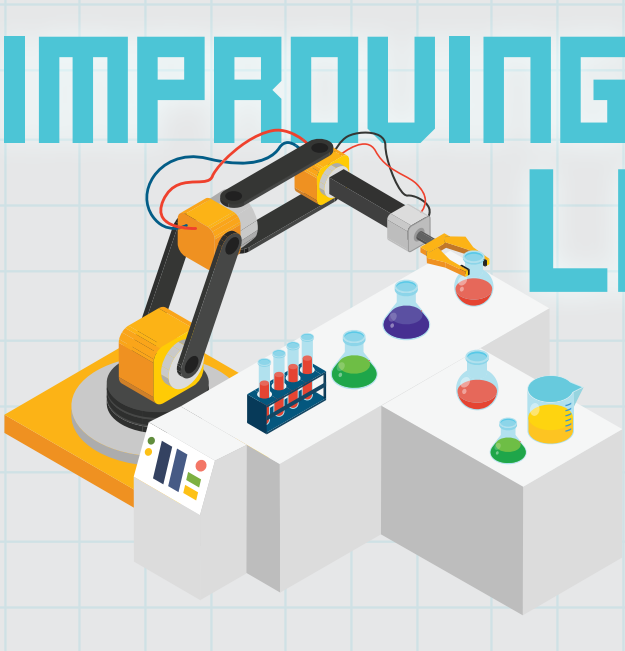
TECHNOLOGY NETWORKS

IMPROVING EFFICIENCY WITH LAB AUTOMATION



Automation and robotics are increasingly prominent features in the laboratory. Freeing up scientists to be creative and transforming the working day for many individuals.

A BRIEF HISTORY

1875
The earliest mention of laboratory automation in the chemical literature is from 1875[1], that's 52 years before the first TV was demonstrated![2]

1945
Little progress was made until the dust had settled after WW2 when commercially available automated equipment started to become much more complex. Spotting a demand, Washington University was the first to teach students how to operate automated equipment.[3]

1961
The world's first industrial robotic arm for factory automation was released by Unimation, paving the way for all automated robotics to follow.

1981
Dr Masahide Sasaki opened the first fully automated laboratory at the Kochi Medical school to make rapid and accurate blood sampling a reality. Others quickly followed and, within 10 years, 72% of Japanese national university hospitals had adopted lab automation.[1]

1993
Dr Rod Markin at the University of Nebraska Medical Center created one of the world's first automated clinical lab management systems, tying together computer processing with physical robotics. The original LAB-InterLink system consisted of multiple testing stages along 112 feet of conveyor belts and was capable of full sample prep, testing and archiving.[4]

2004
The NIH and 300 leaders in research and government identified automation technology as crucial in accelerating medical discovery and improving health.[5]

STATE OF THE MARKET NOW

$ 3.92 bil
2016

$ 5.48 bil
2021

This growth is set to be fuelled by:[6]

- Miniaturization
- Lower reagent costs
- Government funding for biotech and drug discovery
- Growth in emerging markets
- Staff shortages

THE BENEFITS

Laboratory automation has been shown in peer-reviewed literature to reduce human errors by 50%

50%

Whilst increasing productivity by as much as 75%

75%

As such, automation presents an attractive solution for hitting tight deadlines and getting the most out of overstretched teams.[7]

TURNAROUND TIME

Implementing laboratory automation systems has shown to reduce the sample turnaround time of a clinical lab by up to **30%.**[8]

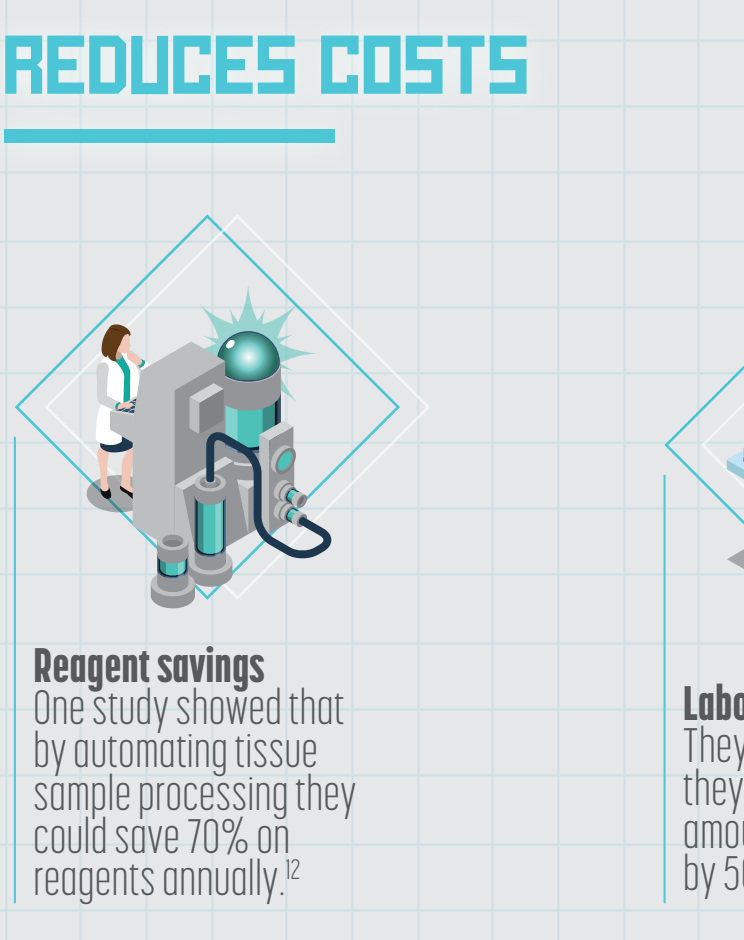
A genetic testing lab could see testing times reduced by **50%**.[9]

A drug discovery lab could reduce the process of designing, synthesizing and screening a compound from **weeks to days.**[10]

WALK AWAY TIME

With so much to do in the lab, automation helps to eliminate tedious, time consuming tasks like the hand labelling of tubes. So you can spend more time working towards your goals!

REDUCES REPETITIVE INJURIES



90% of people that pipette in continuous sessions of 1 hour or more report hand pain.[11]

Studies show that women that pipette **300 hours a year** which is only 75 minutes per working day, are at **much higher risk of hand and shoulder ailments.**[11]

REDUCES COSTS

Reagent savings
One study showed that by automating tissue sample processing they could save 70% on reagents annually.[12]

Labour
They also found that they could reduce the amount of hands on time by 50%.[12]

This represents a combined saving of over **$250,000** per year.[12]

ELIMINATE HUMAN ERROR

A study from Hofstra University revealed that the average cost of a lost sample was **$584** and that sample tracking errors over a 4-month period totalled **$20,000 in losses.**[13]

Differences in pipetting between operators has been shown to be up to **11.8%** when handling 10 μL. Whilst an automated pipetting system can keep errors below **2%**, right down to 1 μL.[14,15]

THE CHALLENGES OF AUTOMATION

Flexibility

The complex parameters of your lab and the automation system you're hoping to acquire must be considered to determine which system is best for you. But, what if it all changes?

It's often difficult to plan for all eventualities so it can be safer to stick with human scientists even if they're slower and more prone to mistakes!

Cost of Adoption

A Penn State study showed that the initial cost of adopting automated specimen preparation technology in a typical clinical microbiology lab to be around $360,000. It would take over 3 and a half years to recoup these costs through labour costs savings.[16]

A huge investment for any lab!

Standardization

Integrating various automated devices to increase flexibility and utility represents of the one greatest hurdles in lab automation. Numerous open source programming languages and standards have been developed but, without proper consensus, none have been widely adopted.

For laboratory automation systems to reach their full potential, vendors must agree upon standards, both in the hardware as well as in the software.[17]

Adapting your methods

Creating methods on automated devices can be complicated and often requires complex programming as well as a deep understanding of the desired process.

It's also important to remember that the assay or protocol you're hoping to automate needs to work on the bench first. Automation alone is unlikely to solve your problems.[19]

Installation and implementation

The initial installation of an automation platform can be time consuming and disruptive, particularly when the system is large and complex.

Siemens automation experts estimate that it can take up to 6 months from those early stages to handing over to routine operation for a typical installation.[20]

Training

Good automation requires staff with the ability to combine their lab skills and problem solving with technical know-how. You'll need to train or hire an automation specialist who can tweak and adapt your automated systems to get the best return on your investment.

Without any willing volunteers in your lab, you'll need to factor in the additional salary of an automation specialist into your plans. Either that or you'll be calling in the vendor company for help every time you need to make a change.[19]

THE FUTURE

NiCoLa-B

The most advanced drug discovery robot in the world.[21]

- Can test up to 300,000 compounds a day
- Can operate 24/7, 365 days of the year
- 3x faster than comparable systems
- Will support up to 50 projects, covering 40 million potential drugs per year
- Can be remotely operated via a mobile app from anywvhere in the world

Fully robotic scientists

Engineers have created prototype robot scientists called Adam and Eve for fully autonomous scientific discovery. They are already able to:

- Generate a hypothesis from a computer model
- Design experiments to test these hypotheses
- Run the physical experiments
- Analyse and interpret the data they generate

Adam's first study consisted of 20 hypotheses on the identity of genes encoding 13 enzymes. The robot quickly confirmed the correctness of 12 of these through automated experimentation. Pretty impressive stuff![22]

Collaborative robots

As automation is utilized for more complex procedures, there is a need for better integration and human interaction. The robots of the future will:[23]

- Have more human-like manipulation capabilities
- Use active force control to prevent risk of harm
- Learn from their operators and detect problems autonomously
- Share information and protocols between instruments, robots and users
- Learn and adhere to SOPs and safety guidelines

Open source robotics

EvoBot an open-source lab robotics system, has been built with affordability in mind, with the aim of making automation available to poorly funded areas of research. It's designed to be:[24]

Reconfigurable
Ease of use is key to making the platform programmable without expert help

Versatile
Flexibility is key for small laboratories with limited resources

Low cost
Achieved by using off-the-shelf components and open-source 3D printing

Extendable
Additional functionality can easily be added by adding new modules to your existing platform

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