July/August 2022
Volume 18 • Number 6

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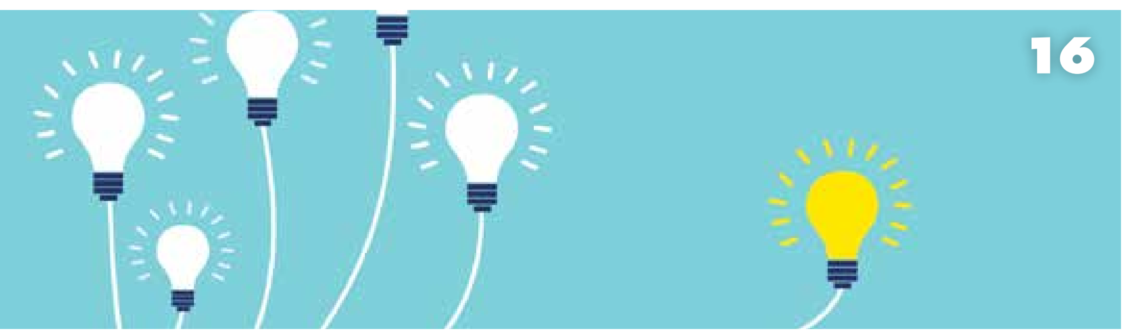

Lab Manager
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BPA WORLDWIDE BUSINESS

DEPARTMENTS

how do you define an innovator?

This issue will look and feel different. While some sections such as Lab Leadership and Insights will look familiar to our long-term readers, we also highlight new additions unique to this issue, such as Profiles.

For this issue, we asked our editorial and creative services teams to give readers their perspectives on what the concept of "innovators" means to them. They were given free reign to discuss any topic related to innovators and innovation. Everyone views innovation and how to achieve it differently, and who or what comes to mind when hearing "innovator" also varies depending on who you ask. This issue gave our team the opportunity to share a personal touch not commonly seen in our published content. I hope you enjoy learning more about the individuals who make up *Lab Manager* through their writing.

For the cover article (page 8), editorial director Scott D. Hanton, PhD, naturally took the leadership approach to innovation. Channeling his decades-long experience as a lab manager to now having a leadership role with *Lab Manager*, Hanton shares his own tips, as well as insight from authors, industry experts, and influencers on how to create an innovative lab culture. He explains how lab managers can cultivate an environment where staff are inspired to brainstorm innovative ideas, share them with peers and leaders, and develop a strategy to implement the innovation.

In our new Profiles section, three of our writers chose to share the life and accomplishments of three individuals that they consider to be innovators in their respective fields. The profiles represent pioneers in diverse areas of science, including deep-sea research, weather and meteorology, and integrative physiology. Though everyone spotlighted has a unique career path and life journey, they all have in common a set of challenges they overcame and barriers they broke to reach their goals.

In addition to sharing our own personal approaches to innovators and innovation, we asked you, our readers, about your thoughts on it. On page 64, you can see how fellow readers responded to questions about innovation in the lab and how they rated the importance of different contributing factors to innovation.

If you want to learn more about the writers behind the articles featured in *Lab Manager*, we recently published a Meet the Team page (www.labmanager.com/meet-the-team) where you can see all the faces that make up the brand. Please reach out to us any time with questions, feedback, or suggestions.

Enjoy,

Lauren Everett

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Managing Editor

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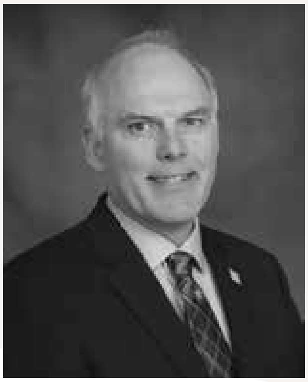

MANAGER MINUTE

Three Keys to Getting Better Ideas

by Scott D. Hanton, PhD

One key to success for most labs is their ability to innovate and develop new scientific results for their lab. Innovation requires many things, but an important one is good ideas. Lab managers can have significant impact on the quality and number of actionable good ideas that arise in the lab. Good lab managers find ways to encourage staff to think creatively, generate a safe environment for those ideas to germinate and be shared, and actively participate in the surfacing of good ideas. Successful lab managers have learned that good ideas can come from anyone and at any time. They also know that all ideas for the lab do not have to originate with them. Here are three things lab managers can do to improve the quality and rate of good ideas for the lab:

#1 – Generate emotional safety

There is an element of risk in sharing truly creative ideas. These ideas often have a key element that is new, different, or unorthodox. If staff are concerned about how they, or their idea, will be treated, most are reluctant to share. No one wants to be ridiculed or embarrassed for thinking about a technical problem in a different way. Lab managers need to create and sustain an environment of emotional safety. In *The Culture Code*, Daniel Coyle provides 13 actions to generate emotional safety. Three of the most important are overcommunicate your listening, embrace the messenger, and make sure everyone has a voice. Make sharing crazy ideas fun, safe, and interesting. Then the innovations will follow.

#2 – Listen to everyone

Great ideas can come from anywhere and from anyone. Sometimes it is the scientists who haven't experienced as much experimental failure who come up with the interesting angle to explore. Other times it is the wise sage who sorts through her deep experience to make the interesting new observation. Ensure everyone has the opportunity to contribute, and that all ideas are evaluated on their merit, not based on the resume of the person providing them.

#3 – Ask dumb questions

Sometimes experts can build habits about how they approach their science. They stop seeing some of the details or some of the interactions. Lab managers can provide a real service by asking dumb questions of the brilliant scientists in the lab. Dumb questions can cause those subject matter experts to see the problem from a different perspective or consider an interaction that hadn't been important before. Asking dumb questions is hard. It takes a self-confident lab manager to excel at this skill. However, as you see success in interacting with your experts in this way, it gets easier and more rewarding.

Thanks for reading. I hope you can use this information. I am very interested in hearing from you. If you have feedback or comments on this set of tips, or suggestions for future Manager Minutes, I'd love to hear from you. Please reach out to me at ***shanton@labmanager.com****. I'm looking forward to our conversations. Thanks.*

Creating a Culture of Innovation

Build the environment that can sustain the innovation journey

By Scott D. Hanton, PhD

"Innovation is seeing what everybody has seen and thinking what nobody has thought," is an important observation from Albert Szent-György, the discoverer of vitamin C. Innovation is more than invention, which is the creation of a novel idea. Innovation requires the application of that novel idea to a product or process to make something better, more effective, or faster, and the acceptance of the idea by those who will benefit from the new application. Through this invention, application, and acceptance process, innovation drives progress.

All organizations require innovation. Business management expert Peter Drucker said, "An established company which, in an age demanding innovation, is not able to innovate, is doomed to decline and extinction." To enable the success of their organizations, lab managers must create an environment where skilled scientists can develop and drive the innovations required for the success of their organizations. A lab environment conducive to innovative science consists of seven key elements: knowledge, motivation, inspiration, questioning, freedom, collaboration, and accountability.

Four Types of Innovation

While these different forms of innovation have different impacts on organizations, customers, and markets, they all require similar environments to occur and thrive.

1. **Sustaining:** Improvements that keep a product or service viable
2. **Disruptive:** Improvements that force a change on existing markets
3. **Incremental:** Slow but steady improvement
4. **Radical:** Revolutionary breakthroughs

Knowledge

Lawrence Ibarria, the co-founder and chief technical officer of Verdant Robotics, said during his presentation at the Lab Manager Innovators Summit, "Innovation is hard. It requires knowledge, depth, and breadth." Innovation requires both the knowledge to understand the right problem to solve and to recognize new possibilities for solutions. Lab managers can enable more innovation by supporting the ongoing training and development of the scientists in the lab. Building knowledge is important for all staff; even the most experienced scientists still have things to learn. It is also important to develop diverse knowledge among the staff with a combination of experts and generalists.

Ibarria also encourages different approaches to building the knowledge needed to innovate. Talking with potential customers, interviewing people impacted by the problem, and brainstorming solutions all contribute to the knowledge of the team. It is vital to keep learning to be effective innovators.

Motivation

Because innovation is hard, lab managers must take actions to encourage and support the effort. In the book *Drive*, Daniel Pink explains that motivation is driven by autonomy, mastery, and purpose. Autonomy provides lab scientists with the control over their work and schedule that enables them to be creative and to follow interesting ideas. Mastery is the application of their knowledge. Purpose provides meaningful targets for their experiments and engages them with the benefits of the work. While it is interesting to solve scientific problems, it is far more meaningful to complete work that improves the world in some way. Having a positive purpose that connects the head and the heart helps engage people in the work and leads to greater fulfillment, both personally and professionally.

Inspiration

Once a clear purpose is established for the lab and the scientific work, scientists can seek inspiration for innovation. Inspiration often comes from two different sources—interesting problems and adjacent knowledge. Lab managers can support inspiration in the lab by exposing staff to the wide range of problems associated with the lab's work, being sufficiently vulnerable to ask questions, and asking for help that engages the whole staff in seeking solutions. Lab managers can also promote diversity in the technical knowledge of staff and support explorations into adjacent spaces. As Tom Freston, former head of Viacom, said, "Innovation is taking two things that already exist, and putting them together in a new way." Innovations often come at the intersections of different kinds of science, each contributing something important to the new combination. Insight comes as new knowledge is applied to interesting problems.

Questioning

To expand on the ideas coming from inspiration requires the openness to question. Lab managers can model generative leadership by helping scientists question the status quo and how previous solutions were applied in this area. Encourage staff to ask "why" and look for improvements. Create an emotionally and psychologically safe work environment where every voice is heard, anyone can ask questions, and questions become part of the fabric of the lab. Innovation requires that new and hard questions are asked and shared. Staff need to know that they are supported to do something differently.

Freedom

The roots of innovation are probes into the unknown. Lab managers can support the exploration of seemingly unreasonable ideas that challenge what is currently understood. Sometimes people new to a field are unburdened with knowing what doesn't work, and can try ideas that may seem unreasonable, leading to unexpected outcomes. Scientists also require the freedom to pivot or adapt as they learn. Following an observation in the lab allows an idea that didn't succeed in one space to be explored in another. For example, Super Glue was an unsuccessful general solvent that became a massive new adhesive product. 3M, and we consumers, all benefitted from the freedom provided to that research.

It is also important to redefine the concept of failure. Brené Brown, research professor, lecturer, author, and podcast host, said, "There is no innovation and creativity without failure. Period." Being able to persist in the science despite many experiments not delivering the desired outcome is a key trait of innovators. My approach is a little different. One of the joys of being a research scientist is not having failure in my vocabulary. We celebrate successes and learnings. Those experiments that don't deliver still provide many positive lessons. Being free of the emotional baggage of failure enables new and different experiments to be conducted and protects the motivation of research scientists as they explore the unknown, seeking new innovations.

> "There is no innovation and creativity without failure. Period."

Collaboration

Because innovation requires breadth and depth of knowledge and new ways of looking at problems, it is best accomplished by a team. Having other people available to think about issues, contribute ideas, ask questions, and improve potential solutions speeds up the innovation process. Innovation also requires skills and knowledge outside the lab, like marketing, sales, product development, and manufacturing. These teams need to include people who work outside the lab. Lab managers can support improved collaboration by insisting on respect and trust. Respect is improved by caring about individuals, listening to everyone, providing compassionate support, and enabling everyone to belong. Trust is won by being authentic, delivering on commitments, being honest, and ensuring that words and actions align.

Accountability

Research and innovation are not independent from goals, objectives, and delivery. Waguih Ishak, vice president and chief technologist at Corning Research and Development said, "As an innovation leader, you must ground creative people in accountability for the organization's objectives, key focus areas, core capabilities, and commitments to stakeholders. Then you give them broad discretion to conduct their work in service of those parameters." Lab managers need to provide staff with the clear and attainable needs of the organization presented as cascaded goals with specific, measurable, attainable, realistic, and timely (SMART) objectives. While the solutions to the key problems can't be planned in advance, the process to discover, explore, and adapt those insights can. That process accountability provides structure and impetus to the research and development, while not limiting or biasing the approaches to innovation.

Lab managers have the power and the responsibility to create the lab culture to enable success. Improvements in each of these seven areas will provide the support and interactions required to promote innovative work in the lab.

***Scott D. Hanton**, editorial director for* Lab Manager, *can be reached at shanton@labmanager.com.*

Maximizing Airflow and Reducing Maintenance

HOW THE POLYSCIENCE SELF-CHANGING DYNAMIC AIR FILTER PROTECTS YOUR APPLICATION AND GIVES YOU THE PEACE OF MIND TO FOCUS ON YOUR JOB

Question

How do you reduce downtime, maintenance, and refuse going into landfills, while remaining productive?

What we've learned from customers is that many of them run expensive and lucrative processes (laser, ICP-MS, Ebattery-tester, reaction vessel, etc.) that require precise temperature control. Chillers are usually tucked away in closets, under the bench, or in that spot in the lab where it is easy to forget…until they stop working, and so does your process. We discovered that 22 percent of warranty returns ended up being classified as "no problem found." We would clean the condenser filter and the chiller worked perfectly once again. A dirty condenser contributes to a very high percentage of refrigeration failures. What this meant to our customers was downtime and the temporary loss of important equipment needed to run their applications, as well as costly shipping expenses.

Answer

At PolyScience, we developed the self-changing Dynamic Air Filter system, where the chiller will change its own filter at whatever interval the customer desires for up to three years.

All PolyScience DuraChill fractional chillers can be equipped with this life-changing innovation. By default, the filter will cycle once per month. This is a proactive approach to preventing breakdowns and lost time. There's enough media for the filter to change once a month for three years. The dynamic, self-changing filter system has dramatically reduced the warranty return rates on these units. This relieves customers of the burden of downtime, shipping costs, and the pain of missing equipment needed for their various applications.

As a bonus to the environment, because the self-changing filter only requires replacement every three years, the amount of additional waste created by DuraChill users is decreased, which means less landfill waste and ocean pollution. Solving the issue of "no problem found" also decreases the need to ship units back and forth to us, again reducing environmental impact.

This is a proactive approach to preventing breakdowns and lost time. The Dynamic Air Filter system dramatically reduces the warranty return rates on these units, thus relieving the customer from the burden of down time, shipping costs, and missing important equipment they need for their various applications.


THE JOURNEY TO
INNOVAT
3
Inspiration
Where might solutions be found?
4
Questioning
Enable broad and open inquiry
Motivation
What problem requires a solution?
2
1
Knowledge
Develop a staff with sufficient depth and breadth of knowledge to conduct innovation
5
Freedom
Offer opportunity to pursue the inspiration

ION

Seven stages to accomplish true innovation

Accountability

7

Learn and adapt. Ensure the research contributes to the needs

Collaboration

6

Bring together different knowledge and experience

Identifying and Addressing Efficiency Gaps in the Lab

DRIVING CHANGE THROUGH INCREMENTAL INNOVATION

by Holden Galusha

While innovation is often used as a catch-all term for new technologies or business models, some conceptualize it as four distinct types: disruptive, radical, sustaining, and incremental. Each type is valuable, but incremental innovation—small improvements to a product or service over time—plays a key role in the health of organizations.

To incrementally innovate in the lab successfully, it is important to identify opportunities, incentivize the change for key stakeholders, and have control over the change's implementation.

"The moment you stop improving it, you've initiated its death cycle."

Four types of innovation

Disruptive innovation

Disruptive innovation is an advancement that upends an existing market. A disruptive advancement most commonly comes in the form of a new technology that is markedly better than anything else currently available, such as lithium-ion batteries replacing nickel-cadmium batteries. Consequently, the new technology may be adopted en masse and become the new standard. Disruptive innovation doesn't only manifest as new technology, however. In some cases, it comes in the form of a new business model. Uber and Lyft are prime examples of this. Although ridesharing companies don't offer any new, tangible product, they upended the taxi industry with a novel approach to offering the service.

Radical innovation

While disruptive innovation impacts existing markets, radical innovation goes a step further to generate a new market entirely. Examples include the invention of the airplane and imitation meat produced by cell culturing. Radical innovation is almost always the result of a technological advancement.

Sustaining innovation

Sustaining innovation is typically seen when companies significantly change their product or service offering to keep up with changes across the industry. For instance, many publishing companies began offering digital versions of their content with the advent of the internet. If they had remained exclusively print publications, they would have dwindled away until finally closing.

Incremental innovation

Arguably the least flashy of the four, incremental innovation is just as important as the other three types—if not more. This type of innovation is characterized by the small improvements, new features, and streamlined processes that ensure an organization becomes more efficient or a product does not become stale. "Incremental innovation is required to keep any product alive," says Scott Hanton, PhD, editorial director at *Lab Manager* and former general manager at Intertek. "The moment you stop improving it, you've initiated its death cycle." Even if a new business is launched through a successful radical innovation, that innovation will not sustain the business' growth long-term. If the business does not innovate incrementally, they will be left behind as their initial radical innovation is mimicked and improved upon by competitors.

The same holds true for laboratories. Once efforts to optimize processes and produce higher-quality results stop, the lab becomes less effective and its output becomes less impactful. Incremental innovation in the lab allows researchers to accomplish more with the same resources, decrease operational overhead, and optimize processes so that more effort and money goes straight to the bottom line: research.

Identifying opportunities for incremental innovation

When identifying opportunities for incremental innovation in your lab, there are a few areas you can examine that will likely be ripe for improvement. These aspects of the lab are often neglected because they don't directly benefit the bottom line, so they're rarely reevaluated after initial implementation. Some of these aspects include inventory management, informatics, and training.

Inventory management

How robust is your lab's inventory management system? Many labs are held back by inefficient processes and use ill-suited software to manage assets and consumables. By auditing your current processes and migrating to a software platform designed for laboratory inventory management, you can streamline communication, minimize mistakes, and save time.

Informatics

Are you taking full advantage of your lab's informatics infrastructure? It is possible that useful features in your laboratory information management system (LIMS) are going unused. Take some time to review your LIMS' documentation for information that can help you extend it. You may be able to eliminate some manual data entry tasks, for instance, which would save time and decrease the margin for error.

Additionally, check if the manufacturers of your instrumentation provide any additional software. Some original equipment manufacturers (OEMs) offer monitoring and remote management software that may prove useful to you.

Training

Take some time to evaluate how effectively new hires are onboarded. Are trainees making the same mistakes or asking the same questions? Consider revising your standard operating procedures and training collateral to curb common mistakes and answer questions preemptively.

Incentivizing incremental innovation

As a lab manager, you have authority to incrementally innovate in your lab to an extent. However, to achieve the best possible results, you will need to communicate your vision and its value to both your direct reports and your superiors. Without staff cooperation, the changes you aim to make will never be implemented properly. Similarly, if you cannot convince your superiors of the positive impact these changes will have, you won't get approval to make them. To maximize the chances of persuading those above and below you in the hierarchy of the lab, you will need to adjust your approach accordingly. The hallmark of effective, persuasive communication is tailoring your message to your audience to address their values and pain points. Because leaders and staff operate at different levels within the organization, they will have different priorities.

> "Without staff cooperation, the changes you aim to make will never be implemented properly."

Convincing senior leaders

Those in leadership positions prioritize the success of the organization above nearly everything else. They make data-driven decisions, so you will need to bolster your arguments with information to win them over. Focus on how your change will have a quantifiable impact. Use hard numbers, projections, and estimations to illustrate how the change will decrease low-value tasks, save money, or otherwise improve the lab's footing in the market. The chances of getting an idea greenlit increase if the anticipated results are made tangible.

You may also take a people-centric approach, such as emphasizing how the change will benefit clients. Improving client relations will benefit the organization's bottom line as well.

Convincing lab staff

Cost versus value is a key concept to guide your approach when managing change with your lab staff. Is the value of the change worth the cost of the time and effort needed to carry it out? The change should only be implemented if you are certain that the value outweighs the cost.

Generally, lab technicians will care most about how your proposed change will affect their day-to-day work; more specifically, will their lives become easier or harder? If it will make their daily routine more convenient, lean into that as the primary selling point and then supplement it with data illustrating how the change will benefit the organization. If the change will make their work more difficult, then emphasizing its necessity to improve the lab overall will be the most persuasive approach.

Additionally, make sure to always encourage your direct reports to share feedback or alternative ideas. Oftentimes the best incremental innovations come from those doing day-to-day lab work because they are the most familiar with the processes.

Innovation requires implementation

It is important to note that your innovation will be limited by the level of control you have over the related processes. "One of the key learnings for me is that, to innovate, you have to implement, which means that you need to have sufficient control over the process to put the change into action," remarks Hanton. Since you are the one establishing a new vision, you'll need to have enough autonomy to course-correct and modify things as needed. If you lack the authority to do so, your innovation will never reach fruition. For example, it will be difficult to streamline new equipment purchasing processes if all purchases need executive approval. A key step in the process is out of your control.

With incremental innovation, you can set the stage for other, more impactful innovations to take place. To successfully accomplish this, make a habit of identifying opportunities, successfully communicate your vision, and be open to feedback from your colleagues.

***Holden Galusha**, associate editor for* Lab Manager*, can be reached at hgalusha@labmanager.com.*

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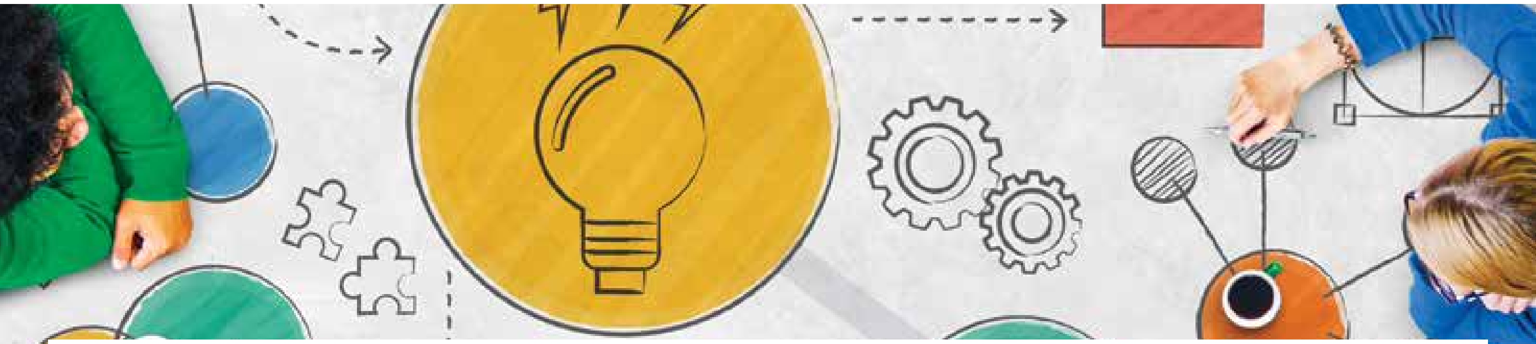

Characteristics of an Innovative Mindset

HOW INDIVIDUAL TRAITS AND QUALITIES CAN BE AN ASSET TO THE INNOVATION PROCESS **by Lauren Everett**

Innovations don't arise simply from an individual's creative idea. A team of partners and advocates are needed to fine-tune the idea or product, test it, introduce it to the public, and generate interest and adoption of it. Therefore, classifying a creative, out-of-the-box thinker as an innovator is only part of the definition. Execution of the innovative idea is arguably more important than the idea itself. In the lab, ensuring you have a team of collaborative individuals with key traits and characteristics that will help an idea move through each of the stages of innovation is crucial.

To get a fuller picture of what traits and behaviors qualify as being beneficial to innovation, researchers conducted a study, published in the *International Journal of Innovation Management*,[1] focusing on an often-overlooked contributor to innovation—an individual's experimentation behavior and the characteristics that influence it. As study authors Lotta Hassi and Satu Rekonen explain, experimentation behavior is "the behavior toward designing, executing, and learning from experiments." So, how can an individual's experimentation behavior affect an innovation project?

Studying the process of innovation

The study included 18 participants involved with short-term innovation projects within a Finnish financial institution and who were unfamiliar with experimentation prior to the project. The individuals represented five different departments and worked in innovation projects focusing on different topics to allow for variation in the study. The researchers acted as tutors during the projects and collected a variety of data from observations during numerous workshops, tutoring sessions, email communication, face-to-face interviews after the completion of the projects, etc.

Based on the observations and results, the researchers identified 12 individual-level characteristics that promote experimentation behavior (see figure 1). These characteristics proved important in specific ways at different stages of the projects' journeys. "These findings suggest how different activities that constitute experimentation (e.g., identifying uncertainties and running an experiment) draw on different kinds of characteristics of an individual. Thereby, the adequate managerial support also changes from activity to another," write the study authors.

A closer look at experimentation characteristics

While all 12 characteristics outlined in the study influenced the direction of the five projects, the study authors elaborated on a few that had a particularly strong impact. One of these was continuous reflection: "Through continuous reflection, the participants were able to notice new pieces of information that were potentially important for the direction of the project," write the authors.

A participant in one project group said, "I questioned many things...and I didn't do it out of spite...sometimes eagerness goes before good sense, and in our team, there was a lot of eagerness. I asked if we are doing the right things because I wanted to ensure that we are not falling of the track."

There's a fine line between sufficient and too much planning, however. This is where action-oriented individuals can shine. "Some individuals were more likely to take action, move from intellectual work to practical, which proved fundamental when building a prototype and running the experiment," write the authors. Remaining stagnant in the planning or brainstorming phase can cause teams to only see the flaws of an idea rather than the potential. At some

CATEGORY	CHARACTERISTIC	DEFINITION
Thinking styles	Continuous reflection	A practice of ongoing reflection, inspection about the work at hand
	Unattached exploration	Postponing fixation on a single idea and staying open to explore different possible directions before closing in on one option
	Iterating between abstract and concrete thinking	Moving fluently between conceptual and practical thinking; maintaining the connection between the two
Personality traits	Action-oriented	Facility to take action, to move from intellectual work to practical
	Opportunity-focused	Ability to see opportunities in different situations
	Mental resilience	Positive adaptation to adversity; not being defeated by challenges
	Intellectual humility	Humility in front of new information, openness for learning, willingness to revise own beliefs
	Courage	Ability to face the risk of refusal and failure
Experimentation skills	Sensitivity toward uncertainties	The ability to notice uncertainties in the idea and remain sensitive to them as the project proceeds
	Designing valuable experiments	Ability to identify the smallest and fastest action or arrangement to produce the wanted learning
	Extracting learning	Ability to identify information from the experiment that is valuable for the work at hand
	Implementing learning and idea adaptation	Ability to interpret and act on the learning that has been extracted—bring the new information back to the idea in a meaningful way

▲ Figure 1: 12 characteristics that promote experimentation behavior.
Credit: Lotta Hassi and Satu Rekonen, International Journal of Innovation Management.

point, experimentation is needed to see what works and what doesn't. Action-oriented individuals can lead this stage.

When the researchers conducted interviews with the participants, the individual-level characteristic that was referred to most often was courage. Even the most confident of individuals will experience a level of discomfort and vulnerability when pitching an idea to someone of authority. This was a common feeling across the project groups. As one participant explained, "...it was quite funny that I was really feeling nervous that [the users] also like this [idea] because I do think it is a good one."

How does other work compare?

Some of the characteristics suggested by Hassi and Rekonen share commonalities among those that have been identified in other work. A study published in 2020 in the *International Journal of Research in Management & Business Studies*[2] explored the impact of the "big five" personality traits on innovative behavior among business students. The study authors hypothesized that these big five traits—extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience—would all have positive effects on innovative behavior among business students. They concluded that extraversion, conscientiousness, and openness specifically hold the positive impact they hypothesized, with conscientiousness being the highest. Conscientiousness has overlapping qualities with Hassi and Rekonen's choice of continuous reflection, as both aim to evaluate and improve one's work. Another similar characteristic between the two studies is openness to experience and unattached exploration. Both characteristics enable individuals to look beyond their scope to embrace other ideas.

As a final example, a Harvard Business Review article emphasizes "an opportunistic mindset" as one of five characteristics of successful innovators, a good match to Hassi and Rekonen's use of "opportunity focused."

These overlapping conclusions further support the importance of the identified characteristics when working on innovation projects.

How managers can encourage innovative behavior

These characteristics come naturally for some and are harder to adopt in others. Building on the example of continuous reflection above, the study authors explained that continuous reflection was a difficult task for many of the study participants, but for a few, it was their way of working. Without these few individuals, the team may have moved too quickly between the innovation processes and missed important details, ultimately leading to a potential failure of their idea. Managers can encourage individuals to pause and consider possible scenarios or red flags before coming to a final decision. Demonstrate that taking more time to get it right is better than rushing to get results.

Because courage was the most cited characteristic among the study participants, it suggests that this should be a primary area of focus for managers. The interviews showed that individuals who accepted the initial challenge of approaching people with a new idea found it became easier to do the more they did it. Managers can offer their staff opportunities to practice their pitches or connect them with mentors who can offer advice and encouragement. Managers can also promote an "open door"-style policy where staff know they are welcome to share feedback or ideas with the manager at any time without feeling like they are a bother.

The study authors also note that different characteristics are especially valuable at specific stages of the projects. For example, opportunity-focused individuals are most helpful after experiments have been performed and learnings have been identified. A mentally resilient individual will remain motivated if conclusions from the experiment phase are critical of the initial idea and require a rethink of ideas.

Continuous reflection is a characteristic needed throughout all stages of the innovation project. It Is important for managers to identify team members who exhibit this trait and involve them in the project from the beginning.

This study offers insight for lab managers to strategically build teams among their staff. Ensuring your teams represent a mix of individuals who exhibit these characteristics will give you the best chance of pursuing innovative ideas and achieving the outlined goal.

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VACUUM GENERATION USING SCREW PUMP TECHNOLOGY

VACUUBRAND® VACUU·PURE® screw pumps are unique, reliable, and versatile systems that can help establish a clean, deep vacuum to meet your laboratory's needs.

Over recent years, laboratory applications have witnessed increasing demands in what has been a rising trend for high product purity and clean processes. To meet these challenges, oil-free and dry pump technologies have been considered for contamination-free operation. These pump technologies do not require operating fluids and thus eliminate the need for maintenance-related oil changes and waste oil disposal in addition to reducing operating costs and improving efficiency and sustainability. For processes involving aggressive gases and vapors, chemical resistance for a vacuum pump remains critical to ensure longevity of the pump and minimize maintenance.

VACUUBRAND® VACUU·PURE® 10 and 10C models meet the many challenges of adapting screw pump technology within research and analysis laboratories. VACUU·PURE enables contact-free rotation of the spindles, preventing and eliminating any occurrence of abrasion or wear and tear. This allows for continuous operation and low maintenance requirements with no scheduled maintenance to replace parts for wear and tear as well as oil- and abrasion-free operation. Consequently, the pumps facilitate an ultrapure vacuum as well as contamination-free exhaust air. The 10C version features chemically resistant wetted materials that allow the pump to be used for applications involving aggressive media. Both versions of the VACUU·PURE operate from atmospheric pressure down to the 10^{-3} mbar range with pumping speeds up to 9 m^3/h for the VACUU·PURE 10C and up to 10 m^3/h for the 10 version. As an additional advantage, the VACUU·PURE is air-cooled and does not require cooling water like some other pump technologies, extending their ease-of-use and flexibility.

VACUU·PURE 10—ADVANCES IN MASS SPECTROMETRY WITH VACUUM TECHNOLOGY

The VACUU·PURE 10 is an ideal solution to support instrumentation including being used as a backing pump for high vacuum systems. There is no scheduled maintenance to replace wear parts and no need for oil changes, allowing for continuous operation and contamination free vacuum supply.

A representative example of the VACUU·PURE 10's abilities involves its use to ensure a stable and clean fore vacuum for secondary ion mass spectrometry for geochemistry applications at the Canadian Centre for Isotopic Microanalysis (CCIM). Mass spectrometry generally requires a vacuum environment to avoid collisions of ions with molecules in the atmosphere as this may degrade the performance of the instrument. The appeal for the VACUU·PURE had to do with its lack of contact seals, which eliminated the need for extensive maintenance and replacement of worn-out seals, and its oil-free operation, which avoids vacuum contamination by hydrocarbons and particulates. The pump was initially deployed on an experimental basis to test its performance prior to its instrumental deployment. The stability and successful performance of the system led to its current role backing a turbomolecular pump for the ion detection chamber portion of the mass spectrometer at CCIM.

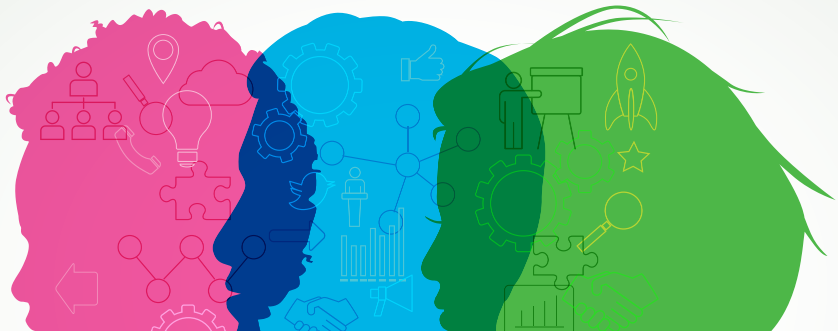
VACUU·PURE 10C—SUPPLYING VACUUM FOR CHEMICAL SYNTHESIS HOODS AT THE MAX PLANCK INSTITUTE

The VACUU·PURE 10C is the chemically resistant version of the VACUU·PURE 10. The VACUU·PURE 10C is unique thanks to its high chemical resistance using wetted materials made of chemically resistant polymers. A thick-walled PEEK encapsulation protects vulnerable parts such as the spindles and stator that come in direct contact with chemicals while eliminating the need for a cold trap in many cases to protect the pump and allowing its use with aggressive gases and vapors.

A notable example involves the use of the VACUU·PURE 10C to support work done in chemical synthesis hoods by the research team of Dr. Grazvydas Lukinavicius at the Max Planck Institute for Multidisciplinary Sciences. The research group is synthesizing fluorescent dyes and probes for imaging biological structures in living cells. Incorporating the VACUU·PURE 10C into their chemical synthesis hoods, the research team has been able to expand their use for tasks that require a vacuum below 1 mbar, such as the evaporation of residual solvents and the distillation of liquids with high boiling points. Being able to connect two synthesis hoods to one single VACUU·PURE 10C pump made it all the easier for the team to save on space and operation costs, while banking on its reliability and low maintenance requirements.

CONCLUSION

VACUUBRAND VACUU·PURE screw pumps are designed to generate a deep vacuum while eliminating process contamination from hydrocarbons and other particulates. There is no wear due to abrasion and no oil-change requirements, resulting in continuous operation, reliable supply of oil-free vacuum down to the 10^{-3} mbar range, and low operating costs. The chemically resistant VACUU·PURE 10C version features chemically resistant wetted materials allowing the pump to be used with aggressive gases and vapors, making the use of a cold trap unnecessary in many cases. The VACUU·PURE screw pumps elevate screw pump functionalities to the next level while uniquely adapting their functionalities for use in research and analysis laboratories.



Stories from the Most Innovative School in the US

LEARN HOW THREE ENGINEERS INNOVATE AND SPUR IT IN OTHERS

by Jonathan Klane, M.S.Ed., CIH, CSP, CHMM, CIT

Everyone wants to be innovative, see more innovations, and use cool new technologies. But how does innovation happen? Who are innovators and what explains their abilities to innovate?

Arizona State University (ASU) has been named #1 in innovation for the last seven years, per U.S. News and World Report. I reached out to my connections in ASU's engineering department to get a variety of perspectives and approaches toward innovation from the ones who do it best. Each principal investigator (PI) took a different tack in their interview, demonstrating how ASU attracts innovators and facilitates creativity.

Fulton Entrepreneurial Professor Mary Laura Lind teaches innovation at ASU

Mary Laura Lind, PhD, is associate professor of chemical engineering and Fulton Entrepreneurial Professor in ASU's School for Engineering of Matter, Transport, and Energy (SEMTE). She's also former graduate program chair for chemical engineering, affiliated with ASU's Biodesign Center for Bioelectronics and Biosensors, and has a research affiliate at the Mayo Clinic in Division of Nephrology and Hypertension. She's an innovator, yet her true passion is teaching the graduate student elective class Innovation in Engineering, as it's not often covered in other courses and is key for students to learn early in their scientific careers.

In addition to teaching innovation, she's part of a multi-university nano-in-water center called NEWT (Nanotechnology Enabled Water Treatment). Its three scientific thrusts are in nanotechnology—multi-function materials, nanophotonics, and scaling and fouling control. This collaborative, multi-disciplinary team and problem-solving approach exemplifies her method to create innovative opportunities.

These innovation examples and real-world solutions help her students view the benefits of the multi-disciplinary problem-solving model, despite the investment of time that is needed. As part of this methodology, she prioritizes her own learning on innovating and works with different centers to share resources. "It's all about fostering an innovative community of scientists and design thinkers," says Lind.

> "Your people are working to contribute as much as they can; they are your most important asset."

What's key for Lind?

Her view is that "Innovation is part of one's practice—it's close to a way of thinking. We need others who share an overall vision yet are multi-disciplinary with strong ethics and complimentary skills." Lind credits another ASU engineering associate professor, Zachary Holman, as a leader in this community.

She also emphasizes, "Create a culture of innovation, use a systems approach to learning, communicate, develop others, problem-solve, be creative, and enjoy your life's work." Her overall themes include "find[ing] common or important problems, iterate, and fail fast," as part of the learning process.

ASU school director and professor Edd Gibson enables innovation in others

Edd Gibson, PhD, PE, is a professor and Sunstate Chair of Construction Management and Engineering in the School of Sustainable Engineering and the Built Environment (SSEBE) at ASU, which he directed and grew significantly from 2010 to 2018. He's been a PI on more than $11 million of research funded by NSF, NOAA, Department of Energy, NIOSH, US Army Corps of Engineers, National Research Council, and others. He's developed many Construction Industry Institute tools, including the integrated project risk assessment tool and may be best known for his work in front-end engineering design (FEED).

Within SSEBE, Gibson started the Global Center for Safety Initiative (GCSI), ASU's OSHA Education Center, and the Prevention through Design Initiative (PtDI) project, which, with Gibson's nurturing, have grown and attracted many researchers and professionals to collaborate on research-to-practice papers and workshops. His perspective is via leadership's vital role: "[You] need a good vision (or to be a visionary) of where the organization should go beyond today."

As Gibson says, "Not much has changed in civil engineering over the years," so it's vital to attempt innovations like these that he's helped nurture and support: Ed Kavazanjian, PhD's Center for Bio-Mediated and Bio-Inspired Geotechnics (CBBG); Bruce Rittman, PhD's membrane biofilms reactor and biofuels wastewater treatment center, net zero waste energy research; and work on gut biome and autism by Rosa Krajmalnik-Brown, PhD. Another nontraditional approach was to help bring physicist Klaus Lackner, PhD, to ASU. There, Lackner directs the Center for Negative Carbon Emissions and was first to propose managing carbon via the artificial capture of carbon dioxide back in 1999, an innovation for that time.

These projects demonstrate how Gibson connects engineering with chemistry, biology, physics, and material science. He sees advantages and benefits to "cut through boundaries, have stretch goals, enable cutting-edge research, and above all, collaborate." Given how people-driven and multi-disciplinary innovation is, he's played matchmaker to bring teams together. Traits and actions that promote his innovative nature include having passion, being willing to fail at times, going to others' talks, and always listening to people's ideas. He's used these to varying degrees to facilitate and support SSEBE's many researchers like those above.

People, experiments, and leadership

While thinking about how to facilitate innovations, Gibson questions himself: "Is this the right direction to go? We may not realize the talent, so what are the pathways versus risks? Are there any unintended consequences? What if x happens?"

He next adds thoughts on experiments and their vision—how do we reach the goal while keeping an open mind? He offers more about ideas: "Where do my ideas come from? It's that voice or intuition that pops up sometimes while I'm sleeping yet our brains are working on problem-solving." Gibson likes to be thinking many "chess moves" ahead. First, the direction must benefit mankind. "If not, why are you doing it?" Then he recommends, "Be nimble and flexible enough to move on and learn."

Gibson had to learn to be a leader early. At 19, he ran a bridge-building crew and at 25 he was platoon leader deployed in a low-intensity combat zone. He advises that leaders need perspective. As Gibson says, "Your people are working to contribute as much as they can; they are your most important asset." Find creative collaborators. He accepts that "not all good researchers are always great leaders" and that "one's leadership skills are often honed over an entire career."

Regents professor Ed Kavazanjian directs an NSF-funded engineering research center

Ed Kavazanjian, PhD, PE, GE, is regents professor of geotechnical engineering at SSEBE. He's a member of the National Academy of Engineering (NAE) for his internationally recognized work on landfills, solid waste, and geotechnical earthquake engineering. He's a distinguished member of the American Society of Civil Engineers and director for CBBG. He was lead author of the Federal Highway Administration's guidance document for seismic analysis, geotechnical transportation facilities, and structural foundations.

Citing Isaac Newton's famous quote "I stand on the shoulders of giants," Kavazanjian says that his work at CBBG builds upon previous research. Though built on the work of others, Kavazanjian ensures that his work goes beyond mere incremental innovation. His contributions to the field are significant and unique, distilled from insight gleaned from other fields. "You've got to do something different from what others are doing—not just incrementally different, but actual step changes. You should set your own course and take [inspiration] from your or others' fields and apply it to your problems."

Another important piece of advice Kavazanjian shares about innovative ideas is to "follow the money." This may seem crass, but as he points out, "It's only a good idea if the one with the money thinks it's a good idea, so find out." It's a practical view; innovation requires funding and there's only so much to go around.

Solve the problems no one else is, then solve more of them

Due to his landfill expertise in engineering with geosynthetics, Kavazanjian was invited to a symposium on preserving archeology sites. He learned that because museums are already "full of stuff," archeologists were excavating, studying, and then re-burying the artifacts. It's an innovative approach but there were adverse effects: the geotextile stuck to the mosaic due to biocementation from calcium carbonate precipitation. Similarly, he was aware that "a landfill with leachate biocemented up the gravel leachate collection layer to become hard as a rock." He realized that problems like these, applied in the right context, can lead to innovative, beneficial applications of biocementation such as creating tunnel linings, supporting foundations, mitigating earthquake-induced soil liquefaction, or quantifying "waste shear wave velocity."

He was also involved with multiple landfills, including a Superfund site in LA County where he hired Kenneth Stokoe, PhD from University of Texas Austin to measure shear wave velocity of the waste, the Superfund site, and other existing landfills using techniques Stokoe developed at soil sites. He and Stokoe published the results and became the recognized experts on this topic. Through much work, he established a waste strength envelope that people are still using 25 years later.

Kavazanjian recommends, "Look for things that make a difference. Science is a team sport; you don't need to understand it all." He adds, "Be a facilitator of others with disparate backgrounds."

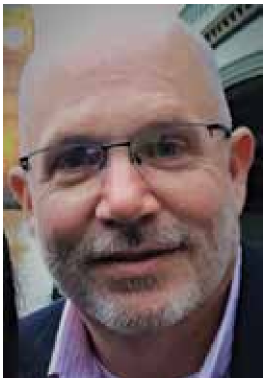
Key takeaways

The commonalities among these three innovators are passion, problem-solving, risk-taking, and idea exploration. They need space to be creative, work with a collaborative multi-disciplinary team, and share each other's lanes. They're willing to fail and are always learning more. They each credit ASU president Michael Crow for leading and inspiring innovations among faculty, researchers, students, and staff.

As these three shared, innovation can be observed, lived, taught, led, measured, valued, funded, facilitated, and part of an organization's culture. By looking at several perspectives, a fuller picture comes into view of how, when, and under what mix of circumstances innovation occurs.

How might you be inspired to innovate?

***Jonathan Klane**, M.S.Ed., CIH, CSP, CHMM, CIT is senior safety editor for* Lab Manager. *He can be reached at jklane@labmanager.com.*



How Chromatographers Are Avoiding the Latest Helium Shortage

◀***Jack Mahan*** is the North American sales manager, Analytical Gas Systems for the IGFG Division of Parker Hannifin, and has over 30 years of experience with life sciences equipment like LCMS, GC, GCMS, NMR, FTIR, and TOC.

Q: Please tell us about your career journey and what drives you.

A: I've spent my entire career with this business and absolutely love the laboratory space. After 33 years, I am still excited to see what the day brings—learning and seeing improvements in health, finding cures, and solving crimes, as well as helping customers, reducing our carbon footprint, and making new friends and colleagues.

There is so much going on in the world today that affects our industry. Helium has taken a direct hit, and the results have been devastating to many labs.

Q: Can you tell us more about these supply challenges?

A: This "helium shortage 4.0" is just as its name implies—another round of helium shortages that's having a direct impact on the chromatography market. This time the causes seem to be a perfect storm: global economic uncertainty, rising costs, conflicts in main supply countries, supply chain pressures, maintenance shutdowns at the larger supplier plants, and the challenge of managing the COVID impact. The resulting impact to chromatographers has been a dramatic disruption in availability, rationing shipments, and a sizeable spike in their price to procure.

Q: Is hydrogen generation really an alternate for GC-FID carrier gas applications, and is it safe?

A: Hydrogen is ideal as it's a much faster gas than helium, which means decreased sample run times and a more productive instrument. Generating hydrogen is far safer than switching to hydrogen cylinders, which require safety closets, secure areas, and long runs of stainless-steel piping. In addition, having a 2000psi+ container of 6,500 liters of hydrogen is never favored by EH&S teams. Generators never store more than 500cc of gas, stay below 175 psi, and can be located next to the instruments.

Q: Is it difficult to switch from helium to hydrogen?

A: It's incredibly simple. The GC does most of the work—just tell your instrument you've switched! Keep all other settings the same for a nearly identical chromatogram. But double the linear velocity to get the same separation in about half the time or use the method translator to get the fastest conditions while still maintaining good resolution.

Q: Can you tell us more about how Parker has innovated in gas generators?

A: Our innovation producing hydrogen from a deionized water source and small electric current is remarkable. We incorporate industry-leading proton exchange membrane cell technology to separate hydrogen from water and then use a palladium purifier to remove trace oxygen, so it is very pure.

State-of-the-art software allows users to monitor activity including flow rates, pressures, purity, water quality, and service schedules, and contains several internal safety controls. Any downstream leak will cause the system to shut down and alert the operator. We're also launching a new "ChromGas" series of hydrogen generators, based on customer feedback, with an all-new user interface.

Our technology is the industry gold standard and we're solving supply chain challenges—eliminating dependance on outside gas supplies, assuring interruption free operations, circumventing gas cost increases, improving safety, and streamlining the lab operation.

For more information on Parker Hydrogen Systems, visit www.parker.com/labgas.

sponsored by Parker

Embracing a New Leadership Role

IDENTIFYING THE RIGHT SUPPORT AND RESOURCES WILL ENABLE NEW LAB MANAGERS TO THRIVE AND SET THEIR TEAMS UP FOR SUCCESSFUL INNOVATIONS **by Michelle Sprawls**

Becoming the head of a lab is more than just making big discoveries; it is about managing a small business. Being a good lab manager is difficult. The role requires a variety of skills, knowledge, and behaviors. Most of us became lab managers after demonstrating some success as scientists in the lab. While we have the scientific and technical skills required to be effective lab managers, most of us must rely on our experiences to develop the leadership and management skills required for the role. That pressure can be overwhelming to new managers, and it is difficult to know where to look for resources or guidance. So where do you begin to look, and who do you go to for help? Here, I share some of the resources I have found in my journey and what helped me.

The benefits of mentorship

One of the best ways to grow as a lab manager is by learning from experienced leaders who have been in your shoes. Finding a mentor can be more difficult than it sounds, especially if the role you are stepping into doesn't have anyone above you. A work mentor doesn't have to be in your department or even from a science field. A mentor can be someone that you admire, that has been at the company for a while, or someone you can trust and bounce ideas off of.

If you struggle to find the right mentor internally, look externally. The Association for Women in Science (AWIS) provides career development, networking, mentorship, and leadership opportunities for women in science. Memberships are built for careers of all levels, whether you are a student, in your early career, or a full member, there's a tier for you. If you are in the clinical setting, The American Society for Clinical Laboratory Studies (ASCLS) has a mentorship program that pairs mentors and mentees one-on-one to discuss any goals or challenges the mentee wishes to work toward. This program is for students, new professionals, and new members. If you can't commit to an ongoing mentorship, The Association of Lab Managers (ALMA) offers a unique opportunity for managers and future managers of laboratory organizations to grow their skills through its annual conference. The ALMA conference includes workshops, presentations from managers who share their experiences, round table discussions with peers from around the world, and networking opportunities.

> "It is far better to navigate the waters with someone who is supportive and compassionate than struggle through it solo and burn out prematurely."

Mentorships are important with early career scientists, as well as managers, at any stage of your journey. It is far better to navigate the waters with someone who is supportive and compassionate than struggle through it solo and burn out prematurely. Having the right mentor can help early lab managers shorten the learning curve and accelerate their professional development.

How to effectively manage your time

Having a mentor is a great, but how do you manage your daily to-do lists within interruption-prone environments? This is where time management comes into play. To maintain a sense of work-life balance, your time management skills need to be top-notch. Some managers respond to the dilemma of lack of time with utmost focus and purpose, while others stress themselves out.

The more successful a lab manager is, the more demands there are to attend conferences, sit on special committees or boards, draft grant proposals or license applications, lead and mange new projects, and attend to other administrative duties. Effectively managing your time is essential to the success as a lab manager or lead scientist. Since a manager's most valuable asset is time, plan ahead. Planning out your day in advance is one of the most important elements of time management. Before you start your day, have a clear idea of what your schedule looks like. Next, prioritize. Of the 10 tasks you have in a day, not all of them will be equally as urgent. Therefore, it's necessary to prioritize. Make a to-do list and categorize the tasks based on their order of priority. Finish the important and urgent ones first and leave the less important ones for later. Now that you have your day planned and prioritized, you need to eliminate distractions—whether that's refraining from scrolling through social media or being disrupted by noisy coworkers. Having your smartphone around serves as the biggest distraction these days so it's imperative to get these distractions out of the way.

Striking a healthy work-life balance

One of the key misconceptions of a new manager is that they must do everything themselves but learning to delegate is crucial. Whether you're a part of a big corporation or own a small business, delegating tasks is always necessary. It saves you a lot of time and enables you focus on the tasks that need your special attention and expertise. The reason you hire people is so that they can contribute in meaningful ways, so take advantage of the help.

Make time for yourself. Amidst all the hard work and hustle, we often forget to take time for ourselves. This results in sleeplessness, fatigue, mood swings, and a general unpleasantness. Therefore, taking time out for yourself is equally important. Take a break in between tasks, eat healthy, spend some time outside, or perhaps listen to some relaxing music.

Lastly, when it comes to streamlining communications, organizing inventory, and general project management, lab managers often seek digital tools that go beyond SharePoint, Zoom, and Teams. Here are a few suggestions on digital aids for communication and project management:

- Asana, Trello, Jira, and GitHub: These tools help teams to see the broad view of a project, allowing users to create and complete tasks, meet deadlines, capture detail-rich notes, and provide templates for common protocols. The tagging functions of these tools allow managers to assign tasks to team members.
- AnyDesk or Teamviewer: Software used for accessing and controlling computers remotely. Beneficial for managers who are away from the lab and need to log in for troubleshooting instrument issues or validating results/methods. If you need to be in two places at once, these apps let you step away while still being online for your team.
- Benchling: A suite of life sciences apps with tools for DNA design, lab notebooks, and more.
- Quartzy: Centralizes lab orders and maps inventories.
- Voice Dream: Converts text into voice and can be used to listen to PDFs of papers in the same way as an audiobook.

"One of the key misconceptions of a new manager is that they must do everything themselves but learning to delegate is crucial."

Managing a lab is difficult without the necessary skills, but those can be taught just like technical science can. No matter if you aspire to be head of your lab in the future, it's your first day on the job, or you've been in your role long-term, developing the required skillset is essential to be a successful lab manager.

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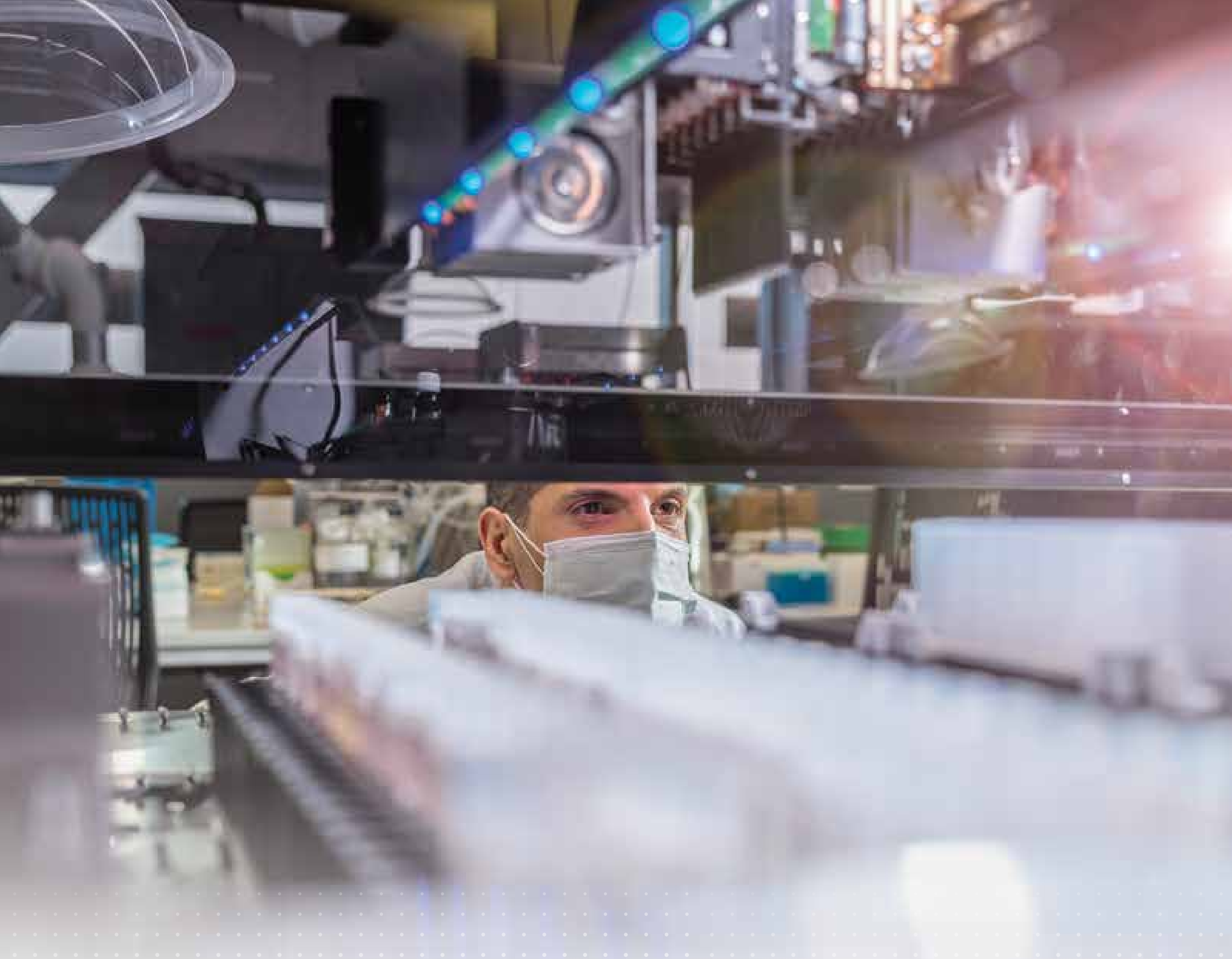
***Michelle Sprawls**, director of science at CULTA, has been diversifying her role in the laboratory and scientific industry since 2013. Sprawls delivered a presentation that expanded upon the topic of management resources and training opportunities during the 2022 Lab Manager Leadership Summit in Baltimore, MD.*



ENABLING TECHNOLOGICAL TRANSFORMATION FOR HEALTH CARE SERVICES THROUGH LAB AUTOMATION

In-class automation of lab services to power the medical community

Diagnostics is a crucial aspect of medical services. Diagnostic tests and therapeutic procedures provide the relevant insights required for the detection, identification, and treatment of medical conditions while also inspiring healthy behavior and improving health care management.

Quest Diagnostics Incorporated (NYSE: DGX) is the world's leading provider of diagnostic information services. Motivated by a goal to empower the public to take action to improve health outcomes, Quest hosts the world's largest database of clinical lab results. Annually serving one in three adult Americans and half the physicians and hospitals in the United States, Quest's focus is to inspire actions that transform lives through the diagnostic insights made available through its clinical lab results.

THE CLIFTON LAB—A NEXT-GENERATION LAB FACILITY

To facilitate these goals, Quest completed its integration of Northeast region operations to its new 250,000 sq. ft. next-generation lab facility in Clifton, NJ in 2021. Serving more than 40 million people per year in seven states across the Northeast, the Clifton lab performs high-volume diagnostic testing services offering increased productivity, superior medical quality, and capacity to meet current and future regional demands.

Among one of the largest medical laboratory facilities in the world, Clifton is state-of-the-art, featuring extensive automation that enables it to perform more than 300,000 tests per day with exceptional accuracy, quality, and efficiency. Two distinct automated lines for clinical testing and a bridge design help enhance process efficiency. The automated facility also utilizes barcode tracing solutions to track and store specimens thus making it easier for health care providers to request follow-up tests or detailed analysis in real-time while allowing the lab to deliver superior provider and patient experiences.

Beyond its advanced facilities and services, the Clifton lab represents a more than $250 million commitment to its customers and community, providing more than 1,000 jobs and serving as an economic stimulus for New Jersey. The automated environment at the facility offers employees skill-building opportunities and the ability to focus on high-value work surrounding medical diagnostic insights.

AUTOMATION AS A MEANS TO AN END

In-class automation at the Clifton lab has enabled the facility to become a platform for technological transformation

driven by powerful tools toward enhanced operational solutions including network integration of patient data for seamless data access, multiple redundancies to improve efficiency and ensure reliability, automation technology to minimize the chance of specimen loss, and Quantum lab services for easier, faster test-ordering. As such, there is an equal influence in workspace culture, and the demands to meet client-customer standards and lab workflows.

Built with purpose and efficiency in mind, automation at the Clifton lab supports employees and elevates daily efforts toward patient care. The significant investment in automation has demanded shifts toward a digital transformation mindset from all of Clifton's employees. A representative example considers the physical routines surrounding the handling of microbiology plates. Quest understands that behind every test tube there is a person, and at Clifton, automation strips out those repetitive physical tasks, allowing its teams to focus on what truly matters: finding actionable insights for patients faster. Rather than become bogged down by repetitive physical tasks, automation allows employees to focus on patient care and the procurement of accurate diagnostic results.

Automation cannot replace the personal expertise of individual workers. Rather, Clifton lab's goals coincide with an integrated approach where automation can enhance the

individual expertise of workers, focusing on evaluating lab results, instead of repetitive tasks, ultimately reducing the footprint of human error, improving efficiency and throughput, and resulting in more accurate and faster patient care.

TRANSFORMING MICROBIOLOGY DIAGNOSTICS

Despite its myriad advantages, automation is not the answer for every lab. Fortunately, the high-volume testing and throughput standards at Clifton necessitate the use of automation as a valuable operational tool.

A representative example concerns the microbiology department. Quest Diagnostics offers a complete spectrum of diagnostic microbiology services. Crucial to microbiological diagnostics is the handling of tightly sealed sterile containers, tubes, or plates that transport relevant media. Maintaining viability, and the prevention of overgrowth of nonpathogenic microorganisms, drying of the specimen, and any sample leakage is highly critical to obtaining accurate diagnostic results.

By increasing automation in the microbiology department, the Clifton lab has reduced the length of incubation for several culture types by anywhere between 25 percent to 60 percent, depending on the test. As a result, significantly less time is spent on negative cultures, allowing Clifton's techs to focus on making accurate, efficient readings of positive results, and subsequently improving overall turnaround time. Much of this has been achieved in what is essentially a closed system with minimal human intervention. Automation of technology allows for faster workflows with reduced footprints of human error while the incorporation of artificial intelligence (AI) further helps in segregating specimens and identifying relevant factors in bacterial culture growth.

Investing in automation has allowed Clifton lab's microbiology department to become more data-driven. Supplemented by detailed daily and weekly reports, the department has found great success in tackling manageable issues before they compound into larger problems, further strengthening lab workflows and processes.

MOVING FORWARD

In a consumer-centric approach, Quest Diagnostics has looked at automation to embrace technology as well as improve the work environment of employees and customer expectations alike. The Clifton lab has become the proving grounds for such an objective and is a facility that, in many ways, brings several labs into one single location that combines large-scale diagnostic services with the relevant redundancy required. The subsequent technological transformation influences the science involved as well as the workplace with a goal to enhance, rather than replace, the critical work of its employees. Two automated core tracks, focusing on clinical testing and bridge design, are crucial to the lab's success in its transformation to a digital platform.

Core lab testing, for a large part, involves responding to the client's needs. Three factors for decision making are identified: (i) authenticity and integrity of results, (ii) consistency toward expectations and turnaround time, which is a big function of client experience calibrated by market performance, and (iii) the service and responsiveness as an entity to customer needs. Quest Diagnostics meets all these conditions through the Clifton lab, where automation drives the turnaround time and responsiveness of various diagnostic tests and processes.

In a holistic approach to lab management, Quest Diagnostics and its flagship facility in Clifton demonstrate how automated technology can be used to boost diagnostic services as well as user experience for customers, patients, and employees. Quest Diagnostics proves the potential of technological transformation for healthcare services through lab automation and its effectiveness to power the medical community.

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Innovative Lab Design for Collaborative Researchers

CALTECH CHEN NEUROSCIENCE RESEARCH BUILDING WINS EXCELLENCE IN INNOVATION PRIZE IN 2022 DESIGN EXCELLENCE AWARDS **by MaryBeth DiDonna**

Neuroscience is a historically underserved area of research, so in recent years the science and technology industry has prioritized funding to address life-deteriorating diseases such as Alzheimer's and Parkinson's. The California Institute of Technology (Caltech) has also answered this call with a facility aimed to position critical resources in one central location so that they can collaborate on initiatives to advance neuroscience research.

The Tianqiao & Chrissy Chen Neuroscience Research Building, completed in October 2020, incorporates neuroscience itself into the design, with the design team working closely with researchers to visualize just how humans would think and feel while working in the laboratories. The goal of the project was to develop a layout plan that would evoke a physiological response from the visual influences and design decisions of the facility, thereby support innovative research and collaboration between those working in the labs.

> "At the heart of the building is the ideas that these scientists are going to have."

For designing a lab facility that encourages innovative ideas and spurs groundbreaking neuroscience research, *Lab Manager* has awarded SmithGroup with the Excellence in Innovation prize in the 2022 Design Excellence Awards. SmithGroup served as the architect, laboratory planner, and sustainability and interior design firm for the Caltech Chen Neuroscience Research Building in Pasadena, CA.

▲The central "nucleus" of the Caltech Chen Neuroscience Research Building symbolizes the power of collaboration, and visually connects people to inspire and bring ideas together.

CREDIT: Ian Allen/Esto

Breaking down silos to promote collaboration

The Chen Neuroscience Research Building was designed as a world-class research facility to accommodate customized labs for researchers across many disciplines. Singaporean philanthropists and media moguls Tianqiao Chen and Chrissy Luo found themselves inspired by a BBC television feature about Caltech neuroscientist Richard Andersen, who developed a brain-machine interface that enabled a patient with quadriplegia to control a robotic arm via thought. Chen and Luo traveled to Pasadena to meet with Andersen, and eventually presented Caltech with one of its largest gifts to date to fund a center for neuroscience innovation. This building brings together scientists who were previously located in brain-research programs across the Caltech campus. These new research neighborhoods for the Division of Biology and Biological Engineering support specialties including bioengineering, medical engineering, and translational medicine, with advanced tools and techniques to further understanding of the brain.

Dismantling physical research silos was integral to this project to encourage innovative research, says Mark Zajdzinski, senior project architect, SmithGroup. "You have neuroscientists talking to biologists, and different cross-discussions that normally wouldn't happen."

The design plan for the Chen building translates into developing new innovators, namely by encouraging mingling and thought sharing between researchers who normally wouldn't interact otherwise. The "nucleus" of the building was designed to be a central hub for collaboration, focused in a creative and informal atmosphere, with offices and conference rooms situated near the research spaces. "It symbolizes the power of collaboration and visually connects people in order to inspire and bring ideas together," says SmithGroup in their Design Excellence Awards entry.

"To me, it's about this core, this nucleus, and the idea of cross-collaboration with principal investigators (PIs) from a variety of different sub-specialties or sub-interests and different disciplines that come together in the middle of this building. And that's the idea behind spurring collaboration that will drive innovation. Whatever that next invention or technology is, or whatever it is, that comes out of this building—it's because of that," says Sandro Bressi, principal-in-charge and southern California science & technology studio leader at SmithGroup.

Future-proof design

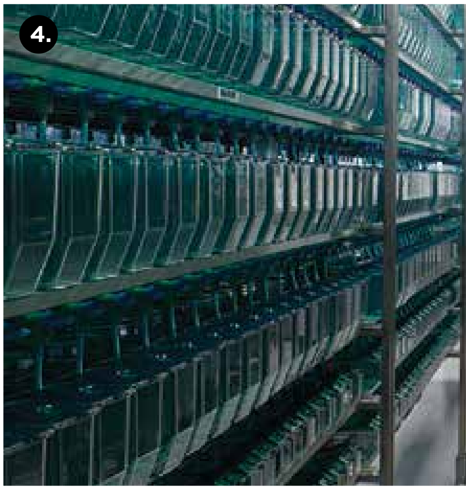
Advancements in research and technology start with the right people developing the right ideas, even if those ideas change quickly. The floor plan of the Chen Neuroscience Research Building was designed so that suites could be emptied and completely redesigned to exact specifications should a handover between different PIs occur as research advances. The floorplates allow for large-scale equipment to be brought in or removed easily, and wet and dry labs are interchangeable to adapt to different specialties thanks to the supportive infrastructure and systems capacity. The piped utilities and gases in labs are arranged in a flexible setup to accommodate multiple configurations using mobile base cabinets, adjustable tables, and ceiling service panels.

One challenge was designing labs that can meet the distinct needs of current researchers while still offering options to accommodate future researchers without costly and time-intensive facility overhauls. "Neuroscience is sort of a different animal in the sense that it requires different types of support. Every single researcher will have different types of requirements that differ from one to the other," says Alex Munoz, senior laboratory planner, SmithGroup, on why communication with researchers and facility management is so crucial to the beginning stages of the design process. "The needs are so specific, you have to go really in-depth to really understand the way that they work in order to translate that into a design that works…in doing so, it is a challenge because it's not a cookie-cutter approach. It's very customized, yet it has to be somewhat of a flexible space—if that PI leaves, it can be repurposed into something else."

The design team held months of "nonstop meetings" with PIs to walk the space, and understand the way that research is conducted and transformed. "Since research changes so quickly, being able to build and design facilities that can adapt to the research as the research is changing and evolving is very important," he says.

Leading with innovation

Being a thought leader when developing a progressive, future-proof design for a lab can be a challenge, says Munoz. Researchers may be reluctant to change the way they've always done things or to move to a smaller lab space. Project team leaders must employ innovative



strategies and clear communication to help researchers be comfortable with their new surroundings.

"One of the biggest challenges you'll find is the cultural change that happens when you have to explain to PIs that they are going to have to adjust the way they work. Their first reaction is that 'change is not good,'" he says, noting that it's important to communicate to researchers how a different design plan will benefit their work. "We're giving them efficiencies and physical spaces that are going to improve the quality of life [and] expedite research. The innovative process that we bring is this cultural change and this approach that we're working with them to understand the science and where we think it's heading."

It's hard to say what the future holds for neuroscience research, but the SmithGroup team is confident that they've equipped the Chen building and its researchers to handle any changes or advancements that might come their way.

"I don't think anybody knows where things are heading; neuroscience changes every day. It's not repetitive," says Munoz. The open floor plates and moveable casework, he adds, are integral to science facilities such as the Chen

1. In materiality, the design of the Caltech Chen Neuroscience Research Building utilizes elements that reflect the warmth of classic southern California, such as travertine and copper, to serve as complements to the surrounding landscape. *Credit: Randall Howard* **2.** The building design, material selection, and lab layouts incorporated neuroscience concepts that researchers shared with the design team, which impact visual queues, response, and behavioral habits. *Credit: John Linden Photography* **3.** The goal was to design and build a world-class research facility that would be customizable for scientists from many different disciplines and bring together brain-related research programs from across the campus. *Credit: John Linden Photography* **4.** The design plan retains the specialized spaces vital to neuroscience research, yet also brings together the various research groups that had been inefficiently dispersed across campus. *Credit: John Linden Photography* **5.** The versatile design rethinks and reorganizes how different fields of science interact, so researchers can work together more productively. *Credit: John Linden Photography*

building where the research is constantly changing and growing. Developing typical lab spaces into specialized suites is possible thanks to good design and infrastructure. "And I think that for the first time, you're actually going to see more spaces flexing and moving to react to the science and the changes that are happening," he says.

"At the heart of the building is the ideas that these scientists are going to have," says Francisco Owens, design principal with SmithGroup, adding that pushing every square inch of the space to its limit in terms of use and flexibility is what spurs innovations and advancement. "Part of creating a place that will continuously inspire and…be a cultivation of innovation is with the architecture and having places that people, when they're together, are just in a better frame of mind. They have the choice to be in spaces that really facilitate the frame of mind they want to be in. I think that was one of the most successful things—when you really look at every corner of the building, there's a very deliberate reason why all these things are in every part of it."

__MaryBeth DiDonna__, lab design editor for Lab Manager, *can be reached at mdidonna@labmanager.com.*

Homage to the Heroines of Scientific History

STORIES AND CONTROVERSIES OF THE WOMEN WHO SPURRED INNOVATION BUT WERE SPURNED **by Zahraa Chorghay, PhD**

One of the most memorable talks I can recall was in 2019. I was being served a delicious story of discovery by Nobel Laureate Martin Chalfie, with a rare ingredient that really stood out to me: the emphasis of innovation as a collaborative effort built from the contributions of diverse individuals. He remarked humbly in response to a question, "You heard of at least six people, all of whom contributed exceptionally important aspects to this discovery … It is very unfortunate that only three people can be selected for the Nobel, however grateful I am that I was part of it."[1]

Conversations with prominent scientists typically focus on results and techniques, and sometimes on scientific thinking, innovative traits, or the moment of inspiration that got them there. But it is rare to see an individual highlighting the contributions of others with equivalent or even more emphasis, enthusiasm, and eagerness than their own.

Given that discovery is necessarily a cooperative venture and that it happens in unexpected ways, our current culture around innovation with an emphasis on hyper-individualism and glorification of the singular, scientific genius with a given set of traits seems counterproductive. This is not to say that we should downplay the narratives of innovators. Rather, we must reflect upon which individuals we choose to confer with honors and why, as well as realize that failure to secure such recognition does not reflect a lack of their ability. By encouraging conversation about the unrecognized labor that has been crucial to innovation, we can challenge our notions and perhaps re-envision the concept of innovation.

For instance, what if Marie Curie had never been recognized for her immense contributions to science? Curie is one of only two individuals to receive two Nobel prizes in two different categories, and the first female Nobel Laureate. She shattered the glass ceiling and inspired generations of women—and countless others—to pursue their dreams of discovery. Despite the merits of her research, she would not have received the prize if her husband, Pierre Curie, had not insisted to the Nobel committee that she gain recognition.[2] It took strong allyship for the couple to be co-awarded, alongside Henri Becquerel, the Nobel Prize in Physics in 1903 for their work on the theory of radioactivity. After her husband's death, because Curie was Polish and there was false rumor of her being Jewish, xenophobic and Anti-Semitic sentiments led to the public opinion that she was "not truly French" and she was further vilified by the press due to an affair.[3] Nonetheless, she survived all the scorn and scandal, letting her innovation speak for itself and won her second Nobel Prize in 1911, this time in chemistry, for isolating radium.

WOMEN'S CONTRIBUTIONS TO INNOVATION HAVE BEEN MIRED IN CONTROVERSY

Today, Curie is a household name, but there are so many others whose contributions were unacknowledged, stolen, suppressed, and lost to time.

An example is the story of Mileva Einstein-Marić. From the time she met Albert Einstein as a fellow student at the Swiss Polytechnic Institute in Zurich (now ETH Zurich) in 1896 to their divorce in 1914, they shared a passion for physics. In 1905, Einstein published five papers, including one on the photoelectric effect for which he would be awarded the Nobel Prize in Physics in 1921. They write "our work" on several instances in letters exchanged between them, her handwriting can be seen in his notes, and those who knew the couple claimed to have seen her calculating, writing, and working with her husband at the dining table or in the garden.[4] Since she did not publish any papers under her name nor did she make any claims on her husband's work, and their relation ended in divorce due to Einstein's affair with his cousin Elsa Löwenthal (whom he later married), the nature of her work and the extent to which she shaped his ideas can only truly be known privately between the couple.[5] Mileva Einstein-Marić's potential contributions to physics continue to be investigated—and debated—by science historians.

More established than Einstein-Marić's contributions but nonetheless sidelined in scientific history are women such as Marie-Anne Paulze Lavoisier. In 1771, at the age of 13, she married one of the founders of modern chemistry, Antoine Lavoisier. Along with assisting in the laboratory and notetaking, she performed scientific illustrations, translated papers into French for her husband, and wrote out experimental results, all of which were necessary for the Lavoisiers' work on the role of oxygen in combustion, among other discoveries.[6] However, being a woman, she was not acknowledged outside of her private circle by the scientific establishment, and we are only now learning about her work.

Even if you managed to publish, there was no guarantee that you would be viewed as a credible authority. In 1935, Grete Henry-Hermann challenged the mathematical proof of her contemporary, John von Neumann, but her critique went unnoticed by the physics community for decades until it was independently discovered by John Stewart Bell in 1966.[7] Had it gained attention, it would have advanced understanding of nonlocal hidden variable theories, changing how the field of quantum mechanisms developed. She continues to be largely unknown today.

Perhaps the most infamous story of uncredited science is the discovery of the double helix structure of DNA, for which Francis Harry Compton Crick, James Dewey Watson, and Maurice Hugh Frederick Wilkins were awarded the Nobel Prize in Physiology or Medicine in 1962. Crucial clues came from Rosalind Franklin's investigation of DNA using X-ray crystallography.[8] Her unpublished data was shared with Crick and Watson largely without her knowledge, and she was not credited in their papers. Watson's book on the subject, *The Double Helix*, further diminished her contributions by portraying Franklin as merely Wilkins' assistant who would have lacked the ability to interpret her data instead of the accomplished and independent scientist that she was.

Most innovators will tell you that they do not pursue their work for fame and fortune, but are driven by their curiosity, need to solve problems, and desire to carry out a project to its end. For brilliant scientists, gaining an award like the Nobel Prize is just something that happens along the way. However, these examples show us that despite the importance of one's innovations, they can be locked out of the upper echelons of scientific achievement without strong support from those who are already deemed acceptable there: Marie Curie had Pierre championing her, but Franklin and others did not find such an ally to advocate for them.

ISSUES OF RECOGNITION LINGER TODAY

More than a century after the founding of the Nobel Prize in 1901, Emmanuelle Charpentier and Jennifer Doudna in 2020 were the first all-female team to be awarded a Nobel in the sciences. Despite their win in chemistry for the CRISPR-Cas9 gene-editing method, there remains a fierce debate regarding who deserves credit for the technology due to an ongoing patent battle. Along with Charpentier and Doudna, Feng Zhang at the Broad Institute of MIT and Harvard, George Church at Harvard Medical School, and Virginijus Siksnys at Vilnius University in Lithuania are all considered key contributors to CRISPR.[9] Unfortunately, given that the currency in the world of science lies in prestigious publications, awards, and patents, an ongoing challenge we face as a society is incentivizing innovation in a way that celebrates cooperation and collaboration.

Perhaps we can start with simple steps, through recognition, acknowledgement, and education—as Chalfie did in his talk, or as Aaron Klug did in his Nobel Lecture in 1982. While accepting the Prize in Chemistry for his work on nucleic acid-protein complexes, research that he had commenced with Franklin, he acknowledged Franklin's contributions to both the science and to his training as a scientist. He said, "Had her life not been cut tragically short, she might well have stood in this place on an earlier occasion."[10]

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***Zahraa Chorghay**, PhD, is clinical writer/editor for* Today's Clinical Lab. *Chorghay obtained her HBSc from the University of Toronto and her PhD from McGill University, where she explored her passion for neuroscience and for making science accessible and inclusive. She can be reached at zchorghay@clinicallab.com.*

Investing in the Future through Collaborative Innovation

BRUCE DEMBOFSKY IS THE INNOVATION DIRECTOR AT AVANTOR, EXPERIENCED IN BOTH DRUG DISCOVERY SCIENCE AND OPTIMIZING LAB OPERATIONS.

Q: Please tell us about your career journey to date, and what drives you.

A: My career started in early discovery research, first in biotech and later in pharmaceuticals with AstraZeneca. After about a decade at the bench, I started getting more involved in lab operations, informatics, and design. That led me to the consulting and innovation portfolio work that I do today at Avantor.

The innovation space is similar to discovery, trying to find and deliver new solutions. I still feel that pressure—patients that need cures—and we want to make the process faster and more efficient. That's what drives my interest in innovating the entire drug discovery process as well as the science.

Q: What are the fundamental requirements to fostering innovation?

A: Recognizing the distinction between being productive and being busy is important. Innovation requires us to look beyond the short term—to say, "we need to get stuff done, but how will we do it better, faster, more cost-effective tomorrow?"

The foundational requirement is that mindset to invest for the future. It's like the difference between a savings account and the stock market—you can put your pennies in the savings account every day, be safe, and make a little return. But occasionally you need to put some time and money at risk to invest.

Q: What advice do you have for labs and businesses that want to promote creativity?

A: Have true openness to new ideas and to collaboration. Make time and be willing to get different groups of people together to share ideas. Ideas build upon each other and are usually best when two or three different but related ideas come together. All ideas are good ideas. Let's share them and have that open dialogue with collaborators.

Q: How do the innovation pipeline and Lab of the Future services help labs innovate?

A: It comes back to the idea of co-innovation, engaging our partners, customers, and internal teams to look at how we can help as a service provider and distributor, to help labs be more efficient, more effective, productive, and faster to market.

We're focused on data and the supply chain issues now—how to connect systems to each other and the supply chain and automate the process. We're working on using sensors and the Internet of Things to get better data and forecasts to increase automation.

Q: How do you think that innovation fosters change and is it worth the risk?

A: I think the risk is if you don't do it. Avoid investing only in things with a short-term payback. Innovation will always have some unknown aspect to it. An example is predictive forecasting—the technology is evolving rapidly, so you have to decide whether investing today is strategic versus waiting and playing catch-up later. It's a double-edged sword, everyone's going to have a different tolerance.

Q: Are digital solutions the answer to productivity?

A: Technology is critical, but it's when the people, the process, and the tech work together that you get the innovation. It's the speed, cost, quality triangle. If you apply innovation, leveraging new tech, you often can have all three. The iPhone is a cool gadget, but it's a tool that enabled innovation like Uber, Yelp, and FaceTime that really changed the deal for us as humans.

A lot of tech in the lab, like the ELN and predictive algorithms, are the tools and as innovators, we want to ask how we can use these to improve—to help people have better lives, help cure disease, or get drugs to market faster. These are life-changing things. Innovation takes people coming together collaborating.

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Lab Manager

Margaret Hamilton
Software Engineer
Led the development of the on-board flight software for NASA's Apollo missions, most notably Apollo 11.

Hedy Lamarr
Inventor and Actress
Pioneered wireless communication technology to support Allied efforts in World War II, which became the precursor to modern-day Bluetooth and Wi-Fi.

Daphne Weld Nichols, CC BY-SA 3.0, via Wikimedia Commons

– INFLUENTIAL WOMEN IN – SCIENCE

1914
2000

2

1936
PRESENT

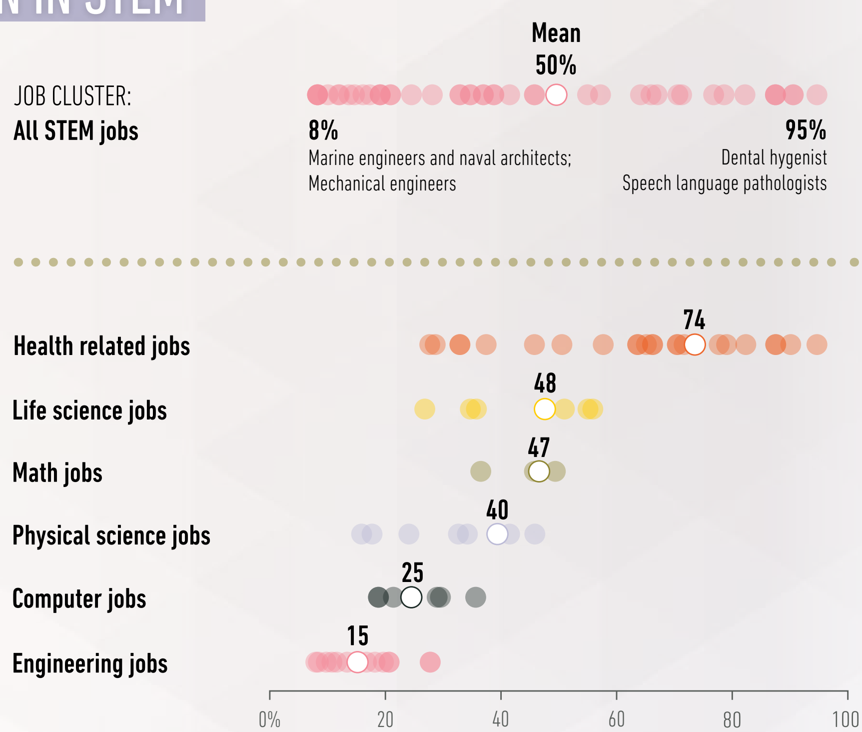
1

Although women make up approximately half of the global population, they have historically been underrepresented in science. Female scientists have had to overcome barriers including limitations in education, funding, and research opportunities. Despite many women overcoming these barriers, female scientists have not always received the recognition they have earned. Learn more about some of the incredible women who have helped change the face of science and where we stand today.

BY THE NUMBERS: WOMEN IN STEM

REPRESENTATION OF WOMEN IN STEM VARIES ACROSS JOB CLUSTERS

Share of women in each of the following job clusters

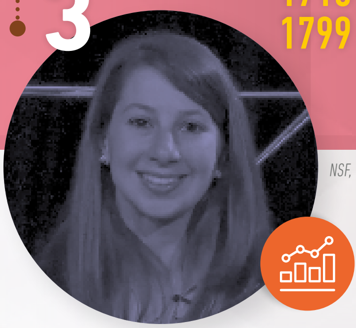


Note: Based on employed adults aged 25 and older. Each circle represents as a single occupation (e.g. mechanical engineer, registered nurse). STEM stands for "science, technology, engineering, and math." Engineering includes architects. Source: Pew Research Center analysis of 2017-19 American Community Survey (IPUMS)
"STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity".
PEW REASERCH CENTER

Katie Bouman
Computer Scientist
Helped develop algorithms to produce the first image of a black hole distilled from data collected by researchers across the world.

1989
PRESENT

3



NSF, via Wikimedia Commons

Maria Gaetana Agnesi
The first woman appointed as a mathematics professor at the University of Bologna.

4

1718
1799

Jeanne Baret
An expert botanist, Baret was also the first woman to complete a circumnavigation of the globe.

1740
1807

5

Frances Arnold
Chemical engineer and professor at Caltech, Arnold received the Nobel Prize in Chemistry in 2018 for her work in using directed evolution to engineer new enzymes.

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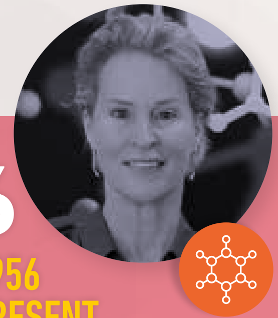

6

1956
PRESENT

Jennifer Doudna
Biochemist and 2020 Nobel Prize Laureate who invented CRISPR-Cas9, a technology that allows scientists to make precise edits to DNA in living cells and opens the door for groundbreaking treatment options for diseases and deformities.

1964
PRESENT

7

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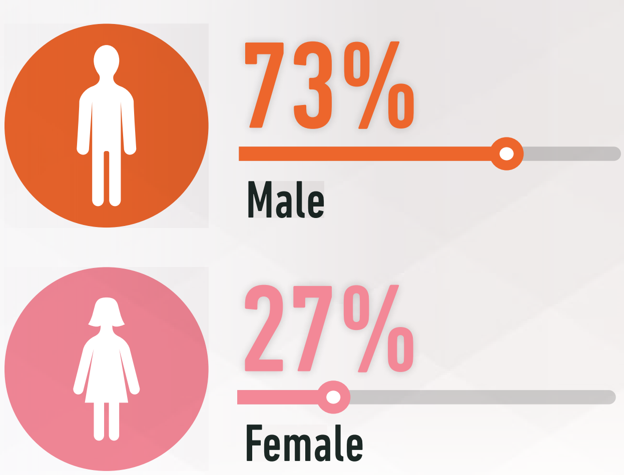
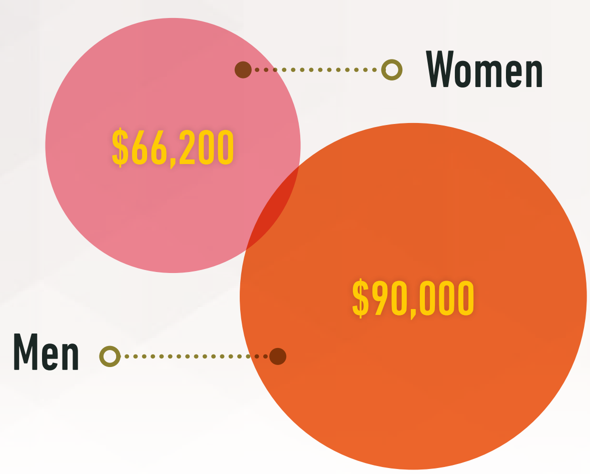
WOMEN IN STEM LEADERSHIP POSITIONS

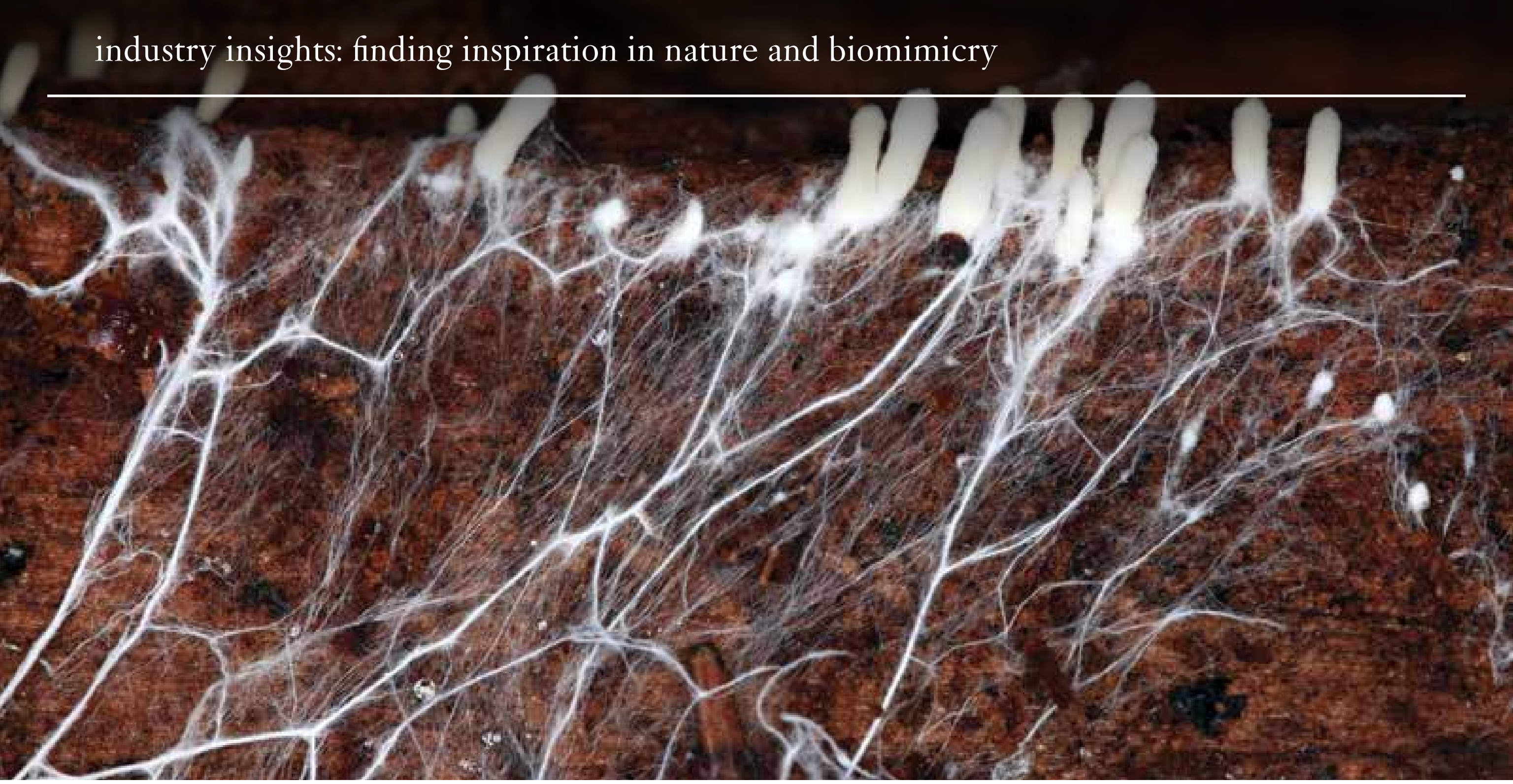
In a survey of the 42 federally funded R&D labs in the US, which are "one of the top employers of STEM talent," men of all ethnicities hold **73 percent** of lab leadership positions. Women of all ethnicities hold only **27 percent** of lab leadership positions. Credit: AWIS



MEDIAN EARNINGS OF WOMEN VS MEN IN STEM

The median earnings of women in STEM occupations are about **74 percent** of men's median earnings in STEM. The gender pay gap in STEM jobs has narrowed from **72 percent** in 2016. Credit: Pew Research Center





Finding Inspiration in Nature and Biomimicry

STUDYING BIOLOGICAL ORGANISMS TO FIND MATERIAL AND STRUCTURAL SOLUTIONS **by Ian Black, MSc**

In the 1940s, while out for a hike one day, Swiss engineer George de Mestral observed how burs got stuck to his clothing. Shortly after this experience, he patented one of the most useful adhesives in the world, Velcro. While it took some refining to reach a finished product, the inspiration for the idea and the vast amount of research and development that followed had been provided to Mestral via biology. The story of Velcro is just one of many where nature has been adapted to fill a need or solve a problem. This approach has gained in popularity in recent years and is now known as biomimicry.

Biomimicry is the modeling of materials, structures, and systems on biological entities and processes. Since Mestral's initial discovery, our understanding of nature and improvements to our technology have allowed for much more complex adaptations. Biology represents a treasure trove of innovation, from using shark skin as inspiration for better swimsuits to building more efficient building ventilation based off termite dens to applying the shape of whale fins to wind turbine blades.

HUNTING FOR INSPIRATION

Innovation is a long and iterative process. After the initial inspiration, there is a lengthy back and forth process—from planning to trial—for any invention. This research and development can take weeks, months, or years depending on the complexity of the problem you are trying to solve.

However, none of this is possible without that initial idea, the inspiration for a solution to a given problem that leads to a brilliant innovation. While many of the great innovators of the past and present have a multitude of ways of drawing inspiration, a growing faction has been looking to an old source: The natural world.

It may seem odd to look for solutions to engineering or construction problems, for example, in a forest or in the ocean, but there are many examples of brilliant solutions and ideas sparked by flora and fauna. All it takes is an open mind and the skill of seeing how a problem that evolution has overcome can potentially relate to a human concern that may not seem relevant.

Architecture is an excellent example of a field that has benefited from employing biomimicry. From material selection to structural design, living organisms adapt to their surroundings to maintain steady conditions. By incorporating this incredible ability into building design through the use of novel insulators and cooling systems we can develop far more efficient and long-lasting buildings. Using insulation in construction at all is a form of biomimicry as animals use fat and fur/hair to retain heat in much the same way.

However, animals aren't the only inspiration for improved building insulations. Some companies now provide insulation and building materials made from mycelium, which can be stretched, extruded, or 3D-printed into desired shapes. Indeed, research has found that bricks made of mycelium offer strong thermal performance. The "roots" of fungi have inspired many innovative designs for packaging, clothing, and more, due to their flexible and compressible structures.

"The 'roots' of fungi have inspired many innovative designs for packaging, clothing, and more, due to their flexible and compressible structures."

THE BENEFITS OF BIOMIMICRY

Not every natural innovation or idea inspired by natural structure is going to pan out in a useful way for humanity. However, the sheer volume of evolved traits that are present in both extant and extinct species suggests that for every dead end, there could be just as many potentially useful innovations.

Being a source of inspiration and innovation is only the tip of the iceberg for the utility of biomimicry. Biomimicry also offers benefits in the form of sustainability. By its very nature, any solution or innovation that develops in the natural world is likely to be sustainable. When we look to biology as a place to generate ideas or help us problem-solve, we will be presented with options that are most likely environmentally friendly and infinitely more sustainable than the synthetic options we might build ourselves.

▲A hike in the woods inspired Swiss engineer George de Mestral to develop the concept of what is now known as Velcro.

There are numerous instances where society's solutions are laughably inferior to nature's. Take mining, for example—where humanity has traditionally used brute force techniques to extract minerals from the earth, recent research has found that microbes accomplish the same feat with varying degrees of efficiency and vastly less damage. While mining with microbes (referred to as biomining) isn't fully feasible yet, it is an area of increased interest. Another example can be found in cleaning supplies. We have historically spent hundreds of thousands of dollars producing harsh chemicals, but nature has already developed compounds that have similar functions and are much safer for the environment.

We often focus on reducing our environmental impact and carbon footprint, but most natural systems do better than net zero output. Many photosynthetic organisms absorb more carbon dioxide than they produce, yielding a net positive in carbon capture. Instead, natural systems are often providing results that improve everything around them. Biomimicry isn't just a chance for us to find solutions–it is a process that can help change our perspective and build infrastructure that will yield net positives, rather than just neutral results.

Finally, there is the benefit of time. From an evolutionary timescale, humans have been innovating and inventing for no more than the blink of an eye. Natural selection has been working on many of the same problems for millions of years. The iterative process of discovery can be slow and arduous, with research and development cycles that can last years. The biological processes that are functioning effectively today have been honed over millions of years of evolution. This refined springboard is available to us now and lets us take advantage of strategies and strengths that have already been tested. The question becomes, how can we find and co-opt them to be useful to us?

Discovering, adapting, and utilizing natural solutions is a challenge that many naturalists and researchers have already begun tackling. We see the results around us everyday, from developing better traffic control systems by examining how ants move to novel adhesives developed from observing the toes of geckos. The world around us is a veritable bounty of ideas, solutions, and inspiration. It's up to us to take advantage of this incredible resource. The next great idea or discovery could be right outside our window.

***Ian Black**, editorial assistant for* Lab Manager*, can be reached at ianb@labmanager.com.*

How Usage Data Unlocks Your Lab's Hidden Waste

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ANNA MANI

GAUGING THE WEATHER, THE ANNA MANI WAY

THE WEATHER WOMAN OF INDIA, ANNA MANI, WAS A PIONEER AND RENOWNED PHYSICIST WHO MADE SIGNIFICANT CONTRIBUTIONS TO THE STUDY OF SOLAR RADIATION AND METEOROLOGICAL INSTRUMENTATION

by Ajay Manuel, PhD

The 1900s ushered great change in Indian history. India would break free of the shackles of colonialism under the British Raj, gaining independence in 1947. Much would be required in the years to follow to battle and recondition Indians from the trauma of colonialism. Embedded in this trauma was a struggle for identity, especially for women, who sought to establish their position within a society that predetermined their futures via cultural and gender-based stereotypes.

Despite the tall order of obstacles and the slim odds, one individual would break away from these customs and become a renowned figure in the science industry. Knowledge would be her tool, and with it, she would inspire many other females to seek greater heights in pursuit of their dreams. Her name was Anna Modayil Mani and this was her world.

Hailing from a Syrian Christian family in Travancore—a formerly prince state of Southern India and most of modern-day Kerala—Anna was born on August 23, 1918, the seventh of eight siblings. Anna's father was a civil engineer, and her family represented the typical upper-class professional household where the males were groomed toward prestigious careers while the females were prepared for marital life and its responsibilities. The female literacy rate at that time was less than one percent, and less than a thousand women were enrolled in colleges.

Against her family's customs, Anna spent her formative years indulging in her one true love: books. On her eighth birthday, she would decline the customary gift of a set of

diamond earrings, seeking instead a set of Encyclopedia Britannica. In a life marked by her trailblazing actions and success against cultural and societal norms, this would prove to be Anna's first. By then, she had already read all the books in Malayalam at her public library, and by the time she was 12, all the books in English.

Books widened Anna's worldview, enriching her mind with new ideas and strengthening her deep sense of social justice. Persistent in her pursuit of higher studies, she enrolled in the honors physics program at the Presidency College in Chennai (then Madras) and graduated with a BSc degree in 1939. A year after the completion of her college education, Anna would successfully land a scholarship to pursue research in physics at the prestigious Indian Institute of Science (IISc) under the supervision of C.V. Raman.

BUILDING A FOUNDATION

A recognized authority at the institute, C.V. Raman was well-known in the scientific community for his work in the field of light scattering. His discovery of the changes in wavelength and frequency of deflected light waves that have passed through a transparent medium, also known as the Raman effect, earned him the 1930 Nobel Prize in Physics. Despite his public championing of women's education, Raman was in reality highly intolerant of female students in his lab at the IISc. After much insistence on her own part, Anna would be accepted into Raman's laboratory as a graduate student. Anna's research at the IISc would lay the foundation for greater opportunities in her future. At the time of her entry, Raman's lab focused on the study of diamonds in an ongoing scientific battle with Max Born on crystal dynamics and Kathleen Lonsdale on the structure of diamonds. Anna spent many hours painstakingly recording and analyzing the spectroscopic and polarization properties of more than 30 different diamonds. The weak luminescence of the diamonds, alongside observations at liquid air temperatures, meant long exposure times of up to 20 hours to record spectroscopic data on photographic plates. Anna would quite often work through the night at Raman's laboratory. Her efforts led to the publication of five papers on the luminescence of diamonds and rubies between 1942 and 1945. She submitted this research for her PhD dissertation to Madras

University, which at that time offered formal degrees for research at the IISc.

However, Madras University declined Anna's eligibility on the grounds of her not having an MSc degree. The lack of a PhD did not waver Anna, who would be awarded a government scholarship for a research internship in England. Arriving at Imperial College London on a troopship in 1945, Anna Mani began the initial steps to cement her future legacy within the scientific community and the greater public. While she intended to pursue research in physics, the lack of an internship would alter her course toward studies on meteorological instrumentation. She studied several weather instruments and their corresponding calibration and standardization procedures while making a few of her own. Armed with this knowledge, Anna returned to an independent India in 1948 and joined the India Meteorological Department (IMD) at Pune. She began working under the supervision of Dr. S.P. Venkiteshwaran who headed the instruments division at IMD.

WEATHERING HEIGHTS

In pre-independence India, even simple meteorological instruments such as thermometers and barometers were imported. Post-independence and amidst an uplifting atmosphere of freedom and innovation, Venkiteshwaran wanted to internalize the process of making scientific instruments in India. His workshop would become Anna's very own testing grounds. In the years to follow, she would take charge of Venkiteshwaran's workshop guiding the manufacturing and calibration of a variety of instruments from rain gauges, evaporimeters, thermometers, anemometers, wind vanes, thermographs, hydrographs, and many more.

Aspiring even further, Anna Mani would standardize the drawings of 100 weather-related instruments while setting up monitoring stations across India to record solar radiation and harness solar energy, an untapped technology in India at that time. Her efforts were in line with her dreams to make India self-sufficient in weather instrumentation as fast as possible. This was a daunting task as skilled labor to operate sophisticated weather machines was not a luxury at that time, but Anna would find her way, inspiring the 121 men who worked with her to put their best into a collective dream for the country's future.

In 1963, Anna began her own personal work in measuring atmospheric ozone and later set up a meteorological observatory at the Thumba Equatorial Rocket Launching Station at Thiruvananthapuram, Kerala. She went on to publish many papers on the monitoring of atmospheric ozone, international instrument comparisons, and national standardization, and in the process earned the moniker, "The weather woman of India."

A LEGACY TO REMEMBER

After a career that spanned nearly 30 years, Anna retired as the deputy director-general of the India Meteorological Department in 1976. She remained busy even after, returning to the Raman Research Institute as a visiting professor for three years, and later set up a millimeter-wave telescope at Nandi Hills, Bangalore. She would go on to publish two books, *Handbook of Solar Radiation Data for India* and *Solar Radiation Over India* in 1980 and 1982, respectively, that continue to serve as standard reference guides for solar engineers.

Her life characterized the trailblazer she had become through her contributions to her country. As a member of many scholarly academies—Indian National Science Academy (INSA), American Meteorological Society, the International Solar Energy Society, etc.—Anna continued to contribute to the scientific community into the later stages of her life. She received the INSA K.R. Ramanathan medal in 1987. Recognizing the potential of wind energy for India, she organized wind measurements throughout the year from more than 700 sites across the country using state-of-art equipment. India's current growth as an emerging leader in renewable energy technologies surrounding wind and solar energy certainly owes its share of credit to Anna Mani's accomplishments.

Beyond science, Anna also became a role model for young women in India. In an era where female Indian physicists were a rarity, she would overcome various obstacles, countless moments of discrimination, and victim politics to pursue and accomplish her dreams. In doing so, Anna overthrew coercive gender stereotypes that negatively portrayed and limited women's potential while differentiating them from men on the intellectual stage. Anna never married and remained ever passionate about her first love, books. A stroke in 1994 left Anna immobilized for the rest of her life. She passed away on August 16, 2001, leaving behind a rich legacy of a life that transcended the restrictive environment of her own culture, and a journey that, in many ways, epitomized the destination.

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SYLVIA EARLE

▲Sylvia Earle on stage at TEDxOilSpill in Washington, DC. *Credit: Pinar Ozger, CC BY-NC-SA 2.0*

THIS TRAILBLAZER SHATTERED BARRIERS TO DEEP-SEA EXPLORATION

SYLVIA EARLE, PHD, LEFT AN INDELIBLE MARK ON OCEANOGRAPHY AND DEEP-SEA RESEARCH BY PUSHING THE LIMITS OF POSSIBILITY **by Rachel Brown, MSc**

"I GUESS WE COULD PUT UP WITH A FEW WOMEN"[1]

In 1969, Sylvia Earle, PhD, then 34-years-old, a research fellow at Harvard University and a research scholar at the Radcliffe Institute, paused at a notice board while walking the Harvard halls. A flyer had caught her attention: "How would you like, as a scientist, to spend two weeks living underwater down in the Virgin Islands?" Tektite, a project run by universities and sponsored by the US Navy, NASA, and the Department of the Interior, offered just that—an opportunity to inhabit the sea floor at 50 feet, researching marine life *in situ* (coincidentally as a test subject for an experiment on cohabitation in a hostile environment).

It was an obvious fit and an enthusiastic "yes." She'd been scuba diving since 1953, when one of her undergraduate professors scored two of the earliest-released apparatuses.

Her application was denied.

It wasn't about experience: with more than 1,000 diving hours already logged, hand-collecting more than 20,000 marine specimens for her PhD thesis, Sylvia was an established oceanographer and botanist. She had been on scientific expeditions to the Indian Ocean, Galapagos Islands, Chilean coast, and the Panama Canal, published in the scientific literature, was named resident director of the Cape Haze Marine Laboratory in Sarasota, and even participated in a different experimental underwater habitat, the Man-in-Sea project run by the Smithsonian Institution. She was the most experienced of any applicant to-date.

As Sylvia recounted the story in a lecture given at the University of Victoria in 2011, she explained that no one had bothered to exclude women in the advertisement, because what woman would apply? They could not conceive of a female scientist wanting to participate in such a project. She was not the only qualified female applicant, but the powers that be simply could not countenance men and women cohabitating in a scientific venture. Sylvia Earle is not an easy person to say no to, however, and the following year she led the first female crew of scientists to Tektite II to photograph and document surrounding sea life.

"THE EXPLORERS WHO EMERGE IRRESPECTIVE OF WHAT SOCIETY THINKS"[1]

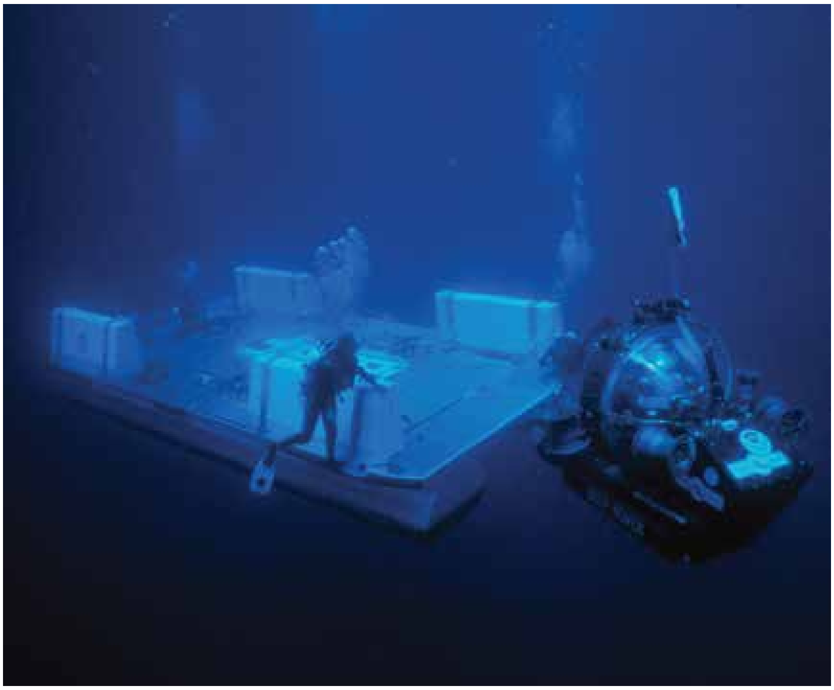
Like leading the first all-female team of aquanauts, Sylvia's life is choke-full of "firsts." One of the first scientists to use SCUBA to conduct research. First woman to visit an underwater habitat via a lockout submersible, a feat she performed while pregnant. First (and still the only) person to walk on the sea floor at 1,250 ft depth, untethered. First woman to descend solo to 3,000 ft depth, tying the overall record that her partner, Graham Hawkes, set moments before. First person to visit the floor of Crater Lake in Oregon, 1,516 ft deep. First woman appointed to the role of chief scientist for the National Oceanic and Atmospheric Administration (NOAA). First female explorer-in-residence for the National Geographic Society.

Aptly named a "Living Legend" by the Library of Congress, Sylvia Earle has been a trailblazer for women in science in a world still uncomfortable with the concept, but so much more than that—a trailblazer for scientific discovery, forever pushing against the boundaries of what is possible. Having led more than 100 expeditions and spent more than 7,500 hours underwater, Sylvia is a true explorer, constantly reaching for what's just out of view, inspired by the likes of William Beebe and Jacques Cousteau, and constantly confounded by the limited access.

In 1964, Sylvia was invited to participate in the International Indian Ocean Expedition, a multinational effort to explore the "greatest unknown in the global ocean," as dubbed by the Special Committee on Oceanic Research.

Sylvia Earle gets out of the JIM suit. *Credit: Flickr/kqedquest CC*

Sylvia Earle surfaces in the JIM suit after a dive. *Credit: Flickr/kqedquest CC*



Divers secure semi-submersible barge after releasing submersible Deep Rover. *Credit: OAR/National Undersea Research Program (NURP); University of Hawaii*

"It was one of the best experiences for me as a scientist, seeing a different part of the planet that I had never imagined that I could explore before," Sylvia recollected in an interview for the World Science Festival. But she soon realized the limitations of such an expedition—scooping up plants, animals, and rocks in a net can only tell scientists so much. "What would you know of New York City if you're flying overhead, dragging a net, and bringing [up] pedestrians and dogs and bushes? You wouldn't know anything about music, or humor, or poetry, or what people actually do." Understanding life in the ocean required first-hand observation. So, Sylvia did just that through projects like Tektite enabling *in situ* marine research.

In 1979, she walked the sea floor alone at 1,250 ft below the surface for two and a half hours in a JIM suit, setting a world record uncontested to this day. At a depth far deeper than light can penetrate, Sylvia descended through the inky blackness strapped like a figurehead to the front of a support submersible. Turning off the lights, she found herself surrounded by a world of glittering bioluminescence. Entranced, she would later descend through this black, twinkling world any chance she had, describing it as "falling through the stars," according to her future collaborator and husband.

"I REALLY WANT TO KNOW WHAT'S OUT THERE"[1]

Despite the excitement and elation of the record-setting dive, she was frustrated by the limitations of the technology. She had a "lively discussion" with a consulting engineer on the project, Graham Hawkes, about the poor maneuverability and perceived lack of sophistication in the operating claws, unaware that she was speaking with the suit's designer. Graham explained the challenges of designing for a marine environment, yet later responded with a new manipulator arm capable of elegant penmanship. So began a decades-long collaboration between the two, surviving both marriage and divorce, with Sylvia constantly pushing against the boundaries of the technology.

The two of them founded Deep Ocean Engineering in 1982 to expand what was possible together. Their company designed and built the one-person Deep Rover submersible, capable of operating to 3,300 feet. At a time when similar submersibles were two-person designs requiring a pilot, Sylvia insisted the Deep Rover be simple enough to operate that scientists could pilot them solo. They also designed the Phantom, a small, affordable remote operated vehicle widely popular across industries and applied to such disparate tasks as police searches, treasure hunts, and hull inspections in addition to scientific research.

For Sylvia, too much of the ocean was still out of reach. She pushed for instruments that could go deeper. "Graham was the skeptical engineer," she said in an interview with the *New York Times* in 1993. "I kept prodding him: 'I want to go [to the Marianas Trench]. How can we not go?' It was inconceivable to me not to have access to such a unique environment." In an interview for the documentary, *Mission Blue*, Graham recounted that he simply didn't believe it to be a realistic possibility. "I spent, I think, five years going from 1,500 to 2,000 feet, and here is Sylvia saying, 'I want to go to 37,000 feet.' I can tell you all the reasons why we can't do it." He was inspired, nevertheless, and over time came around to the idea. As a starting point, the Deep Flight, a plane-like submersible capable of descending to 4,000 feet, was designed in 1984 with the expectation that future iterations could reach far greater depths by using sturdier, more costly materials. Naturally buoyant for safety reasons, the wing design would drive the vehicle deeper while in motion.

Production on Deep Flight paused, restarted, and fizzled out across the late 80s and 90s due to separation and competing roles for Sylvia. She established Deep Ocean Exploration and Research (DOER Marine) in 1992, a marine engineering and consulting company, to further advance deep-sea research. DOER Marine continued to reach for access to Challenger Deep in the Marianas Trench with work on the DeepSearch submersible, expected to take a crew of two or three to Challenger Deep in 90 minutes. The company also had a hand in developing the submersible Deepsea Challenger that famously carried James Cameron to Challenger Deep in 2012, designing the manipulator arm on the submersible.

"THIS IS A TURNING POINT"[2]

The 1990s marked a predominant shift in Sylvia's focus from driving deep-sea exploration advancements, though her story remains one of consistent dedication, passion, and innovative approaches.

Since suddenly finding herself thrust into the spotlight following the Tektite II project, complete with a ticker-tape parade, a White House reception, and seemingly endless requests for speeches, Sylvia describes a sense of responsibility, given the opportunities she had been provided, to share with the public the wonders she'd witnessed. She quickly became an outspoken advocate for marine research. Over five decades and 7,000 hours underwater, she witnessed first-hand devastating change globally and championed the need for conservation measures. Following her time as chief scientist at NOAA, she was resolved to effect meaningful change. Her advocacy increased and her platform expanded as an explorer-in-residence.

In 2009, she won the TED prize for her new project, the Sylvia Earle Alliance (SEA) Mission Blue. It stands as a call for everyone to get involved in whatever capacity they can to "ignite public support for a global network of marine protected areas, Hope Spots," which would help drive ocean recovery. Mission Blue brings resources and data to support applications for ecologically-relevant marine protected areas nominated by the public. The initiative involving 200 allied conservation groups and organizations has been gaining momentum. Since 2009, the protected area of the ocean has increased from a fraction of a percent to near six percent, which includes 143 Hope Spots covering 57,577,267 square kilometers, with the goal of 30 percent by 2030.

Sylvia Earle's innovative spirit has left an indelible mark in her field and on society at large, as evidenced by a long list of accomplishments and acknowledgments accumulated in her career. She's written 225 publications, lectured in more than 100 countries, and received 32 honorary degrees and more than 100 awards and honors globally, including *Time Magazine*'s first "Hero for the Planet", Netherlands Order of the Golden Ark, UN Global 500, and a Medal of Honor from the Dominican Republic.

Innovation requires creativity, a fresh perspective, collaboration, and a refusal to accept current limitations or societal expectations as barriers. Sylvia reflects on this in *Mission Blue*, "You can think of a thousand excuses why you can't do something. The trick is to not let that get in the way of making things happen."

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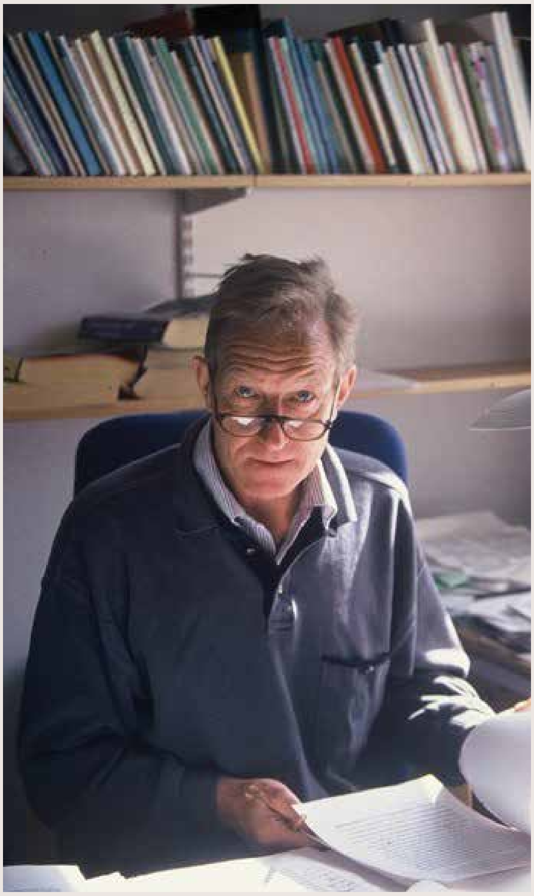


▲ Professor Bengt Saltin. Photo by Karin Söderlund, from Professor Bengt Saltin's Memorial Fund through the Swedish School of Sport and Health Sciences, GIH.

BENGT SALTIN

A COLLABORATIVE APPROACH TO INTEGRATIVE PHYSIOLOGY

BENGT SALTIN WAS A DISTINGUISHED SCHOLAR AND MENTOR IN THE FIELD OF EXERCISE PHYSIOLOGY

by Michelle Dotzert, PhD

When I'm running, I imagine a cacophony of sounds throughout my body—pop, bang, snap, pow, woosh—as electrical signals travel to my muscles, as calcium ions are released, as actin-myosin crossbridges form, as my lungs expand and contract, my heart rate increases, and dozens of other processes occur.

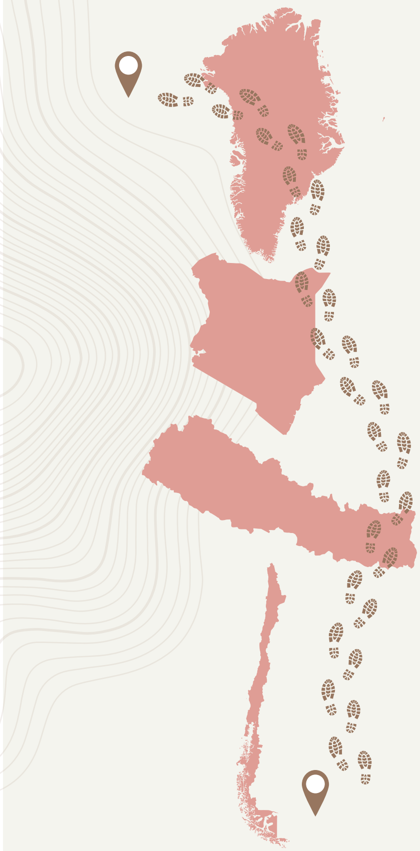
Exercise triggers a cascade of signals that perturb homeostasis, and stimulate acute neurovascular, cardiovascular, and metabolic responses. Each of these systems may be examined in isolation but collaborating across fields and areas of expertise to study points of intersection—for example, blood flow and metabolism—provides greater insight into the mechanisms underlying the effects of exercise on human performance and disease states. Bengt Saltin (1935-2014) PhD, MD, was a champion of this collaborative approach, and demonstrated that exercise was an optimal tool for studying integrative physiology. Saltin's experiments led to the development of the modern field of exercise physiology. His integrative and highly collaborative approach to research yielded more than 450 peer review articles. More importantly, his unique approach to leadership and efforts to foster collaboration among colleagues, peers, and trainees created new avenues of research and established a new generation of leaders in the field.

OUT OF THE WOODS

Saltin had an appreciation for sports, nature, and the outdoors from a young age and had aspirations of becoming

EXPEDITIONS

Saltin's research was not confined to the laboratory. He led and participated in several field expeditions.



North Greenland[1]
Studied adaptive responses in limb muscle and the substrate oxidation during submaximal arm or leg exercise after a cross-country skiing expedition over the Greenland icecap. Study participants traveled approximately 650 km over 42 days and reached an altitude of 2,500 m above sea level.

Kenya[2]
Many of the best runners in the world are from East African countries—Kenya specifically. The study was designed to characterize Kenyan runners with respect to their oxygen uptake and blood and ammonia responses when running.

Himalayas[3]
To examine the effects of acclimatization to extreme altitude on the cardiovascular system, 14 climbers on an expedition to the Himalayas were studied at lower base camp (5,250 m) following 56-81 days at altitude (between 5,250 and 8,700 m).

Andes[4-8]
The 1998 Danish High-Altitude Expedition to the Andes involved a series of experiments in Denmark, followed by an ascent to 5,260 m at Mount Chacaltaya in Bolivia. Volunteers remained at this elevation for nine weeks, and researchers carried out numerous experiments to understand the acclimatization process, the lactate paradox, gas exchange, cerebrovascular physiology, and more.

a forestry officer. A knee injury sustained during a bandy match left him with plenty of time to study for matriculation exams, and the combination of excellent grades and his mother's insistence steered Saltin from the woods to medical school. He obtained a medical degree from the Karolinska Institute in Stockholm in 1962. His research career began when his physiology teacher, Ulf von Euler, introduced him to professor Erik Howhü-Christensen at the Royal Gymnastic Central Institute in Stockholm. Saltin defended his doctoral thesis in 1964, accepted an associate professor position at the Karolinska Institute, and later a professorship at the August Krogh Institute in Copenhagen.

Saltin's career flourished over the next 50 years, and following his death, the Canadian Society for Exercise Physiology honored his life and contributions with a symposium in 2015. Speakers—including several of Saltin's trainees—described Saltin's role in developing the field of exercise physiology from "work physiology," as well as his contributions across the fields of environmental physiology, exercise training and metabolism, human performance, altitude and sport physiology, and numerous others.[1–4] In addition to celebrating his academic achievements, Saltin was lauded as a pioneer and advocate of the concept "exercise as medicine" and as a visionary leader at the Copenhagen Muscle Research Centre (CMRC).

PHYSICIAN-PHYSIOLOGIST

As a trained physician and physiologist, Saltin studied exercise through a variety of lenses. His research had implications for numerous populations, from professional and recreational athletes to cardiac patients.

OLYMPICS

Saltin had an interest in understanding the limits of human performance, and was involved in sports and athletics throughout his career.

- Early in his career, he participated in the preparation of the Swedish athletes for the Olympic Games in Mexico in 1968.[1]
- Considered a leading anti-doping expert, Saltin was a member of the World Anti-Doping Agency's (WADA) Health Medical and Research Committee from 1999-2004.[2]
- Saltin was awarded the first Olympic gold medal of the 2002 winter games in Salt Lake City. International Olympic Committee President Jacques Rogge presented him the medal for his research and "contributions in basic cardiovascular and muscle physiology, as well as his exceptional findings in the field of exercise physiology."[3]

PUTTING BED REST TO BED

In 1966, in a collaboration with researchers at the University of Texas, Southwestern Medical Center at Dallas, Saltin helped conduct a National Institutes of Health project that produced one of the most pivotal studies in exercise physiology. Results from the Dallas Bed Rest and Training study demonstrated the highly adaptive capacity of the cardiorespiratory system, a finding relevant to both athletes and patients in the clinical setting.[5]

During the study, healthy 20-year-old male volunteers underwent three weeks of complete bed rest with zero weight bearing—mimicking the clinical treatment for acute myocardial infarction at the time—followed by about 55 days of aerobic exercise training. Cardiopulmonary function was assessed at baseline, after three weeks of bed rest, and after 55 days of training via maximal oxygen uptake (VO2max) during stress testing to exhaustion. VO2max is considered the best index of aerobic capacity and indicates the ability of the cardiovascular system to supply oxygen to working muscles as well as the muscles' ability to extract the oxygen to generate energy.

The results were striking. Bed rest was associated with a 27 percent decrease in VO2max, a 26 percent decrease in cardiac output, and a 31 percent decrease in stroke volume. Just three weeks of bed rest among healthy individuals was hardly benign. It was actually harmful.

In the clinic, cardiac rehabilitation has since displaced bed rest as the standard of care following myocardial infarction—as well as other diagnoses of cardiac dysfunction. It combines prescriptive exercise, cardiac risk-factor modification, and other elements to reduce morbidity and mortality.

Unsurprisingly, the exercise training phase of the study induced more favorable adaptations. Exercise was associated with a 45 percent increase in VO2max, a 40 percent increase in maximal cardiac output, and a 48 percent increase in maximal stroke volume.[5,6]

What made this study relevant to athletes was the mechanisms by which bed rest and training affected VO2max. In addition to measuring changes in central (cardiovascular) factors, the researchers measured changes in arteriovenous oxygen difference (muscle oxygen extraction), a key peripheral factor. Bed rest reduced VO2max primarily via central factors, whereas training enhanced VO2max through a combination of increased central and peripheral factors.

EXERCISE AS MEDICINE

Since the bed rest study, other examples of Saltin's work examined the effect of exercise training in a variety of clinical populations, including people with diabetes and heart failure, as well as aging populations. He was a pioneer and advocate for the concept of exercise as medicine.

In 2006 Saltin and his colleague Bente Klarlund Pedersen published a review of the evidence for prescribing exercise therapy as treatment for several diseases, including metabolic syndrome disorders, heart and pulmonary diseases, cancer, and depression, among others. In many cases, the evidence showed exercise therapy to be at least as effective as medical treatment, and in some cases it was even more effective. Saltin and Pedersen described exercise therapy not as a paradigm change, but as a necessity given the volume of evidence.

In 2015, they published an updated review with evidence for prescribing exercise for 26 different diseases. The review encompassed the effects of exercise therapy on disease pathogenesis, symptoms, and explored possible mechanisms of action.

In addition to examining the scientific evidence, Saltin and Pedersen reiterated, "The accumulated knowledge is now so extensive that it has to be implemented." They also emphasized the importance of a physically active lifestyle at the societal level, calling for improved infrastructure and accessibility:

"…It is now time that the health systems create the necessary infrastructure to ensure that supervised exercise can be prescribed as medicine. Moreover, it is important that society in general support a physical active lifestyle. People do not move when you tell them to. People move when the context compels them to do so. In order to enhance the physical activity level of the population, accessibility is important."[8]

The concept of "exercise as medicine" has evolved into a United States-based health initiative. In 2007, the American College of Sports Medicine and the American Medical Association co-launched Exercise is Medicine® (EIM), with the goal of making physical activity assessment and promotion a standard in clinical care. EIM now exists in almost 40 countries.

THE NEXT GENERATION

Saltin's tenure as head of the CMRC from 1994-2004 is an important part of his legacy. In the early 1990s, he accepted an offer from the Danish National Research Foundation to develop the CMRC. He and seven other senior researchers in exercise physiology were to carry out the center's goal—to focus on the regulation of skeletal muscle metabolism and its coupling to muscle blood flow—through an integrated approach to research.

There was significant collaboration and interaction between researchers and labs from the August Krogh Institute, the Panum Institute, Bispebjerg Hospital, and the Capitol Hospital of Copenhagen, and various groups from abroad.

A former senior scientist at the CMRC, Robert Boushel, noted that the combination of many students and visiting international scientists, among other factors, made the center "a 'beehive' of scientific collaboration."[4]

Saltin is credited with supporting the development of numerous researchers in exercise physiology during his tenure at the CMRC. At least 15 students from the CMRC continued on to become full professors. Several of the speakers at the 2015 symposium honoring Saltin reflected on his benevolence. Boushel remarked: "He was very generous through providing opportunities and guidance to young scientists." [4] According to one of Saltin's postdoctoral trainees, Martin Gibala, "His scientific curiosity was perhaps exceeded only by his generosity."[3]

In a perspective on Saltin's impact and career, Michael Joyner, MD and physiologist, wrote:

"At some level, the best labs are like Montessori schools for bright young people. Bengt showed it was possible to run a large and high-powered research center at a major research center at a major research university in the same way."[1]

Imagine the possibilities for discovery and innovation should more leaders in the scientific community adopt this approach to leadership.

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Tina Phillips, PhD

ASK THE EXPERT

HOW COLLABORATIONS WITH NON-SCIENTISTS CAN LEAD TO SCIENTIFIC INNOVATION

by Rachel Muenz

Tina Phillips, PhD, is the assistant director of the Center for Engagement in Science and Nature at the Cornell Lab of Ornithology. She conducts social science research and evaluation across numerous citizen science projects both within and outside the lab. Her research interests center on understanding and documenting the educational, social, and conservation impacts of citizen science globally.

Q: Can you give me a summary of what the Cornell Lab of Ornithology does?

A: Most people associate the lab with birds, and we certainly focus a lot of our work on birds, but we also engage in lots of other taxa. For example, we have a vertebrate museum here, a program that studies whales, and one that studies elephants. So, we are more than just birds. We are committed to conserving and protecting birds and biodiversity through research, education, and citizen science. We have a whole bunch of citizen science projects where we engage the public in helping us to answer important biological questions.

Q: How can non-scientists help bring about innovation in science?

A: A lot of our citizen science projects are considered top-down or contributory, where the science is being driven by the scientist, but there's been lots of questions that have come from the participants themselves. And for eBird for example, the community helps to generate new tools. They'll say, "Hey, it would be really cool if we could understand at the county level what birds are here or I want to be able to track my yard birds or I want to be able to see where birds are increasing or decreasing." A lot of the new innovative tools that we provide for people are born out of the participants themselves. There are new methodologies that participants help to develop—that happens quite a bit—and then there are new discoveries.

For example, we have a project called Bird Cams, and there was a three-year citizen science side project called Bird Cams Lab. We asked people to come up with their own questions and their own investigations. Through that process, people [came] up with new discoveries, new behaviors that hadn't been recorded before—new questions being asked about nestling vocalizations of red-tailed hawks, for example. There's really no limit to the kinds of innovation that scientists would benefit from when they're asking for volunteer input and engagement, especially in large-scale studies. So, it's almost impossible for me to think about science without citizen science being part of that equation.

Q: What are some specific examples you've seen of ways citizen scientists have helped scientists innovate?

A: I think citizen science is at its greatest potential when you have the inclusion of local knowledge. For example, the inclusion of local knowledge helps

Key Citizen Science Projects at the Cornell Lab of Ornithology

eBird: A global program with more than 1 billion observations that allows anyone to report their bird sightings at any time, as well as explore trends and data through a host of data visualizations.

NestWatch: Dates back to 1965 under a different name, this project focuses mainly in the US and Canada. Allows people to report information about breeding birds, including species, number of eggs, and number of young.

Nest Quest Go!: Draws on the power of the internet to transcribe information from the three-by-five index cards used to record breeding bird data from the historic NestWatch (Nest Record Card) program to create an entirely digital database of more than 300,000 records.

Project FeederWatch: Started in the 1980s, this project involves people observing birds at their feeders to report the number of birds and species during the winter months.

Great Backyard Bird Count: An annual, global four-day event in February where people observe birds in their neighborhoods to provide a snapshot of birds in winter.

Celebrate Urban Birds: Focuses on observations of birds in urban environments.

in ways like disaster preparedness. We saw this first beginning with the Deepwater Horizon Gulf [of Mexico] oil spill. It was a bunch of community members that got together to say, "You know, we need to understand what the effects of that oil spill are in our soil and air." They enlisted the help of some local scientists [and] came up with new tools and methodologies for really trying to understand what the impact of that oil was. There's lots of examples of that local knowledge, that community resiliency coming together, to engage in disaster preparedness for future events.

Another great example is the Flint water crisis. A lot of what we know about lead contamination in Flint, Michigan came from citizen scientists, from people who were very concerned and took it upon themselves to figure out how to test the water and how to work with scientists to do a collective strategic monitoring of the water systems in and around Flint. Local knowledge and community stakeholders are helping science innovate, because if it's not for that knowledge and those stakeholders, we may not even know the problem exists. If not for that engagement, scientists are just doing what they think is important to what their research agenda is all about. Not to say that that's not important, but there's lots of blind spots there. When you're engaging with communities, you're really opening up your vision of what science questions are important and to whom and that to me is the greatest potential of citizen science. I think it helps science to be more responsive, accessible, certainly more relevant to communities, and also more transparent.

Q: Why is it important for non-scientists to participate in science?

A: When you look back, historically, [better science] is [connected to] stakeholder engagement. So, you know, breast cancer research got better after there were a whole bunch of advocates, people wanting to understand the problem, and doing their own research and being engaged with scientists. Many of them were female advocates saying, "We need to do this better—we need better science [and] research." And that happened because the stakeholders were involved. AIDS research is another great example. The gay community were their own advocates and they learned the language of science, they attended conferences and participated in research forums and made the science and research better. In addition to being responsive, relevant, and transparent, I think it's better when it's not just a handful of scientists talking to themselves, but instead seeking input, ideas, and observations from the greater body of people and stakeholders out there. There's also a lot of science learning that happens on the part of the participants, and that's really important.

Q: What do you think is essential for citizen science projects to be successful?

A: First, it has to be inclusive; it has to allow anyone to participate. I think citizen science has a long way to go before everyone feels included. There has to be the goal of making it as inclusive as possible. Second, the data must be of high quality and for that, there has to be a sound research question. It has to be testable. There have to be standardized protocols. That's just the basics of good science. Everyone has to be gathering information in a similar manner, so that we can ensure high-quality data. And there has to be some way to check that the data are high quality.

I also think there has to be a committed scientist [involved]. I have seen several citizen science projects fail because there is not a committed scientist at the helm, somebody who actually wants to do something with that information. It doesn't have to be a professional, credentialed scientist, but somebody has to be committed to analyzing that data. Otherwise, people do feel like, "Well, why am I doing this, if nobody's doing anything with the data?" Also, there has to be a feedback loop. People who are spending their free time providing these observations need to then be provided information about what did you learn from my data in the collective? There has to be that two-way communication between scientists and participants. The feedback has to be regular about how the data are being used and what's novel and what the data are telling us, otherwise, people do tend to drop out.

Lastly, it has to be fun. People tend to be motivated to engage in citizen science out of an intrinsic motivation. There's just an interest and enjoyment there—they want to learn. To keep that motivation going, it has to be fun and engaging. Some projects, especially those that are community led, sometimes those aren't really born out of intrinsic motivation; people will join those because they have a concern about soil, air, or water contamination. So, they're not necessarily looking for fun. However, even in those kinds of projects, there needs to be time for social space and social gatherings and some measure of fun and enjoyment, otherwise, people burn out. We have to provide for that emotional connection for people to continue to engage.

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Streamlining LC-MS measurements for proteomics research

LOW-FLOW LC COLUMNS FACILITATE INCREASED SENSITIVITY AND HIGH RESOLUTIONS FOR LC-MS MEASUREMENTS

▲Robert van Ling

▲Jeff Op de Beeck, PhD

▲Paul Jacobs

__Robert van Ling__ is the low-flow HPLC column product manager at Thermo Fisher Scientific. Robert started his career in the mid-90s in nano- and capillary LC at LC Packings, one of the leading companies in this then-young analytical field. Since then, he has held several roles in marketing and sales support for the separation and characterization of biomolecules and most recently was part of the introduction team for the Thermo Scientific™ μPAC™ HPLC columns.

__Jeff Op de Beeck__, PhD, is staff scientist at Thermo Fisher Scientific's R&D facility in Ghent where micropillar array technology is developed and produced. His work under the supervision of professors Gert De Smet and Wim De Malsche formed the basis for the current micro–Pillar Array Column, which is branded by Thermo Fisher Scientific as the μPAC™. He holds a Master's degree in biomedical sciences from the University of Antwerp and a PhD in chemical engineering from the University of Brussels.

__Paul Jacobs__, PhD, is R&D director at MSS (Microfluidic Separation Solutions), part of Thermo Fisher Scientific in Ghent, Belgium. Paul holds degrees in engineering in physical electronics, biomedical engineering, and a PhD in applied sciences (biosensors development) from the University of Leuven, Belgium, which he complemented with several management training programs. Paul has accumulated extensive expertise in a wide variety of life sciences and medical device technologies, ranging from biosensors to in vitro diagnostic assays, as a research engineer and program manager in a few international companies as well as for start-ups. Paul was co-founder of PharmaFluidics.

Q: Why is LC-MS crucial to bottom-up and top-down proteomics research, and what does Thermo Fisher Scientific have to offer in this aspect?

RL: In either top-down or bottom-up proteomics, mass spectrometry (MS) is the key technology. In combination with liquid chromatography (LC), MS provides high-efficient separations alongside sensitive detection as well as extensive identification and quantification of the proteins composing a highly complex sample or mixture. Thermo Scientific's™ Orbitrap™ MS plays a crucial role in LC-MS top-down and bottom-up proteomics alongside various new innovations focusing specifically on low flow chromatography. These innovations include the Thermo Scientific™ Vanquish™ Neo, an optimized ultra-high-performance liquid chromatography ((UHPLC)) system, and the recently introduced µPAC HPLC columns. Together with the Orbitrap, they enable extremely high peak capacities and resolution separations at nano-LC flow rates ranging between 200 to 750 nanoliters per minute. Furthermore, the Thermo Scientific™ EASY-Spray™ PepMap™ Neo UHPLC columns serve as complementary counterparts to complete the bottom-up proteomics LC column portfolio.

Q: Compared to analytical flow LC-MS, what do low-flow columns offer for proteomics research, and what sets them apart?

JO: Low-flow LC columns facilitate increased sensitivity that can be achieved by moving toward lower flow rates. This is due to the electrospray ionization process, which tends to be much more effective at nano flow rates approaching several nanoliters per minute and up to 300 or 500 nanoliters per minute. This will bring increased ionization efficiency and detection sensitivity, which is needed to identify and quantify low abundant biomarkers from precious biological samples. The combination of µPAC HPLC columns with the newly introduced Vanquish Neo system give excellent results by combining precise gradient formation at nano-LC flow rates with high resolution microchip-based LC separation with a user experience that makes it easier to use and optimize.

Q: What information can low-flow LC-MS extract and how is this facilitated by the advanced HPLC column solutions?

JO: In bottom-up proteomics, a digested cell lysate sample typically contains tens of thousands of peptides that come from a vast population of proteins, and these are often present over a huge dynamic concentration range. Low abundant proteins can have an important biological role, and therefore it is highly desired to have a method that allows identifying and quantifying them. This is where nano-LC comes in the picture. Apart from the ionization efficiency achieved using very narrow columns and low flow rates, nano-LC ensures that samples get less diluted and thus maximizing the signal response in MS measurements. The use of µPAC based LC column formats also allows operating optimized and longer separation channels at lower pressures, which further amplifies the resolution and peak capacity. These are also the reasons behind why the field has evolved into using nano-LC as the method of choice in proteomics, backed by the last decade of innovation in system hardware.

Q: What challenges had to be addressed in the development of these solutions and what remains unresolved?

PJ: The driving factor behind these solutions was to meet user demands for higher resolution measurements with increasing peak capacities and narrowing peaks. This was facilitated through the µPAC HPLC columns that eliminate eddy dispersion to increase separation resolution and combine relatively high loading and equilibration flow to reduce the overhead of these non-productive cycles in the analysis. This allows the gradient analysis to be run at the optimal flow rate for the nano-spray and thereby achieve the highest sensitivity. Most importantly, µPAC allows this to be done with high reliability. The µPAC HPLC columns are made out of single monolithic silicon blocks (wafers) with the pillars forming the backbone of the stationary phase extending from the bottom of the microchannel with no loose particles or frits. This makes them extremely stable and robust, providing for longevity and high retention time stability. As the µPAC HPLC columns are manufactured using lithography and micromachining, they are also highly reproducible and easily replaceable.

Lab Manager Reader Survey: Innovation

OUR READERS SHARE THEIR THOUGHTS ON INNOVATION IN THE WORKPLACE

by Stephanie Edwards, MA

The concept of innovation is multifaceted. At its simplest, it can mean a new idea, method, or device; in the broader sense, innovation can be the outcome of people collaborating to evolve and modernize their workplace. STEM fields are often considered by the public to be at the forefront of innovation, with scientists and engineers working toward new, exciting, and life-changing discoveries. But what does innovation mean for those working in and around the lab and how are organizations inspiring their teams to develop innovative ideas? The *Lab Manager* team asked our readers what innovation looks like to them on an individual level, at the workplace, and on a broader level.

Demographics

Our survey participants span a diverse range of ages, with the majority falling between 45- to 64-years-old. Unsurprisingly, many survey respondents work as lab managers (53 percent), though other job titles included research scientist, consultant, principal investigator, and technician, among others. The most represented workplace for this survey was hospitals/medical centers and the most common industry was clinical diagnostics. However, our readers come from a wide range of different jobs across academia, industry, and government labs.

Age

18-24	1%
65+	6%
25-34	13%
35-44	24%
55-64	26%
45-54	30%

Field of research/industry

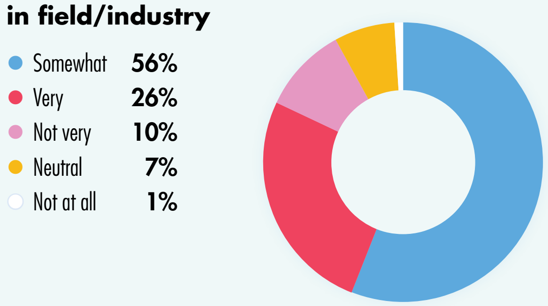
Informatics/Bioinformatics	1%
Instrumentation Design/Development	2%
Forensics	2%
Energy/Petroleum	2%
Agriculture	4%
Pathology	5%
Infectious Disease	5%
Food Safety	5%
Environmental Science	11%
Pharmaceuticals/Biopharmaceuticals	13%
Molecular/Cell Biology or Genetics	15%
Other	17%
Clinical Diagnostics	18%

Survey respondents represented diverse areas of research. Additional fields of research included materials science, process development, metals and mining, cellular agriculture, and lab architectural firm.

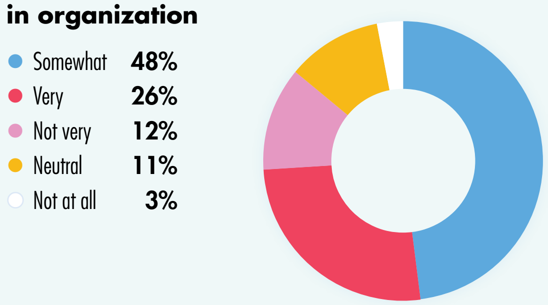
Perceptions of innovation

Innovations within the lab and broader industry are incredibly important to our readers. They place high value on the presence of innovations in their day-to-day workplace (67 percent saying they value innovation within their workplace at the highest rating offered) and similar importance on the ability of the organization to be innovative on a larger scale.

Perceived degree of innovation in field/industry



Perceived degree of innovation in organization



Fifty-six percent of respondents feel their field or industry is somewhat innovative while 48 percent feel their organization is somewhat innovative.

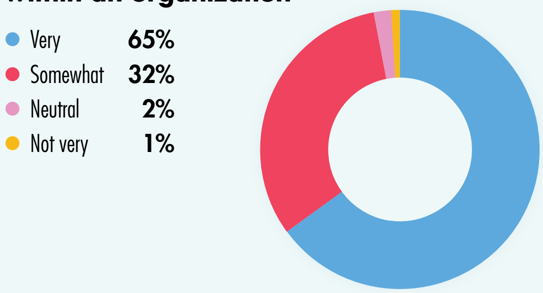
To reach readers' desired levels of innovation at both the micro- and macro-level, some work needs to be done to bridge the gap between what our readers expect versus what they experience. Although three-quarters of respondents consider innovation to be extremely valuable and important, most view their workplace and/or organization as only being somewhat innovative. Additionally, most readers feel like innovation is promoted and encouraged by their workplace, leaving lots of room for the link between performance and innovation to be strengthened. However, like anything else in the workplace, innovation can be risky. When it comes to innovation, our readers are most worried about the financial and operational risks, which include the possibility of failing quality standards and the wasted time and resources if an idea doesn't pan out.

Luckily, it looks like closing the gap between expected and experienced innovation is possible, with almost all respondents feeling like their workplace and/or organization is open and willing to change when it comes to innovative technologies and workflows. There is also not one specific area where readers think innovation is especially lacking within their organizations and they would like to see an increase at all levels of staff, management, and other stakeholders. Innovation being valued across whole organizations opens an exciting space for lab managers to promote and encourage an innovative culture within their lab, where no idea is a bad idea and staff feel comfortable to express their thoughts, concerns, and pain points. To emphasize the importance of establishing an innovative work culture, one survey participant says, "Great ideas can come from anyone, from undergraduate students to seasoned alumni. Diversity within the team also provides a broader viewpoint from which to problem-solve."

Innovative technology

One of the most common ways workplaces and organizations can embrace innovation is through the adoption of new technologies. Innovative technology in the workplace is so crucial to our readers that not a single respondent considers its adoption not important at all.

Importance of adopting new technologies and innovations within an organization



The majority of respondents (65%) believe it is very important that organizations adopt new technologies and innovations.

Approximately 80 percent of respondents felt their organization was very willing or somewhat willing to adopt innovative new technologies and workflows. How can lab managers use this information to help create more innovation in the workplace? For just over half of our readers, feedback from both team members and members of leadership drive innovation within their organization, proving that our readers have a voice and play an important role in making their workplace a more innovative space. Using this voice, lab managers can make tangible moves toward a more innovative lab. For example, they can build a business case for the adoption of new tools and workflows and advocate to upper management that these technologies could lead to more efficient processes, and, ultimately, enable innovative work.

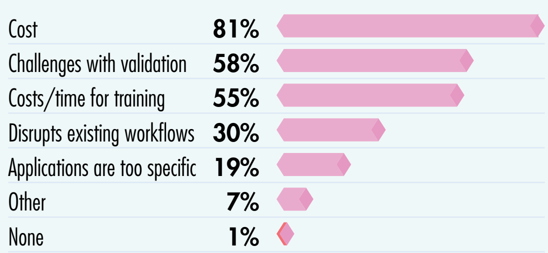
Once the lab manager has been given approval to invest in a new tool or technology, they can communicate the benefits of adopting it to their team. Change can be difficult, even if it is good change, so it's important for lab managers to set up a strategy to successfully implement the new tool or workflow. As one survey participant explains, "Innovation is change. People tend to resist change. But the risk can lead to rewards that benefit everyone."

The top three risks of adopting new technologies, according to our readers, are cost, QA/QC, and time. Supply and demand issues also pose a significant risk and limit organizations' access to new technology in the first place.

Science is a field that is constantly changing and evolving, and those of us who work in the field have experienced at least one major innovation that has changed the way we work. For readers of *Lab Manager*, automation and digital lab technologies have made the biggest impact in their workflows. One of our readers writes that "the introduction of automation in our laboratory has really brought a lot of changes in terms of quality and service. [It's enhanced our] accuracy, precision, turnaround time, and even sample management."

With the impact of COVID-19, innovations in lab safety and remote work have increased and have changed the way we do our jobs and collaborate with our teammates.

Perceived risks associated with adopting new technologies



The majority of respondents indicated cost (80 percent) as a risk associated with the adoption of new technologies.

10 WAYS AN INNOVATIVE TECHNOLOGY OR IDEA HAS CHANGED THE WAY YOU WORK:

Technologies and innovations that have changed the way you work

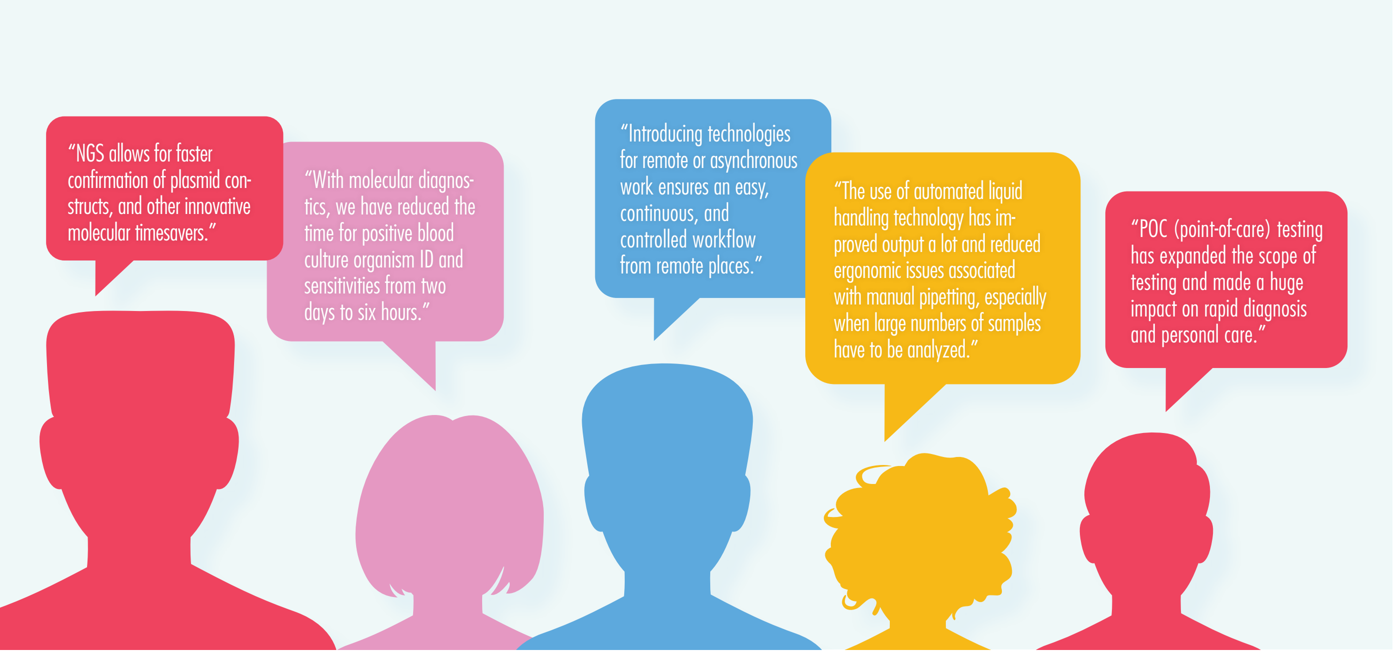
Automation	51%
Digital lab technologies such as ELNs, LIMS, remote monitoring, IoT, cloud-based solutions, etc.	49%
Innovations in laboratory safety, biosafety, or PPE	38%
Innovations in laboratory design	35%
Innovations in laboratory reporting or compliance	31%
Technologies for remote or asynchronous work	31%
Environmentally friendly/ "green" technologies	30%
Molecular assays	29%
Innovations in diagnostic testing (e.g. point-of-care testing)	28%
Innovations in ergonomics	19%
Artificial intelligence and/or machine learning	19%
Miniaturization and/or microfluidics	14%
Online fundraising/crowd-sourced science	3%
Other	3%

Another respondent notes, "Introducing technologies for remote or asynchronous work ensures an easy, continuous, and controlled workflow from remote places."

We also asked our readers to share their thoughts on some specific areas that are at the forefront of innovative technologies today. When it comes to "green" technology, respondents considered all innovations as having a significant positive impact, with reduced waste output slightly edging out the others. For lab design innovation, readers overwhelmingly love flexible and open spaces, and for remote work, communication tools and automation made the biggest impact.

Whether we see innovations in funding, learning, or design, it'll be exciting to see what new technologies alter our working world as we continue to evolve and adapt.

Stephanie Edwards is the eMarketing coordinator for Lab Manager. *She can be reached at sedwards@labmanager.com.*



Automating Lab Information Management Systems

AN ALL-IN-ONE AND FULLY CUSTOMIZABLE CLOUD-BASED LIMS THAT STREAMLINES AND OPTIMIZES OPERATIONAL EFFICIENCIES IN LABORATORIES

*◀**Jaswant S. Tony** is the founder and chief executive officer of GoMeyra, an innovative cloud software company providing enterprise technological solutions for the health care industry. Its premiere product, GoMeyra LIMS, is an automated, customizable laboratory information management system that improves workflow efficiencies, enabling laboratories, medical providers, employers, and enterprise organizations to process lab tests and deliver patient results with unprecedented speed. GoMeyra Network, a unique built-in feature, allows independent labs across the country to collaborate and compete with larger diagnostic providers. For more information, go to www.gomeyra.com.*

Q: When did you decide to start GoMeyra and why?

A: I started GoMeyra in 2020 during the early months of the pandemic, when testing for the SARS-CoV-2 virus had become a problem. There was a dire need for public access to tests and a software platform that processed test data efficiently. GoMeyra LIMS met the challenges and turned a LIMS platform into a solution that works fast and facilitates seamless communication between scientists, businesses, laboratories, and the public.

Q: What problems do GoMeyra's products resolve, and how does the company's platform hierarchy accommodate these goals?

A: Our cloud-based LIMS software solution enables laboratories, medical practices, and other health care facilities to manage samples and process accurate test results quickly. The system greatly reduces the need for manual data input, mitigating the risk of human error. It is designed to alleviate bottlenecks and streamline workflows to significantly improve turnaround time. The all-inclusive software offers faster accessioning, front-end integration with client electronic health records (EHRs), simplified record keeping and reporting, and capacity for adding assay workflows. In many ways, GoMeyra's intuitive LIMS architecture has elevated testing, assessment, and delivery of results within the medical laboratory industry.

Q: What are the innovative features of GoMeyra's LIMS?

A: GoMeyra LIMS follows a platform similar to Microsoft Office 365. It has the ability to link multiple labs within one system and fully integrate lab management workflows in an online platform that is far more flexible, structured, and efficient than many legacy systems. When you use GoMeyra LIMS, you become part of GoMeyra's private lab-to-lab network, which was built into the system and continues to grow. It allows labs, regardless of location, to work together to efficiently manage overflow testing and guard against bottlenecks. In essence, the GoMeyra NETWORK maximizes each lab's capacity and versatility during spikes in testing nationwide. Additionally, having a LIMS that speaks to other labs enables smaller independent labs to team up, take on more business, and compete with larger diagnostics providers. Local labs can easily scale up and operate as national businesses.

Q: How do these advanced features specifically benefit medical labs, providers, and patients?

A: The growth of precision medicine necessitates innovation. GoMeyra's advanced features help automate existing lab workflows and processes to dramatically speed up test processing, increase productivity, and expand daily testing capacity. This makes it easier for labs to deliver same-day updates for test results to doctors and their patients. In addition, GoMeyra LIMS maintains strict compliance with recognized data security and privacy standards such as HIPAA, HITRUST, and NIST. Using GoMeyra's compliant platform, independent labs can become certified to handle testing for large organizations, which may not have been possible with an in-house LIMS.

Q: What new products or modules are next for GoMeyra?

A: GoMeyra will be expanding its LIMS platform, adding diverse panels and test processes for male and female health services, flu testing, and more.

We also recently launched GoVirtual Clinic. This single-interface, cloud-based telehealth solution allows labs, physicians, or nurses to administer medical tests and consult with patients over a secure remote platform. In the first phase, users can schedule and manage virtual testing appointments, order test kits, monitor online waiting rooms, conduct virtual appointments, and share test results with patients in real-time. We will soon release more modules for updating medical histories; ordering prescriptions, labs and imaging; accessing test results; coordinating insurance; handling billing; and more—all from a single portal.

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To see the "Solutions for Key Challenges in Biotech Labs" and other Big Picture series, please go to *Lab Manager*'s website at **LabManager.com/ big-picture**.

The BIG Picture

TACKLING THE TOPICS THAT MATTER MOST TO LAB MANAGERS

Biotechnology labs face many challenges such as operations and process issues, taking risks when pursuing innovative ideas, constantly changing and advancing technologies, and data and security challenges. However, labs and companies involved in the biotech field seem up to these challenges and are equipped to carry out a variety of solutions. This six-part series offers guidance for managing a biotech lab, how to optimize lab operations, some examples of how technology can help improve efficiency, and more.

The Big Picture is a digital series produced by the *Lab Manager* editorial team. Each month, the series features a collection of in-depth articles, expert insight, and helpful resources, covering a specific industry, trend, or challenge.

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A Day in the Life of a New Lab Manager

Stepping into the role of a lab manager can feel overwhelming, but having the right support and resources to perform the variety of tasks expected of you can set you on the path to success. In this Q&A piece, we talk with Enrique Hernandez, lab manager, R&D, at Endless West. Hernandez attended the 2022 Lab Manager Leadership Summit earlier this year in Baltimore, MD, to consult with industry experts and fellow attendees and learn the skills and knowledge needed to be an effective lab manager. Hernandez discusses the challenges they faced so far within their newly appointed lab manager role and how they have found solutions. They also share advice for fellow lab professionals who may be in a similar situation.

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