which scientists collaborate on research projects.

## Centralized data storage

Internet of Things (IoT) equipment is replacing manual processes and upgrading recordkeeping and data storage systems. There are many examples, including the use of IoT-enabled water meters for water usage monitoring or IoT-enabled sensors on industrial vehicles to monitor performance.<sup>2</sup> In these cases, money was saved on work-hours due to the replacement of a manual, labor-intensive process with an automated process. The capabilities of IoT devices also allow for data collection and storage in a centralized database on a network of servers capable of storing massive amounts of data. This centralized data storage system is called storage in the “cloud” and earns its name by enabling any Enabling Verifiable Science Through Smart, Connected Lab Devices device that is connected to the internet to access data stored there. Taken together, using IoT devices and the cloud to collect and store data for processes that were historically done manually has resulted in reduced expenditure of time and money and error avoidance associated with manual recordkeeping.

IoT and cloud technologies have slowly made their way into scientific laboratories. Some companies have developed sensors that can connect to several widely used lab instruments, such as freezers and incubators, and monitor the performance along with changes in temperature or humidity, for example. Users can also set notification alerts that are sent when certain parameters are suboptimal and need to be checked. Historical data collected by these devices is stored and can be reviewed at any time so that the involvement of the instrument in experimental variability or failure can be verified and validated. All of these tasks can be done remotely and shared with colleagues and collaborators.

Various manual tasks that take place in a laboratory can also contribute to reproducibility issues. The PIPETMAN M Connected from Gilson, Inc. (Middleton, WI) is a cloud-enabled motorized pipette that can collect data on each pipette stroke during an experiment. It connects to the cloud via Bluetooth and works synchronously with a wireless tablet called TRACKMAN Connected. Together, these products help researchers detect manual errors that occur during an experiment, such as sample confusion, dilution error, and lack of calibration. TRACKMAN Connected comes preloaded with a microplate tracker application that is able to track and record pipette activity when working on 96- or 384-well plate experiments, and effectively avoid errors in sample placement. It has an environmental sensor that provides a time-stamped record of the surrounding conditions, which can affect pipetting accuracy. At the end of a pipetting run, TRACKMAN Connected generates a detailed report with the data, environmental conditions, and performance feedback. All reports and data can then be sent to an electronic lab notebook to be stored permanently, reviewed retroactively, and shared with others (see *Figure 1*).



*Figure 1 – Cloud-enabled pipetting and data recording. A pipetting plan can be created using a microplate tracker application, which collects data on each pipette stroke by Bluetooth pairing to a smart pipette. This will help researchers detect manual errors that occur during an experiment. After the pipetting is done, a detailed pipetting report can be saved in an electronic lab notebook and reused later as a template for the next experiment. (Source: Gilson, Inc. and sciNote.)*

Gilson’s tablet app plus smart pipette combination is available via a limited release program to interested researchers who can test the product and provide feedback. Abdellatif Elm’selmi, leader of the École de Biologie Industrielle’s Department of Molecular Biology in Cergy, France, has been using the connected pipetting products for qPCR protocols that require pipetting on a 96-well microplate. He particularly appreciates how the tracker application guides him through each pipetting step via a map created on the tablet, noting, “The process is faster and more reliable than with a regular pipette and increases trust in daily results.”

Valentina Garcia, another researcher participating in the early access program, uses these products to streamline her in vitro drug-dosing experiments. “Cloud-connected pipettes have increased the productivity in our lab by automating repetitive processes, tracking pipetting protocols, generating reports, and removing the need for manual checklists every time an experiment is carried out,” she reported.

## Electronic lab notebooks

More data may not always be better, especially if it cannot all be integrated and stored in a

central place. As discussed above, the cloud can act as this central place where data can be stored. However, experimental data needs to be organized in a way that any scientist looking at it will know exactly which protocols and steps were done and in what order. Keeping digital, editable, and sharable laboratory notebooks in the cloud can help to create an organized and centralized location where all research activities and data can be stored. These notebooks are known as electronic laboratory notebooks (ELNs). Many different ELNs have been developed, but cost and complexity have limited their adoptability among scientists. To address these issues, the team behind the sciNote electronic lab notebook conducted and published the largest study on user perception of ELNs to determine the issues faced by labs.<sup>3</sup> They found that the major barriers to ELN adoption are 1) cost (including financial outlay, staff hours, troubleshooting, long-term maintenance, and support), 2) ease of use, and 3) accessibility issues across different devices and operating systems. Notably, 99% of study participants agreed that ease of use would influence their ELN choice, and they are more likely to adopt a product that was flexible and generic, rather than an ELN designed for a specific research area. Participants also worried that they would not be able to efficiently extract and move data between different electronic records and lab instruments, leading to either data loss or duplication; 74% expressed a need for an ELN that can be accessed both inside and outside the lab.<sup>3</sup>

Based on these findings and conclusions, the sciNote electronic lab notebook was developed. In addition to being a recordkeeping tool, locally installed or web-based, its data, project, and inventory management functionalities provide a safe space for individual users or R&D teams in labs to collaborate and organize work on projects and manage all related data. Currently, sciNote is partnering with Gilson on the cloud-connected pipettes and providing a centralized location for data storage and sharing through the sciNote ELN.

## Conclusion

---

Recent innovations in internet-enabled laboratory devices and equipment have largely overcome the barriers that many researchers cite as reasons for not switching to cloud connectivity in their lab. The benefits to using some of the devices discussed here include the ability to automate manual tasks; collect data and track protocol steps; provide real-time feedback; and store data in a secure, centralized, and sharable way. Taken together, IoT laboratory devices and connection to the cloud can empower researchers to achieve verifiable science and make lab life simpler in the process.

## References

---

1. Freedman, L.P.; Cockburn, I.M. et al. The economics of reproducibility in preclinical research. *PLOS Bio* 2015, 13(6); e1002165.
2. [https://www.sas.com/en\\_us/insights/articles/big-data/3-internet-of-things-examples.html](https://www.sas.com/en_us/insights/articles/big-data/3-internet-of-things-examples.html)
3. <https://scinote.net/blog/largest-study-userperception-electronic-lab-notebookspublished/>

*Tiphaine De Jouvencel, Ph.D., is product manager of the IoT MLH Business at Gilson, Inc., 3000 Parmenter St., Middleton, WI 53562, U.S.A.; tel.: 608-836-1551; e-mail: [tdejouvencel@gilson.com](mailto:tdejouvencel@gilson.com); [www.gilson.com](http://www.gilson.com)*

## Related Products

---



- PIPETMAN® M Single Channel Pipette



- TRACKMAN™ Laboratory Assistant