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The European Federation of National Associations of Measurement, Testing and Analytical Laboratories

EUROLAB Special Briefing

Against the background of a worldwide pandemic, laboratories are dramatically changing the way they operate and rethinking their processes

The laboratory of the future is entering a new era, characterized by networked devices with smart functions, complex automated robots and new interfaces. A correct handling of enormous amount of data, as well as intelligent laboratory systems, will be necessary for their continued viability.

Current and future trends in automation, artificial intelligence and connected devices will drive a continuous improvement of laboratory systems, which will be characterized by a marked change in the way technicians and specialists handle their day-to-day operations. Robot-handled experiments can save time for researchers – allowing them to focus more on new ideas – and eliminate any risk factor involved in human errors. AI-powered algorithms can help identify relationships between results, choosing the best experiments to perform based on the situation and analysing vast quantities of data in less time than previously possible.

Speaking of data, its nature itself is changing to a more collaborative-oriented format which is far easier to acquire and communicate, allowing to continuously adapt and improve laboratory processes. Flexibility will be among the top requirements for laboratories in the next few years, as they will have to be capable of modifying the parameters of a process according to the type of sample, without the need for the intervention of a technician.

All of this does not mean that laboratories should not be able to maintain their traditional testing capabilities. But they should still be prepared for an influx of new technologies and products that are already being put in the market and to which they must adapt, such as: additive manufacturing, connected devices, biotechnologies, nanotechnologies, mechatronics.

New manufacturing methods and procedures will also create new issues and defects, against which laboratories must be prepared to act, by diversifying their workforce (e.g. adding and training new technicians familiar with digitalized methodologies), developing a collaborative group-oriented mindset between different laboratories that can counteract the increasing complexities of the new procedures, and knowing how to propose appropriate methods for testing – given that, in a rapidly evolving world, products or manufacturing methods will be brought to market faster than standardisation will produce standards.

As an example of new, rapidly-developing ideas and operation methodologies, the British laboratory of the University of Liverpool has recently built an intelligent robot capable of not only working with chemistry experiments, but also to make its own decisions about what to do and when to do it. The robot's capabilities have been detailed by the University's spokesperson Andrew Cooper, who was recently the lead author on a paper on *Nature* about this new technology, together with the robot's programmer, PhD student Benjamin Burger. He notes the fact that autonomous robots like these can help in tackling problems on an unprecedented scale and complexity. Various complex modern technologies rely on mixtures of molecular and mesoscale components. As of yet, this multi-length-scale complexity cannot be fully captured by atomistic simulations.

This particular robot was specifically instructed to search for improved photocatalysts for hydrogen production from water: it operated autonomously, conducting over 688 experiments over eight days, working for 172 out of 192 hours using a combination of laser scanning coupled with touch feedback for positioning. It successfully managed to carry out tasks in an independent manner, from weighing out solids and dispensing liquids to running catalytic reactions and quantifying the reaction products. Driven by a batched Bayesian search algorithm, it can select the best next experiment

to perform among more than 98 million candidates, based on the outcomes of the previous ones. Thus, it managed to identify photocatalyst mixtures that were six times more active than the initial formulations.

These new technologies can open new avenues of research and discoveries previously unthought of, allowing for far more flexibility and modularity than before.

Sources:

- Cosmos Magazine: https://cosmosmagazine.com/uncategorized/robot-loose-in-the-chem-lab/
- Paper on nature: https://www.nature.com/articles/s41586-020-2442-2
- EUROLAB Member contributions – ALPI & EUROLAB France: Laboratory of the future

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