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SALARY AND EMPLOYEE SATISFACTION SURVEY

The editors or *Lab Manager* are currently working to bring you the latest data on salaries and employee satisfaction within the scientific community through our 12th annual Salary and Employee Satisfaction Survey. The results will be featured in our September print issue, highlighting trends in benefits and compensation among lab professionals, and identifying key responses relating to demographics, training, education levels, and more. While we look forward to sharing the findings with you in September, we encourage you to review last year's trends by visiting www.labmanager.com/11th-annual-salary-satisfaction-survey.

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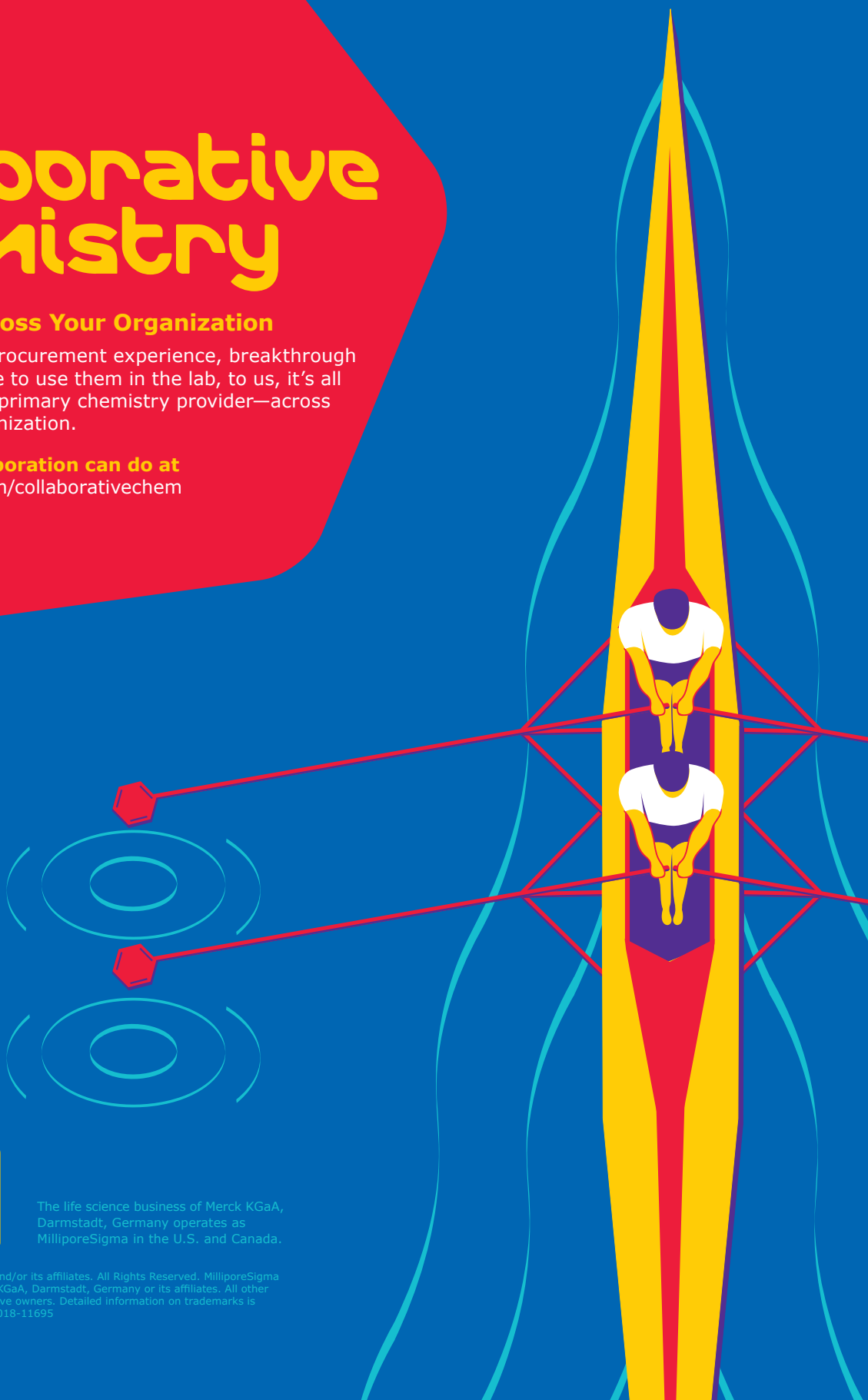

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adapting to change

Ten years ago this month, LabX Media Group relaunched *Lab Manager* Magazine after purchasing it earlier that year from Vicon Publishing (Amherst, NH). Much has changed since that first reissued copy hit the desks and benchtops of researchers and managers around the country. Back in 2008, our website (www.labmanager.com) was not much more than a repository for the print product. Today it is filled with the very latest industry, management, safety, and technology news and information. Back then, our editorial offerings were only available in print and online. Today our editorial and creative services teams offer a wide range of webinars, informational videos, eBooks, infographics, and more. Technology- and industry-specific information on our website (then unavailable) is now organized by category, making it easy for visitors to find exactly what matters to them. As for social media—something that 10 years ago was barely a "thing"—*Lab Manager* now has a presence on Twitter, Facebook, and LinkedIn.

Over the years, we have conducted regular surveys of our readers in order to stay on top of the issues that concern them most. Not surprising, we know that funding and staffing are two topics that keep many up at night; informatics and cloud computing are technologies they need to stay abreast of; and laboratory safety and government regulations are always top of mind. Ten years might as well have been a century ago when it comes to the changes affecting the way managers run their labs, purchase their equipment, and conduct their research. Like the audience we serve, we are committed to changing with the times—moving beyond print to new media platforms, products, and services. We hope you'll stay with us for the next fast-moving 10 years.

This month's issue looks at developments in laboratory design. Just as *Lab Manager* recognizes the need to adapt and change according to audience and market demand, so it is with lab design. "The next-generation laboratory demands be flexible and easily adaptable to help reduce R&D costs and enable faster new product development," says author Roger Humphrey in our cover story, "Building a Future-Friendly Lab." Of equal importance is the need to attract high-caliber talent, which requires well located and designed facilities. "Organizations must compete for data scientists not only against the major technology companies—whose reputations for offering highly desirable workplaces are considered by some to be unrivaled—but also against companies outside the technology sector," says Humphrey.

There's much more on the topic of lab design in our July issue, as well as many important management, safety, and technology articles. Take a few minutes to review our editorial offerings to find what matters most to you.

Happy summer.

Best, Pam

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BUILDING A FUTURE-FRIENDLY LAB

FLEXIBLE DESIGN AND ACCESS TO TALENT ARE THE KEYS TO AGILE R&D

by Roger Humphrey

The death of the blockbuster drug has forced a reckoning in laboratory design—one that's exposed new pathways to a more agile, future-friendly lab. We know the lab of the future must leave behind old conventions, so scientists can more quickly bring meaningful therapies to patients. It's clear that speeding up innovation has become critical to making research and development (R&D) viable in a time of an ongoing decline in profits. The next-generation laboratory must be flexible and easily adaptable to help reduce R&D costs and enable faster new product development.

Blockbuster drugs were typically made in industrial-strength labs—and industrial-strength measures were required to reconfigure them as new research priorities emerged. Facing changing patient needs and ongoing financial pressure, most biopharmaceutical companies simply no longer have the kind of time or extra funding that major lab redesigns traditionally require. Nor can companies afford to offer up mediocre space simply because it fits a budget. Today's top talent won't be inspired by yesteryear's lab design, nor should they be.

> "Today's top talent won't be inspired by yesteryear's lab design, nor should they be."

It's clear that life sciences and biopharmaceutical companies need new ways to shorten R&D timelines while focusing on cost reduction and ongoing industry consolidation. R&D returns for large biopharmaceutical firms fell from 10.1 percent in 2010 to a feeble 3.2 percent in 2017. What's been less clear, until now, is how to achieve the lofty goal of a shorter, more productive R&D timeline.

Fortunately, new approaches to physical space have emerged that make a genuine contribution to the effort, according to "Journey to the Next Gen Lab," a new report by JLL (Chicago, IL). From more flexible space that promotes agility amidst rapidly shifting research priorities to tech-driven features that can help organizations leverage big data and attract talent, innovation in lab design can lead to more efficient innovation in the work itself.

Following are three lab design trends helping organizations achieve a "faster, lighter" lab of the future.

Trend 1: Designing for flexibility and collaboration

"Eureka!" moments can happen anytime—unlike a traditional laboratory transformation. Historically, reconfiguring a pharmaceutical or biotech lab to support research for an all-new remedy or cure has been a time-consuming and expensive undertaking. But that's

changing as life sciences companies increasingly steer clear of conventional lab designs in favor of flexible spaces to keep up with the pace of innovation.

Amidst rapidly shifting research priorities, forward-looking lab designs are those that can be easily reconfigured to accommodate different kinds of research and help scientists perform their studies as quickly as possible. Also important are spaces that facilitate creative interaction with colleagues, preferably without requiring de-gowning.

> "R&D real estate is already becoming more highly flexible and multiuse."

As evidenced by JLL research, R&D real estate is already becoming more highly flexible and multiuse. Although flexibility enhancements bring some upfront cost considerations, the ability to easily move heavy-duty items such as chemical fume hoods can make R&D more cost efficient in the long run.

For example, mobile benches and unassigned workspaces are being used to allow for fast changes in personnel and/or the type of work being performed. Some lab designers are installing retractable electrical cords in the ceiling and technical infrastructure into movable facades so workspaces can be set up in different configurations around the lab floor, rather than being limited to fixed walls. Another strategy is to build heavy-duty floor slabs in laboratory corridors to accommodate periodic moves of heavy equipment.

Trend 2: Less wet lab, more computational science space

Lab samples are no longer the only subject worthy of close analysis. Thanks to continuing advances in data and analytics technology, as well as access to large data sets, drug development has become increasingly

▲ *Boston University's BioSquare facility, courtesy of JLL Project and Development Services.*

integrated with data science. With the help of cloud computing, researchers can quickly access, search, and analyze electronic health records and genome research for new insights. And analytics-fueled research comes with lighter regulatory requirements than, say, research involving animals or hazardous materials.

> "Drug development has become increasingly integrated with data science."

Yet all that computing requires seats, desks, power, and space. As a result of the growing promise of computational science, wet labs are shrinking to make way for more office space. In terms of lab design, the evolution represents a fairly significant shift in space utilization when you consider that a traditional R&D facility typically consists of mostly lab space and a relatively small proportion of office space.

The rise of artificial intelligence, machine learning, and other computing technologies in laboratories only adds fuel to the fire of change. In the future, lab proportions will likely shift to equal parts wet labs, flex space, and office space for data scientists. The shift in research modes could also help decision-makers divert funding from sensitive lab requirements, such as bacteria-resistant countertops and sinks, to state-of-the-art data analytics tools, such as electronic laboratory notebooks and powerful computer systems.

Trend 3: Focusing on talent recruitment and retention

The war for talented biologists and chemists is ongoing, with no sign of relief in sight with the concurrent pressure for more productive R&D. Adding to the pressure is the growing competition for in-demand data scientists to work with today's voluminous research data. Life sciences R&D organizations must compete for data scientists not only against the major technology companies—whose reputations for offering highly desirable workplaces are considered by some to be unrivaled—but also against companies outside the technology sector.

This mandate to attract and retain more skilled talent is having a ripple effect on major real estate decisions, as illustrated in JLL's "*Life Sciences Outlook*" report. Biopharmaceutical companies are intensifying their drive to be near leading academic research centers and the supportive R&D ecosystems that surround them, despite the high rents of attractive cities like San Francisco, San Diego, and Boston.

Talent wars are also contributing to a growing focus on amenities, aesthetic appeal, state-of-the-art equipment, and attention to sustainable design. The dark labs of yesteryear are giving way to lab designs that incorporate natural light, sustainability features, and attractive sight lines that, ideally, will promote well-being and inspire creative thinking about research problems.

Rather than hiding R&D space deep inside a facility, for example, some biopharmaceutical companies are creating lab spaces on the perimeters of their facilities to showcase their cutting-edge technologies and abundance of natural light. Perimeter placement serves the dual purpose of attracting new recruits while also making it easy for senior scientists to pop in after hours or on weekends to check a test result—a convenience that can help boost retention, too.

Collaboration-friendly space in particular can be a game changer for organizations looking to spark the interest of the next generation of scientists. Many of today's science students demonstrate a strong desire to share ideas with their peers and prefer spaces where they can learn as teams, rather than in isolation. Forward-looking R&D organizations are providing comfortable, inviting places for formal and informal collaboration to spark great ideas.

Smart technology is also becoming a differentiator in the lab workplace. Some labs are adopting Internet of Things technologies—from smart safety goggles and self-cleaning lab benches to sensor-powered sample freezers. Providing access to the latest tech-enabled tools not only helps attract new talent, but also can help employees become more efficient and nimble.

> "In the future, lab proportions will likely shift to equal parts wet labs, flex space, and office space for data scientists."

The future of lab design is flexibility

It's become abundantly clear that flexible lab design and access to talent are the keys to agile R&D. By investing in adaptable laboratory features today, a biopharmaceutical company can position its R&D operations for long-term agility. And investment in sustainable, inspiring design that fosters well-being and makes room for collaboration can further advance the ultimate goal of R&D: the next great breakthroughs.

Is your organization ready for the future of R&D? If you're creating your next-generation lab around the needs of both your ever-changing research priorities and the newest generation of scientists, the answer could be yes.

Roger Humphrey *is executive managing director of the Life Sciences Practice at Jones Lang LaSalle and the former executive director, global real estate and integrated facilities management (IFM) governance, at Merck & Co. Inc. He can be reached at roger.humphrey@am.jll.com.*

The University of Ottawa's Living Lab

CUTTING-EDGE SCIENCE IN A FAMILY-FRIENDLY ENVIRONMENT

by Lauren Scrudato

Families planning a visit to the newly renovated Canada Science and Technology Museum in downtown Ottawa now have the opportunity to participate in cutting-edge scientific research.

The Living Lab, which is the product of a collaboration between the University of Ottawa and the Canada Science and Technology Museum, is transforming the way language and cognitive development research is done. Founded by three University of Ottawa professors, the lab is unique because it offers families who are visiting the Science and Technology Museum a dynamic, interactive, and playful environment that kids of varying ages can enjoy while researchers collect data and observe trends of how children learn. It also allows parents the chance to chat directly with the researchers to learn more about the science behind how their children grow and develop.

> "The most unique aspect of the lab to me is that we're 'demystifying science' and making it accessible and transparent to all guests visiting the museum."

The founders include Cristina Atance, professor of psychology in the Faculty of Social Sciences at the University of Ottawa; Tania Zamuner, professor of linguistics in the Faculty of Arts; and Chris Fennell, also a professor of psychology. Fennell has been specializing in infant bilingualism for more than a decade and studies the process of language learning in infants as young as three months old. Atance focuses on the cognitive abilities of toddlers, and Zamuner's research includes language acquisition in preschoolers.

"The most unique aspect of the lab to me is that we're 'demystifying science' and making it accessible and transparent to all guests visiting the museum," says Fennell.

The timing for the idea of the Living Lab couldn't have been more perfect, according to Fennell. The museum recently underwent a significant $80.5 million renovation, which allowed the design of the Living Lab to fit seamlessly with the rest of the exhibits and attractions of the museum. The upgraded museum—and the Living Lab—have been open to the public since November 2017. The Living Lab encompasses 750 square feet of state-of-the-art study space within the museum. To the founders' knowledge, the Living Lab is the largest of its kind in North America. However, the team found inspiration for its development through similar facilities located in Boston in the US and in Vancouver, Canada. The Living Laboratory at the Museum of Science in Boston was initiated in 2005 to be used as a model for scientists around the world to

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1. From left: Professors Chris Fennell, Cristina Atance, and Tania Zamuner. Photo credit: Bonnie Findley **2.** A peek into the Living Lab from outside the glass walls. Photo credit for this and photos 3 and 4: Joelle Martin (Studio G.R. Martin) **3.** The play area within the Living Lab. **4.** The Living Lab encompasses 750 square feet of state-of-the-art study space within the museum.

"Social sciences aren't necessarily the first thing people think of when talking about science fields."

develop their own Living Labs, just like Atance, Zamuner, and Fennell have done. According to Zamuner, the Living Laboratory in Boston was key to the successful creation of the Living Lab in Ottawa. The Boston lab was a great resource because it provided essential elements needed to create an interactive research environment geared toward children, as well as an example of goals for both public and professional audiences. The Ottawa team also visited a similar lab in Vancouver to get a firsthand look at how to manage this type of facility, which unlike most labs, is open to the public.

Managing a lab that is open to the public does present a unique set of challenges. In a traditional lab, researchers can control the type of participants involved in a study. But as Fennell explained, every day at the Living Lab is different, and the researchers never know what ages of children, or how many, they will receive. But these challenges ultimately become an asset, forcing the researchers to be innovative, think creatively, and push the boundaries of research methodologies.

To collect the data the researchers are looking for, they must engage children in fun games and problem-solving tasks. The games performed at the Living Lab generally last just about five minutes each, so families still have plenty of time to explore other areas of the museum. Parents can observe the process through glass


4.

walls or Skype video, and the researchers explain exactly what they are studying and what different responses from their children mean.

"We have seen many repeat participants coming back to visit the museum," says Fennell. Repeat guests allow the researchers to collect additional data on the same participant and note any changes or trends. As of April 2018, the team had already worked with a total of about 700 participants.

One of the experiments that Zamuner conducts seeks to determine whether repeating words actually helps a child learn and retain vocabulary. She does this by introducing a child participant to a "sleeping" stuffed bear named Mr. Wiggles, who enjoys learning new words. While Mr. Wiggles sleeps, the child is shown a series of images on a computer screen. During the training, the child is asked to either say the image of the word on the screen (what Zamuner refers to as a produced condition) or to listen when the computer presents prerecorded words (a heard condition). The child is then instructed to "wake up" Mr. Wiggles and tell him as many words as they can remember. Zamuner compares the number of words recalled from the produced vs. heard conditions.

"The results will lead to a better understanding of how speech production can be used as a tool for clinical assessment and therapy," says Zamuner. "The findings will also be relevant to software developers working on automatic speech recognition systems that enable players to control gameplay through their own speech."

The Living Lab is also equipped with some of the latest instruments and technologies, such as eye-tracking software, which can assist the researchers in measuring participants' engagement and retention during experiments.

Noting that the Living Lab in Ottawa is still in an infancy stage itself, Fennell and Zamuner outlined some of the long-term goals and vision for the lab. First, they emphasized the importance of expanding their existing collaboration. The team hopes to recruit more researchers in different fields and specialties to ensure a well-rounded experience for children of all ages. By widening the age range of participants and testing out new experiments, the researchers will gain deeper insights into how children learn. This goal will be accelerated through a collaborative university grant, according to Fennell.

"We have seen many repeat participants coming back to visit the museum."

Zamuner also hopes that the Living Lab and museum will spark young guests' interest in STEM fields—particularly social sciences—as a potential career choice. "Social sciences aren't necessarily the first thing people think of when talking about science fields," she says.

Zamuner noted that one of the unexpected rewards of working at the lab has been observing how well undergraduate and graduate students at the University of Ottawa have done assisting with the research and interacting with the public.

"They have accepted the challenge of conducting the experiments, and [they] properly explain the results and process to not only the parents but [to] the general public," says Zamuner. If more university students join the Living Lab team, Zamuner envisions them acting as hosts for community groups and giving tours of the museum. She also discussed the potential of having "Ask the Scientist" stations positioned throughout the museum, so that guests have even more access to researchers.

As the team continues to grow, the Living Lab's research results will prove to be especially useful as the next generation of children grow up in an ever-advancing digital age. So far, the benefits of the Living Lab have been two-fold—researchers gather the findings they need, while parents become more educated about their children's development.

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THE SECRET SCIENCE OF GREAT DESIGN

“Good design is in the things you notice. Great design is in all the things you don’t” -Win Hovens

Custom designing a new product can be a particularly challenging task. While there are endless ways to apply innovation, great design more often focuses exclusively on functionality, efficiency, and efficacy. When considering product design, often the best products are the ones we use every day and pay little or no attention to. Such products are not burdened with non-essential features and are fully thought-through down to the smallest details.

There is a popular quote among designers: “Good design is in all the things you notice. Great design is in all the things you don’t.” For example, have you ever pulled on a door that was meant to be pushed? It’s because of the design of the door. By placing a handle on the push side, rather than a flat plate or a push bar, the design dictates an incorrect action. Properly designed doors, that work as they are intended, simply go unnoticed.


PUSH

DESIGNING WITH THE USER IN MIND

Unfortunately, there are some basic fundamentals to great design that are often overlooked or abandoned. Frequently, product design is compromised for reasons of cost effectiveness, novelty, or simply from a lack of understanding of its primary function. The designers at Plastic Concepts (Billerica, MA) specialize in fabricating products for laboratories, understand this and know that when designing custom-built products for any industry, it's important for the designer to design backwards, from the person, and to fully understand the intended use. They also understand that it is important to build a product that is both innovative and useful, as well as being understandable, long-lasting, and aesthetically pleasing. This is especially true when designing for laboratories that may have very specific material and design requirements.

BUILDING CUSTOM LABORATORY SOLUTIONS

Designing custom laboratory solutions requires both knowledge and experience, as well as a thorough understanding of the applications involved. Laboratories often require a variety of work surfaces and storage solutions that are durable, long-lasting, chemical-resistant, and easy to clean. In many cases, polypropylene and other plastics are ideal materials. Capable of producing virtually any type of product in any size or configuration, from tanks and totes, to cabinets and fume hoods—one of the key secrets to their process lies in a hidden element of design—the plastic weld.

ENGINEERING SUCCESS

On first impression, plastic welding may seem simple enough. Using a gun that heats air or nitrogen, the fabricator feeds plastic welding material through the gun and adheres it to whatever they are working on. However, not all plastic welds are created equal. Building an exceptional product requires experience, patience, focus, and a steady hand to get it right. Building a product for laboratory use requires full knowledge of the materials you are working with, the correct temperature and pressure, the manner in which the welding material is fed, the type of gas used, and the rate at which you use it. An error along the way can end up in a failed fabrication, or worse, a product that fails under use.

Laboratory products and furnishings often have to be built to withstand harsh chemicals, as well as to support heavy equipment and instruments. This requires both quality materials and design. When fabricating products for laboratory use or chemical storage, the fabricators at Plastic Concepts use a deeper chamfer than most to ensure a stronger weld. The chamfer, which is a 45 degree "gutter" that runs along the edge of the plastic material to be affixed to another flat surface, is critical to producing a strong weld. Essentially, the deeper the chamfer the more welding material will be added, and the stronger the weld will be. To build laboratory-grade products, the fabricators at Plastic Concepts lay down eight to 10 welding strips in each chamfer as compared to the two or three strips often used in regular consumer goods and offshore products destined for laboratory use.

ONE EXAMPLE OF GREAT DESIGN ACHIEVED

Great design solutions are often the product of simple necessity. An excellent example of this is the construction of a portable enclosure for neuroscientist at Children's Hospital Boston who were carrying out research on the effects on the visual cortex of varying light/dark cycles in groups of mice.

The challenge was that the researchers wished to study only a small number of animals housed in a facility with high cage density and limited space. In this situation, altering the light/dark cycle of an entire room was not feasible. The challenge was to build a light-tight portable chamber that allowed for monitoring of internal temperature and humidity. Further, the chamber needed to accommodate multiple groups of animals with different light/dark cycles, be portable, and easily sanitized.

Using polypropylene, as it is easily cleaned using liquid disinfectants, engineers at Plastic Designs developed a multi-unit chamber capable of holding either eight small mouse cages or six rat cages with the option to house both mice and rats at the same time. Doors had an overlapping gap seal to ensure light tightness, and upgraded versions of the sensors were developed to detect extremely low light levels (four lumens). Airflow was controlled by a filtered fan on the side of each unit, which ensured air quality equivalent to the surrounding lab. Lighting was provided by a 20-watt fluorescent bulb and temperature and humidity were monitored by a probe in each unit connected to a digital display.

Since development, Children's Hospital Boston has ordered three such units and report that the mice placed in these chambers remain healthy and show no signs of stress. This design, driven by necessity, has since been adopted by other researchers and the studies performed in these chambers have been published in multiple papers.

Finally, while many novice purchasers may be attracted to off-the-shelf products based on price, often these products suffer from inferior design, materials, and construction not noticeable to the user. Often products aren't designed with the end user in mind and, as mentioned earlier, are compromised for reasons of cost effectiveness, novelty, or simply from a lack of understanding of its primary function. At Plastic Concepts, each product is designed with empathy, within context and with collaboration and then fabricated with the best possible quality in mind.

They design and fabricate with the hope that their end product is so great that the end users never even notice.

This In Focus feature was crafted by Lab Manager*'s Creative Services Team and sponsored by Plastic Concepts.*

Planning a Successful Lab Renovation

ON-SITE FIELD OBSERVATION, VERIFICATION, AND DOCUMENTATION PROVIDE MULTIPLE BENEFITS **by Deborah Suzan Huff, SSOE Group**

A common challenge for laboratory renovation projects is the lack of existing or accurate documentation, such as building blueprints, maintenance records, and inspection reports.

Nonexistent or inadequate documentation necessitates on-site field review of existing conditions. Conducted by the design team during the planning and analysis phase of the project, on-site investigations may range from simple visual observation and manual measuring to full 3-D laser scanning and modeling.

Here are insights into on-site field observation, verification, and documentation that can save time, trouble, and money during the construction phase of a laboratory renovation project.

> "On-site investigations may range from simple visual observation and manual measuring to full 3-D laser scanning and modeling."

The problem

A lack of quality design documentation is a common issue in building renovation projects. Whether the project occurred 25 years ago or five years ago, more often than not, paper or digital files do not reflect the actual built condition; hard copies are misplaced or destroyed, and digital copies become corrupt or outdated as well.

Ideally, property owners, the architect or engineer of record, contractors, and authorities having jurisdiction should all retain paper and/or digital copies of the original building design and subsequent renovation documentation. However, over time, ownership might change, designers could retire, contractors may go out of business, and governmental organizations could change policy about document retention. Additionally, any available 2-D drawings may not reflect construction changes that took place in the field but were not amended. So, for any given renovation project, the accuracy of documentation is questionable, if it is even available.

A worthwhile investigation

On-site field investigation in the planning/design phase is frequently abbreviated or removed from the project scope altogether because it adds some cost and time; however, when included, an upfront survey and documentation of existing conditions will minimize frustration, delays, and added expenses during the construction phase.

Consider this scenario:

A single laboratory is undergoing modification to accommodate several large pieces of equipment. The existing cabinetry will remain but finishes and utilities are scheduled for upgrade. The design team was not contracted for an on-site visit but was provided floor plan drawings of the existing building. Review of the given documents indicated the corridor to be used for equipment transport appeared to be of adequate size for all required clearances.

Once the contractor receives the equipment on-site, preparation of the existing corridor for equipment

transport identifies a discrepancy that will prevent going forward with the planned installation. At some time, after the original building was completed and occupied, the corridor clear width was reduced by 18 inches to accommodate the expansion of an adjacent laboratory. The largest piece of equipment will not fit in the corridor for transport to the renovated laboratory.

> "For any given renovation project, the accuracy of documentation is questionable, if it is even available."

An alternate means to install the equipment is devised that includes a partial removal of the existing cabinetry, temporary removal of an exterior window, and the rental of a lift to install the equipment from the exterior. Once the equipment is in place, new cabinetry will be installed, the exterior window will be reinstalled, the crane will be removed, and the adjacent landscape will be repaired.

The added cost and time delay resulting from incorrect existing documentation could have been avoided through on-site verification of observed critical existing conditions.

Budgeting for design is crucial

Of note, construction documents are intended to convey expectations for a final product rather than the means and methods to construct said project. Often, the actual built conditions are not wholly reflected in the record documents. Therefore, a best practice approach to building renovations is to include time and funds for on-site investigation of existing conditions during the planning stage of design. Correct information acquired in the design phase could result in substantial savings during construction.

Since each project is unique, the scope of on-site investigation will vary. Sometimes projects require simple observation and recording of critical dimensions, or an

existing facility may have unforeseen conditions that warrant analytical investigation, testing (potentially destructive), and/or imaging. Where documents are missing or existing buildings have complex systems (e.g., extensive piping), 3-D laser scanning and modeling are available options.

Whatever the means, on-site investigation and advance planning are much less expensive than reacting to an unknown condition during construction.

"Often, the actual built conditions are not wholly reflected in the record documents."

On-site investigation saves tenfold

Consider another scenario: A second-floor laboratory renovation in an existing building includes the installation of a large, heavy piece of equipment that is sensitive to vibration. The design for the new unit involves a separate structural support system with a new equipment platform, foundation, and footings. Preliminarily, it appears that no additional modification of the existing structure or floor plan layout is required, as the unit will fit through an existing window opening per provided drawings. However, during a predesign site visit to verify existing conditions, site constraints are observed that interfere with the proposed equipment installation plan. Specifically, the unit will need to be loaded into the building by crane from the opposite side of the building.

Unfortunately, the proposed alternate installation plan introduces potentially significant additional costs to the project. First, the existing corridor must be large enough to accommodate the transport of the unit across the breadth of the building. If clearance is not adequate, partial demolition and subsequent new construction of existing laboratories adjacent to the corridor may be required. Second, due to the weight of the unit, a significant live load will be introduced to the existing building's structural system during transport. The construction of temporary structural shoring of the second floor plate along the first floor corridor is likely required. This will add cost and time to the project while also disrupting occupants on the first floor (e.g., through noise, lack of access, and use of spaces adjacent to the corridor during equipment installation).

Further on-site investigation (destructive coring and testing of the existing concrete structure) and observation of critical dimensions via field measurement were conducted. The tests confirmed that the existing structure was suitable to accommodate the temporary live load for the equipment transport and, with minor modifications to the existing corridor (temporary removal of a drinking fountain), the width was adequate to accommodate the equipment transport. So, by allotting funds at the beginning of the renovation project for on-site investigation, much added cost, time delays, and frustration were avoided.

Construction phase surprise brings costly trouble

In a final scenario, an existing building is relatively new, so on-site observation is removed from the design contract. Available documents indicate that gases are piped to each laboratory and subsequent workstations from a remotely located central supply room. The new laboratory

project will utilize the central supply room for gases as well, to save time and cost to the project by minimizing the amount of workstation cabinetry and installing new piping only within the laboratory proper.

During construction, the contractor discovers that gas piping and the central supply room were not installed as indicated on the original documents. As a value engineering measure, the piping and central supply room were eliminated in lieu of localized cylinder installation and use. Because the selected cabinetry is a long lead item, the new workstations were ordered prior to commencement of construction activity. The cabinetry is delivered to the project site and is ready for installation; however, the new units do not accommodate gas cylinders.

A solution is forthcoming to add piping and an adjacent cylinder storage room; however, because the discrepancy between documents and actual built conditions occurred during construction and not the design phase, the project will suffer overages. This includes time and cost associated with the design of a new piping system, review of the design by authorities having jurisdiction, acquisition of materials, rework of new construction to accommodate the storage room, and installation of the new piping system.

This situation may have been avoided if field verification had been included in the project scope.

Substantially save on your next project

Plan for a successful project. Allot time and funds for on-site field observation, verification, and documentation to avoid unwelcome surprises and save substantially in the long run.

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A Guide to Selling Used Lab Equipment

EDUCATE YOURSELF ON YOUR RESELLING OPTIONS, THE MARKETPLACE, AND YOUR INSTRUMENTS **by Erica Tennenhouse, PhD**

Laboratories often find themselves needing to shed some or all of their equipment, whether the lab is upgrading to newer instruments or shutting down its operation altogether. When it comes to selling used lab equipment, the more information you have about the item for sale, the market, and the available avenues for reselling, the better.

Octavio Espinosa, senior director of sales, marketing, and Reid Hjalmarson, director of marketing at BioSurplus (San Diego, CA) outline three main routes that their clients use when reselling lab equipment. First is direct purchase, in which a reseller will purchase the used item outright. Second is putting the item consignment; in this case, both parties—the used equipment vendor and the lab—share the proceeds from the sale. Third is putting the item up for auction. Which option to choose depends on the lab's particular needs; where a lab is looking to monetize assets quickly, they would benefit from selling equipment outright to resellers. But if time is less of an issue, consignment can yield a higher return. For labs that are selling large sets of assets—for example, if a facility is closing down—they may forego consignment because they are on a timeline, but want a better return that they could get from selling the items outright; in these cases, some companies, including BioSurplus, run auction events.

"We will take care of the whole thing, the lotting—the catalog, the marketing, the execution of the event and the backend shipment, and cleaning the facility—literally from start to finish," says Espinosa.

For labs looking to sell their used equipment, it is important to plan early, says Roger Gallo, CEO and president of EquipNet (Canton, MA). Labs should begin by establishing what they have. If time allows, Gallo recommends having a laboratory equipment specialist conduct a professional inventory, which leaves the lab with an itemized record of which items are owned and leased, which items must stay in the building, which can be redeployed to another location, what can be sold, and what the assets are worth to potential buyers. When it comes to selling lab equipment, knowledge is power.

> "Whether you're selling real estate, clothing, or lab equipment, merchandising is essential."

Labs should also consider how they showcase their equipment. "Whether you're selling real estate, clothing, or lab equipment, merchandising is essential," Gallo says. "Equipment stacked up in a warehouse is not going to look as attractive as items that are currently being used, doing the job they are meant to do.

Many companies opt to purchase expensive, new equipment directly from the original equipment manufacturer even when a similar pre-owned piece is available at a significant discount because they want to be sure they are getting all of the relevant ancillary items,

Gallo notes. Providing all of the accessories, software, and manuals is therefore a good way to maximize the value of a piece of pre-owned equipment.

The actual value that a used item will garner depends on a multitude of factors. Whether the item is functional, how it looks cosmetically, and how old it is are all part of the equation, but another important determinant of an item's value is the demand for it in the marketplace, says Espinosa. Some of BioSurplus' current "most-wanted" items include the Nanodrop, LC-MS and GC-MS systems, HPLCs, rotary evaporators, and ultra-low temperature cold storage.

> "The actual value that a used item will garner depends on a multitude of factors."

Lower-demand items tend to be those that are frequently being upgraded because the constantly-changing technology renders these instruments archaic in a short time period, says Hjalmarson.

With a good understanding of the channels available for reselling their lab equipment, the demand of certain instruments in the marketplace, and the pieces they plan to resell, labs can position themselves to maximize their return when they sell their used equipment.

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Managing Bench Spaces

ONLINE TOOL RENDERS LAB BENCH DESIGNS IN 3-D

by Steven Hopster

With new technologies and methodologies changing rapidly, laboratories today have adopted new processes in the way experiments are performed, discoveries are made, and tests are conducted. Perhaps more important now than ever before is the need for lab managers and lab architects to stay flexible in the planning of their lab design project, whether it is a new facility or the renovation of an existing laboratory.

Embracing flexibility in lab design can deliver significant cost savings. A testing laboratory at a large tech company was faced with financial challenges recently—but for good reasons. The lab division of the company, dedicated to testing top-line servers, saw its market share grow rapidly and determined it needed to expand its operations. The company estimated the cost of a building expansion at $100 million but instead turned to a Texas-based lab furniture manufacturing company for a more cost-effective option. The company developed and installed lab benches with hydraulic shelves to offer the flexibility of movement—up, down, forward, and backward. This enabled laboratory technicians who previously worked with three workstations, testing one server at a time, to utilize a single-unit workbench and server rack testing with four servers at a time.

Things to consider when designing your wet or tech lab:

Remain flexible in your choice and anticipate relocation

Fixed casework is considered a standard solution but often requires significant investment and downtime if modifications are needed. Modular furniture enables reconfiguration of the lab layout and efficient expansion for new usages while realizing space and cost savings. This is especially true at facilities with multiple laboratory units, where a "building block" approach helps ensure components can be repurposed as needed, affording maximum flexibility of space for future needs.

Most labs of any size inevitably need to relocate at some point. Whether within the same facility or across town, the move might be due to an expansion in project work, updated real estate/facility requirements, changes in technology, or the need to relocate to attract top talent. Modular lab furniture delivers time and cost savings through more convenient takedown and shipping options as well as greater flexibility in reconfiguring furniture components to accommodate the new laboratory layout. A potential bonus is that reutilization of the lab components is good for the environment and might earn your organization LEED sustainability credits.

CRITERIA	MODULAR LAB FURNITURE		FIXED CASEWORK
REPURPOSE	Countertops and cabinets are replaceable		Permanently installed
RELOCATE	Can be moved to any location		Permanently installed
MOBILITY	Mobile with added casters	VS	Permanently installed
PRODUCTION TIME	3 weeks & expedited shipping available		8-12 weeks – cannot be expedited
SHIPPING & INSTALL TIME	4-10 days (USA)		2-4 weeks (USA)
TOTAL COST	Less expensive than large casework projects		Less expensive than modular furniture for small projects

▲ *A comparison between modular and fixed lab furniture.*

Leverage time and cost savings

Time is crucial in your lab project work and it's vital in lab design planning as well. While it might sound like a truism, time is money. Modular lab furniture is typically produced, shipped, and installed in one-third to two-thirds less time than traditional, fixed (bespoke) lab furniture. Modular furniture has lower long-term cost of ownership than fixed furniture. According to a study performed two years ago that compared order sizes using casework versus modular furniture, the number of benches increased as modular furniture decreased in price. In other words, if the lab size is small, casework might be cost-effective, but as the lab size becomes larger, modular becomes cheaper.

> "Lab managers and lab architects [need] to stay flexible in the planning of their lab design project."

Toughness relates to value as well. To protect your investment in expensive equipment and accessories, ensure that the laboratory furniture you select meets stringent durability and safety requirements.

Utilize the correct materials and arrangement for lab benches

Key to an efficient and exceptional lab design is the selection of the lab bench, typically the workhorse of daily laboratory operations. Choosing the correct lab bench countertop surface is also vital as chemicals and substances can easily corrode a lab bench. The correct surface for the type of project work will ensure the durability and long life of the lab bench and the safety of personnel.

For wet labs, choose chemically resistant countertop surfaces for lab benches that are easy to clean and resistant to bacterial growth and corrosion.

"Reutilization of the lab components is good for the environment and might earn your organization LEED sustainability credits."

Three widely accepted choices for countertops are:

- **Epoxy resin**—Provides exceptional physical and chemical resistance required in cutting-edge laboratory environments.
- **Phenolic resin**—Is nonabsorbent and provides a high resistance to chemicals.
- **Stainless steel**—Consists of a low carbon steel that contains about 10 percent chromium, giving it unique stainless, corrosion-resistant properties.

Product Comparison	Phenolic Resin Countertops	Epoxy Resin Countertops	Stainless Steel Countertops
Application	Moderate	Heavy Duty	Moderate to Heavy Duty
Material	Paper & resin based	Silica & resin based	Metal Alloy
Corrosive Resistance	Moderate to High	High	Moderate
Carbon-based Resistance	Moderate to High	High	High
Heat Resistance	Moderate	High	High (discolors)
Moisture Resistance	Moderate	High	High
Bacteria Resistance	High	High	High
Impact Resistance	Moderate	Moderate	High
Lead Time	1 - 3 weeks	2 - 4 weeks	3 - 4 weeks
Investment	$$$	$$$	$$$$
	LEARN MORE	LEARN MORE	LEARN MORE

▲ *Countertop material choices based on applications and requirements.*

For cleanroom labs, choose stainless steel, epoxy resin, or phenolic resin. For electronic labs, surfaces with built-in electric dissipation capabilities will protect sensitive equipment being assembled or serviced from accidental damage from static shocks.

Many tech labs use electrostatic dissipation (ESD) equipment in their project work, and dedicated electrostatic dissipation protected areas (EPAs) are a necessity since static charges as low as 10V can damage sensitive components. Built-in ESD work surfaces provide distinct advantages over the portable ESD mats that were once popular. Compared with ESD mats that can easily become damaged from day-to-day occurrences such as working with chemicals and solvents directly on the mat or dragging heavy equipment across the surface, ESD workbenches offer dual layer high-pressure laminate (HPL) protection. Plus, the entire ESD workbench countertop surface is impact-, wear-, temperature-, steam-, and water-resistant. Cleanup is also simple since the bench surfaces are washable with an approved ESD worksurface cleaner.

"Choosing the correct lab bench countertop surface is also vital as chemicals and substances can easily corrode a lab bench."

With your lab furniture needs in mind and several options available, lab managers can now use an online option for evaluating different lab configurations. This new resource—3DConfigure, from Formaspace—enables users to generate photorealistic lab bench renderings in real time.

Lab managers and lab architects can customize products for current and future projects and receive free, same-day, online renderings of different lines of workbenches.

The online tool makes it simple to customize products, such as the selection of frame and surface countertop material, type and location of storage components and lighting, computer monitor mounts, height-adjustable components, anti-vibration, and ESD-resistant materials. Photorealistic renderings enable users to save and share custom configurations for future review as well as visualize lab bench options from all angles.

With labs needing to accommodate both current and future needs, flexibility is key. Innovative web applications help users visualize their lab layout and component options in real time.

For more information, go to www.formaspace.com/laboratory-furniture.

5 KEY FACTORS TO CONSIDER WHEN SELECTING LAB FURNISHINGS

The pace of research and development has greatly accelerated, and so has the need for well-equipped and efficient laboratories

Whether you are expanding your lab, setting up a new facility, or simply replacing outdated fixtures, there are a number of considerations when selecting laboratory furniture and casework. Investing in laboratory furniture and casework involves a deep understanding of the specific needs of the lab and the researchers that work there. However, selecting the correct laboratory furnishings can go a long way to improve workflows and enhance research.

1. PLAN, PLAN, AND PLAN SOME MORE

Selecting casework and fixtures for your lab goes beyond just getting the correct measurements and specifications. Before you place your order, you will need to consider a number of factors including features, materials, and durability. Full understanding how your lab space is being used today, as well as changes that might be forecasted in the future, enables lab managers and designers to select furnishings that are both long lasting and functional. Additionally, it's wise to consider planning for maintenance and upkeep of your furnishings— lab furnishings are a valuable investment for the long-term success of your lab.

When planning your layout and placement of furnishings, consider your work zones and traffic flow. Don't place your hazardous storage in high traffic areas, and be certain to place benches and key instruments and equipment so that staff aren't continually bumping into each other. By investing in some early strategic planning, you will avoid hassles and hazards in the future.

2. DESIGN FOR FLEXIBILITY

For some labs with fixed numbers of samples and testing requirements traditional lab setups may be sufficient. However, for most researchers, fluctuating sample qualities and changing requirements is the norm. For such labs, adopting a flexible design may be the wisest course of action. Flexible lab furniture allows you to quickly reorganize your lab and restructure your workflows at any time. These adaptable workspaces allow lab managers to quickly expand or reduce their operating size, optimizing both workflow and worker productivity. Further, the ability to move typically fixed objects such as benches, cabinets, and fume hoods is certainly more convenient and cost efficient than a full renovation.

3. DON'T SACRIFICE QUALITY

The quality of your laboratory furniture and casework is an important consideration when equipping your lab. Materials used must be appropriate for the tasks at hand, durable, and long-lasting. In many cases, your lab

"Flexible casework and furnishings allow labs to scale up or down as projects and staffing needs change"

"Great laboratory design has the ability to enable great research"

furnishings will be in use for a decade or more, so it's important to consider the quality of the materials and construction prior to placing your order.

Popular materials for lab furnishings include metal, plastic laminate, polypropylene, stainless steel, and wood. Metal furnishings and casework are sturdy and long-lasting, but often more expensive than more fragile plastic laminates. Polypropylene furnishings offer easy customization and high durability making it a good choice for chemical stations and acidic environments. Stainless steel's versatility and easy cleaning make it a good choice for labs where hygiene is of utmost importance. Wood furnishings offer affordability with high visual appeal and still remain popular among academic and teaching labs.

4. CHOOSE SIMPLE, EFFICIENT DESIGNS

Great laboratory design has the ability to enable great research. Prior to designing or redesigning your laboratory space, it is important to fully understand how your furniture design and layout can promote productivity and efficiency. Investing in layouts and furnishings that consider both functionality and ergonomic principles will result in a more healthful and productive lab.

Adequate lighting, instrument placement, and surface heights are all important elements to consider when designing for productivity. Furnishings that require workers to reach, bend, or stretch excessively are clearly undesirable. Ease-of-use is an important aspect of design. Researchers and technicians are often involved in solving difficult problems or engaged in focused tasks. They really should not invest their time trying to figure out how to adjust seating heights or open storage cabinets. Simple intuitive furnishings, without unnecessary embellishments or functionality, are often the best choice.

5. FIND COST EFFICIENCIES

Regardless of industry, most labs today are faced with increasingly shrinking budgets. When expanding, renovating, or setting up a new lab, many lab mangers feel they need to sacrifice design, innovative technologies, or sustainability to remain on budget. However, through continuous and early cost planning, most projects can be kept within their budgets.

One of the keys to success is "right-sizing" the lab. By investing in flexible laboratory furnishings, labs can scale up or down easily as projects and staffing requirements change. Before doing a 100% build-out to include specialty lab space, it's often prudent to simply start with infrastructure (power and utilities) and grow into the space as needed. Adding flexible casework and workstations is a simple task, and suppliers like Fisher Scientific have in-stock inventories with their Fisherbrand™ quick-ship options to avoid incomplete shipments and unnecessary wait times.

This In Focus feature was crafted by Lab Manager*'s Creative Services Team and sponsored by Fisher Scientific.*

Connecting Laboratory Instruments

INTERFACE STRATEGIES DEPEND UPON COMPLIANCE REQUIREMENTS

by David Strauss

It would be great if there was a one-size-fits-all interface solution, but reality is never so simple. The optimal instrument interface is dependent on your compliance requirements, the instrument, the integration outcomes, and, of course, the amount of effort you wish to expend. In this article, we will define the interface selection criteria and then discuss interface options.

Interface Options	Security	Integration Potential	Setup Difficulty	Extraction Difficulty
Print & Scan	Medium	Low	Low	NA
File Share	Low	High	Low	Depends
Real Time Serial or IP	High	High	Medium	Medium
Database Query	High	High	High	Low
Enterprise Content Management	High	High	Very High	Low
Direct Printer Capture	High	Medium	Low	Depends

Selection criteria

Security is defined as the opportunity for data tampering. For compliant labs, data custody throughout the interface activities is required by either physical or procedural processes. If compliance is not required, simpler, less costly options can be selected.

Integration potential is the ability to extract specific data from the instrument output. The low end of the spectrum is essentially qualitative information such as a scan or picture of the instrument data. The high or quantitative end of the spectrum is a well-structured data source from which individual results with full context can be extracted. The end user requirements should drive selection of this option. There is no need to employ a more complex option if qualitative information is sufficient.

Setup difficulty is a measure of how much effort is required to connect the instrument.

Extraction difficulty is relevant only in quantitative interfaces and is determined by how well the interface data is structured. Report files are often more difficult to parse since the information is highly formatted for readability. Report files are also a maintenance concern since unusual information can result in parsing errors. In increasing order of structure: csv, xml, database table, database query, web service.

Interface options

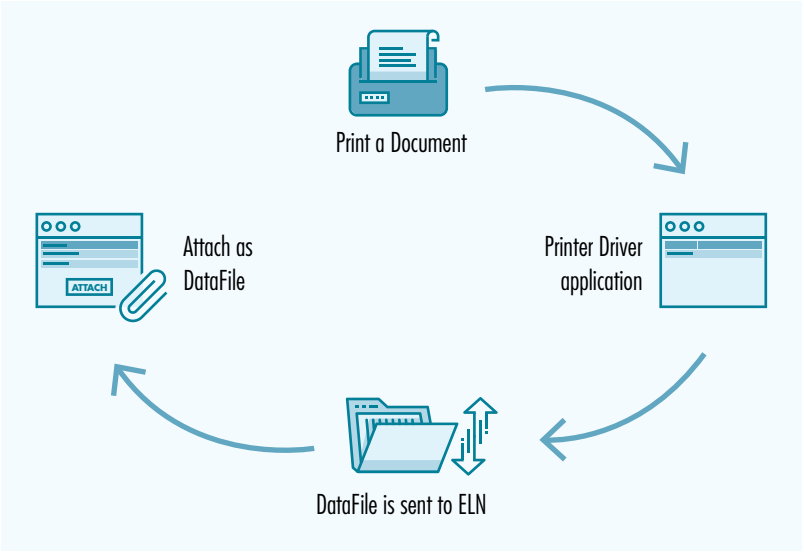
Print & scan

Historically, scientists obtained printed reports from instruments. The reports were sized and pasted into paper notebooks. With the advent of LIMS and ELN, the paper reports could be scanned and attached as electronic media within a compliant audit-trailed solution. This interface option is supported by most instrumentation and is relatively easy to implement. Setup is limited to purchase of a scanner and a secure compliant storage solution. This interface option does have some large negative aspects, however. Quantitative data extraction is not likely, and individual data points must be manually transcribed, with the potential for transcription errors and, of course, more scientist effort. Lack of searchability is another negative aspect of the print & scan interface. Although it is possible to deploy textual search tools against scans, these tools are not 100 percent effective

and cannot be considered validated. Finally, security is a concern as the printed documents may be modified and the scanned files may be manipulated prior to attachment. Print & scan should be deployed only if the other interface options have been exhausted.

Direct printer capture

The next step up from print & scan is direct printer capture, which uses a custom printer driver to capture the instrument report output and then stores the resulting electronic file in a secure space.



A custom printer driver or a printer application (utilizing the same technology as software such as the Adobe PDF driver) is designed to immediately send "printed" files to secure storage. Printer drivers are compatible with virtually any Windows application that can print files, making this an extremely viable tool. It also provides greater compliance to regulated environments as there are rarely intermediary "stops" for the files. A custom printer driver can also provide the instrument output in text format to facilitate parsing of individual data points.

If the printer driver is not directly connected to secure storage there will be a gap in security while the file is "parked" on a local drive or file share.

Direct printer capture is a secure interface method, applicable to most instruments and with the potential to extract quantitative information.

File shares

A network file share, such as Dropbox, is easy to set up and use and can handle all file formats, including Word and Excel. File shares allow files to be easily shared among groups of people. Accessibility is both a positive and a negative characteristic. It is essential to employ a robust access control list on a file share that allows users to write files but restricts modification or deletion. Backup and archival processes must be well defined and adhered to.

File shares are ubiquitous across most organizations but controlled/secure shares are rare. File shares are the go-to option for labs that do not have storage solutions such as LIMS, ELN, or content management systems.

"Real-time" instrument interface

Another way to connect instrumentation to an ELN is through a direct connection to the device itself. Real-time interfaces are typically established using a serial (RS-232) or network connection to either a LIMS or ELN solution. Real-time interface provides immediate data capture from the instrument directly to the LIMS or ELN solution. The authenticity of the data is implicit as there are no steps between the instrument and the ELN application. Once the instruments are interfaced appropriately, there is rarely a problem, but getting them set up is a little more difficult than the previous strategies mentioned. It is important to note that the setup of a "real-time" connection varies between instruments and can depend on the vendor and model. Some instruments may have only a serial connection, whereas others have network connections available.

Special hardware to convert serial output to an IP connection prevents any hard-wiring that would otherwise be necessary. Expertise is often required to get these connections to work initially.

Parsing the instrument data stream is required with specific drivers capable of "understanding" the stream of data coming from the instrument and being able to translate it into a human-readable format.

Database querying

Other instruments produce massive amounts of data and are extremely complex, almost forcing a connection straight to the instrument database. Examples of this would be Empower, tiamo (connecting to Oven KF devices), or any application that stores scientific data. We refer to these as "application to application" interfaces. The idea is that an application, your ELN, could access the instrument database and retrieve the data in a meaningful way. One of the advantages to this is that the application has access to large amounts of raw instrument data. However, when working with data generated by third-party applications, it is important to understand the database structure, which, even for the same application, is likely to change from version to version. Also, there is the possibility that an ELN may not be granted access or given support when attempting to connect to the database. Remember, these database companies are also trying to sell services and getting your ELN connected may be costly. This doesn't even include what it may cost the lab just to set up.

Today, the "big data" paradigm is well established. Using this paradigm, data shall be shared across systems and organizations, and specialized data sources should be designed to be consumed and accessed by different systems and applications.

To solve this, SciCord has created SciMart, a type of data mart to provide relatively simple analysis-specific tables, which can be produced by scientists with just a little bit of basic IT knowledge. To create the data mart, rather complex queries are executed for each data mart table. These queries are CPU intensive and must be run during off-hours to avoid loss of production

system performance. Despite this very minor limitation, these queries are able to turn generic results tables into specific analytical tables.

Enterprise Content Management system

Enterprise content management (ECM) systems, such as Agilent OpenLab, MasterControl, Documentum, and SharePoint are designed to store and manage process documentation for laboratories. An ECM is capable of storing large amounts of company files, which can enhance business processes. ECMs contain powerful security features and are more controlled than the file share method we described earlier. They are a popular choice for highly regulated industries, such as pharmaceuticals.

With this greater security, it may be more difficult to access, adding a layer of complexity between the ECM and the ELN. How does the authentication work? Is it as simple as usernames, passwords, and being granted permissions? One of the easier scenarios would consist of a simple HTTP connection (usually implemented through temporary links), but this is not common; more than likely, a custom interface module will need to be developed to interact with the ECM and obtain the data.

Despite all of this security, an added benefit is that once the data is validated (reviewed and approved), there is no need to duplicate parts of the process to ensure data accuracy, as this has already been completed.

Parsing files

Most of the above examples rely on the parsing of files. The exclusions would be real-time interfacing methods and some forms of database interfacing, but even these may require some parsing or data translation. Parsing files is an automated process that reduces the work of the scientist or reviewer, and limits the possibility of transcription error. In fact, as long as the parsing is being done correctly, there shouldn't be any possibility for transcription error, unless some formatting has changed that would make the mapping incorrect.

To parse files, it is necessary to have experience mapping data, as the data needs to be directed to the appropriate areas within a template or ELN document. If an input format changes, then it is possible that the parsing component will need to be made aware of this, otherwise there will be a disconnect between what is searched for and what is returned.

Conclusion

Instruments vary and the ways in which instrument data is obtained also varies. Who knows whether it will ever be universal, but for now, you must consider several of these methods and find the solutions that work best for you and your lab.

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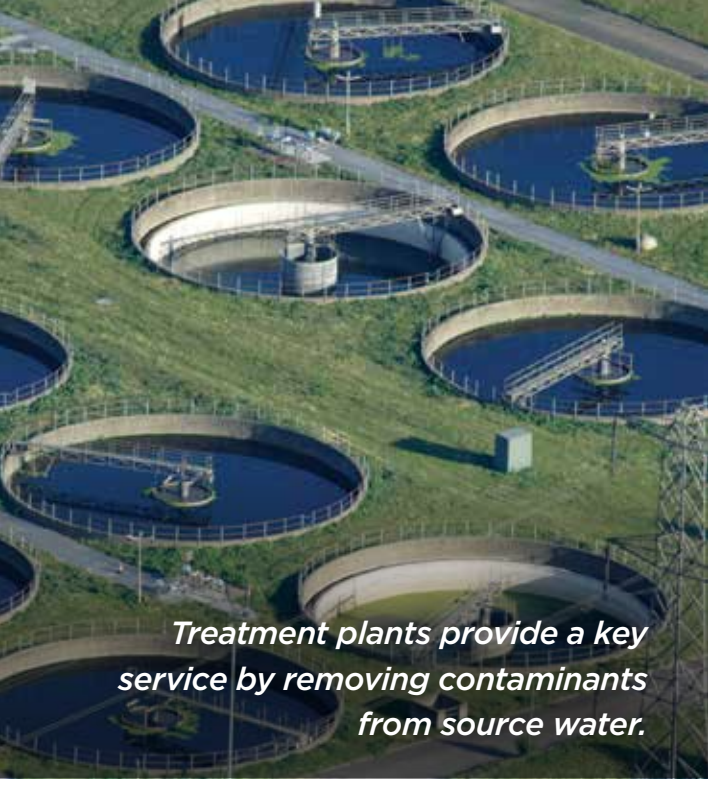
DO YOU KNOW WHERE YOUR WATER HAS BEEN?

The long journey from source to tap

Water is the essence of life on Earth. The majority of living organisms are made up of mostly water—the average adult human, for example, is composed of about 60 percent water. We also use large quantities of water in our daily lives. Approximately 400 billion gallons of water is used in the U.S. on a daily basis for a variety of purposes. In our homes, we use it for drinking, cooking, bathing, laundry, and landscaping. In industry, water is used for sanitation and to produce commodities such as paper, chemicals, refined petroleum, and food. Our heavy reliance on water is underscored by the fact that we can only survive a week without water, compared to our ability to live for a month without food. Yet nearly two billion people worldwide lack access to clean water. In the developing world, 80 percent of illnesses are water-related. Water contamination issues are not exclusive to developing countries though. Three-quarters of people in the U.S. live within 10 miles of polluted water.



Treatment plants provide a key service by removing contaminants from source water.

The treated water then travels through an underground system of pipes, pumps, valves, and storage reservoirs to eventually reach our homes.

WATER'S HIDDEN JOURNEY

Before it gets to our homes, water takes a hidden journey that begins at the source [see infographic: From Source to Faucet]. Water sources include surface water (rivers, lakes, and streams), ground water (aquifers that lie underground), and waste water from our homes that gets treated.

When it rains or snows, the precipitation percolates into aquifers and trickles into bodies of surface water. From these sources, water either gets pumped or flows by gravity into a treatment plant. At the plant, the water is treated via a number of processes specific to the relevant town, state, or federal guidelines. An example process involves water passing through screens to remove debris before being exposed to an agent that causes fine particles to coagulate. The water is transferred into large tanks where those solids sink to the bottom and get removed. The water then passes through sand filters, gets sterilized with chlorine, and is treated with fluoride. After treatment, water is stored in tanks and distributed to our homes through an underground system of pipes, pumps, valves, and storage reservoirs.

In some rural areas, homes may not have connections to municipal water and homeowners rely instead on water extracted directly from the ground into their wells. The layers of rock and sand that the water moves through on its way to the well act as natural filters.

Throughout its journey, water has many opportunities to become contaminated. Industrial waste is sometimes dumped into rivers and lakes, or directly into the ground. Pesticides applied to lawns and farmland can enter surface water and groundwater in large quantities. Aging pipes are susceptible to buildup of bacteria. When you flush your toilet, the wastewater ends up in a septic system that discharges effluent to shallow groundwater, which is a common source of contamination. Chemical compounds in prescription drugs can end up in local water supplies if they are flushed or thrown in the garbage. Fats, oils, and grease can produce toxic by-products and accumulate in sewer pipes, hindering wastewater from flowing freely to treatment plants. The list goes on.

Did you know?

Growing a day's food for a family of four requires around 6,800 gallons of water.

TESTING THE WATERS

While treatment plants provide a crucial service by removing contaminants from source water, they don't always do a perfect job. It's not uncommon to come across

To ensure that water has been properly treated, water samples must be collected and transported to a lab for testing.

Following solid phase extraction, extracted analytes are quantified using a variety of analytical methods and data is validated prior to reporting.

news reports about communities being subjected to unhealthy levels of contaminants in their drinking water.

It is therefore important that treated water be rigorously tested before it is deemed safe to use. Water samples must be collected from treatment plants, storage facilities, distribution networks, and points of use, stored under proper conditions, and transported to a lab. Once in the lab, the sample preparation step serves to separate contaminants from the water matrix. Those contaminants are then quantified using analytical methods such as chromatography and mass spectrometry. Finally, the resulting data must be validated and properly reported.

Did you know?

Over 90 percent of the world's supply of fresh water is located in Antarctica.

A modern technique that is utilized for separating analytes from aqueous matrices is solid phase extraction (SPE). Compared to liquid-liquid extraction, SPE uses less solvent, generates less waste, reduces the operator's exposure to harsh solvents and solvent vapors, and eliminates the chance for forming emulsions.

EFFECTIVE SOLID PHASE EXTRACTION REQUIRES THE RIGHT SYSTEM

To measure the concentration of oil and grease in water, n-hexane is often used to extract oils, greases, and other hexane-extractable materials from samples. Horizon Technology's SPE-DEX® 3100 offers several useful features for extraction of hexane-extractable analytes from water:

- A dedicated controller with pre-loaded methods streamlines method development
- The compact footprint saves valuable bench space
- Flexible to accommodate 47 mm and 90 mm SPE disks
- Highly efficient extractions reduce solvent usage and generate less hazardous waste
- Built-in sensors and safety mechanisms enable worry-free, unattended operation

Solid phase extraction is also used routinely in a variety of applications where volatile and semi-volatile compounds must be quantified in aqueous sample matrices. When preparing these samples for analysis,

A modern technique for separating analytes from aqueous matrices is solid phase extraction (SPE). Compared to liquid extraction techniques, SPE uses less solvent, generates less waste, reduces the operator's exposure to harsh solvents and solvent vapors, and eliminates the creation of emulsions.

Horizon Technology's SPE-DEX® 5000 offers the following features:

- Intuitive software streamlines method development
- Rugged hardware to tackle samples with varying levels of particulates
- Accurate solvent delivery results in superior analyte recovery and reproducibility
- Minimal maintenance reduces downtime and overhead costs
- Automated, unattended operation maximizes throughput and productivity

This In Focus feature was crafted by Lab Manager*'s Creative Services Team and sponsored by Horizon Technology.*

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Cover Up!

EFFECTIVE PPE RELIES ON GUIDANCE, CONSISTENCY, AND PROPER USE

by Vince McLeod

Modern laboratories today contain serious threats to worker health and safety. Whether from biological agents or blood-borne pathogens, toxic or hazardous chemicals, or physical hazards from dangerous equipment such as autoclaves, centrifuges, or sterilizers, we, as lab managers, know that accidents happen. Here are a couple of examples from our recent experience:

A researcher using strong nitric acid suffered only minor burns thanks to his knowledge of proper procedures and the location of a nearby safety shower, and quick action by fellow lab workers. While pouring acid from a standard four-liter glass container into a smaller container, he spilled acid on his lap. He quickly made it to the safety shower in the hall outside the lab with assistance and proceeded to remove his shirt and pants while drenching himself under the shower. Although his clothes were destroyed, he received only minor burns to his stomach and upper thighs.

A researcher was burned on the hand and upper arm when she accidently knocked over a Bunsen burner while sterilizing samples in a clean flow bench. Alcohol quickly spread over the bench work surface and ignited the researcher's lab coat sleeve as she tried to wipe up the spill. Fortunately, the safety shower was nearby and the coat sleeve was quickly extinguished.[1]

The two incidents above are all too common, but serve to demonstrate a point. In the first, no lab coat was being worn. In the second, a lab coat was being worn, but gloves were not being worn. When are lab coats necessary? When should gloves be worn? What types are best? We hope to answer these and other questions in this month's Safety Guys column.

The Occupational Safety and Health Administration's (OSHA's) excellent publication, *Laboratory Safety Guidance*,[2] discusses the preferred hierarchy of controls. Prioritized from most effective to least effective, these are:

- Engineering controls
- Administrative controls
- Work practices
- Personal protective equipment (PPE)

Examples of engineering controls include ventilation, machine guarding, biosafety cabinets, ventilated work stations, and anesthetic gas scavenging systems. Administrative controls simply modify workers' schedules to minimize potential exposures. Work practices are designed to limit or reduce duration, frequency, or intensity of potential exposures. Examples would include substitution of less hazardous materials or changing procedures to safer methods. PPE, known as our last line of defense and the least effective, requires use of protective gear or equipment to put a barrier between the worker and the hazard.

Although controlling a hazard at its source is the first choice, engineering controls are not perfect. PPE is our last defense because it means the hazard is actually present—and without PPE, hazardous exposure or injury will likely occur.

Protection concepts are built into current OSHA standards, are found in 29 CFR 1910 Subpart I, and are covered by at least 11 separate standards. We are focused on 29 CFR 1910.132, Personal Protective Equipment.[3]

The Occupational Safety and Health Act of 1970 states our mission simply, "To assure safe and healthful working conditions for working men and women." The PPE standard states employers must determine whether PPE

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should be used to protect their workers, and if PPE is to be used, requires documentation that the equipment selection is based on the hazard, that employees are provided properly fitted equipment, that they are trained on the equipment assigned, and that the equipment is kept in good repair.[3]

PPE determination

The first step in identifying hazards and proper controls is conducting a thorough job hazard analysis (JHA). A thorough JHA will identify the potential risks associated with each particular job and devise ways to control or eliminate them before an injury or accident occurs. The JHA technique looks at the individual tasks connected to a job and identifies controls for the hazards in each job step. When the hazard cannot be removed or controlled adequately, for example, unexpected splashes or spills, PPE must be used. The JHA uses a system that considers each body area: eyes, face, head, hands, feet, ears/hearing, respiratory system, and whole body.

Determining exposure from toxic materials is usually performed and entails air sampling and analysis that is best conducted by a safety and health professional such as an industrial hygienist.

Basic laboratory PPE

We recommend setting basic PPE requirements for all laboratories. Included are long pants, closed-toe shoes, lab coats, and safety glasses. The primary piece is the lab coat, and the selection must be based on expected hazards. We would recommend serious consideration of new-generation, multihazard lab coats. Those offering both flame resistance and chemical splash protection cover many potential common incidents and are economical.

Add gloves to your basic outfit if prevention of skin contact and contamination is needed. Consult chemical compatibility charts (available from all major chemical glove manufacturers or distributors) before deciding on type and material.

A note on PPE fitting

Remember that employees need a choice of several different PPE options (that meet the safety requirements) in order to select for personal comfort and preference. If PPE does not fit properly, its use and effectiveness are often drastically reduced. OSHA provides good assistance through the use of eTools and other guidance.[4]

PPE use training

Workers need to know when PPE is necessary and what tasks or areas require use of PPE. This should be spelled out in your JHA and list all the PPE required for specific tasks. When training employees on PPE use, be sure to show how to properly check, put on, take off, adjust, and wear the assigned PPE. Training should also cover the limitations of PPE. PPE gear is specific for the anticipated hazard(s). Misunderstanding or confusion can lead to more serious injuries, or worse. Workers must have a thorough understanding before using any PPE.

Remember to include proper care, maintenance, useful life, and disposal of PPE. OSHA inspectors will often quiz

workers to see whether they understand why they are wearing PPE, the hazards they are protecting themselves against, and how they care for and store their equipment.

Follow-up, auditing, and revising

Proper maintenance of PPE is paramount to protecting the worker. Poorly maintained or dirty equipment puts workers in greater danger. Conduct regular checks of workers' PPE to ensure equipment is handled appropriately.

Monitoring or auditing the program on an ongoing basis is very important. Thoroughly investigate any accidents or near-misses involving the use of PPE. Use findings to support safety committee meetings and discuss case studies.

PPE is very effective in preventing injury. But it is also the most vulnerable to failure, as it relies on consistent and proper use by the worker every time. If you devise and apply solid PPE guidance, your employees will maximize protection.

Vince McLeod *is an American Board of Industrial Hygiene–certified industrial hygienist and the senior industrial hygienist with Ascend Environmental + Health Hygiene, LLC, in Winter Garden, Florida. He has more than 35 years' experience in industrial hygiene and environmental engineering services, including 28 years with the University of Florida's Environmental Health & Safety Division. His consulting experience includes comprehensive industrial hygiene assessments for major power-generation, manufacturing, production, and distribution facilities. Vince can be reached at vmcleodcih@gmail.com.*

Resources:

1. *Lab Safety Incidents*, personal communique, Environmental Health and Safety Division, University of Florida, Gainesville, FL.
2. *Laboratory Safety Guidance*, US Department of Labor, Occupational Safety and Health Administration, Washington, DC, 2011. https://www.osha.gov/Publications/laboratory/OSHA3404laboratory-safety-guidance.pdf
3. Personal Protective Equipment, US Department of Labor, Occupational Safety and Health Administration, Washington, DC. http://www.osha.gov/SLTC/personalprotectiveequipment/index.html
4. Eye and Face Protection eTools, eMatrix, Expert Advisors and v-Tools, US Department of Labor, Occupational Safety and Health Administration, Washington, DC. https://www.osha.gov/SLTC/etools/eyeandface/index.html

The Ins and Outs of Lab-Developed Tests

ADDRESSING NEEDS UNMET BY FDA-APPROVED ASSAYS

by Mike May, PhD

The U.S. Food and Drug Administration (FDA) describes a lab-developed test (LDT) as an *in vitro* diagnostic "that is intended for clinical use and designed, manufactured, and used within a single laboratory." Though it's straightforward in theory, such a test can be complicated in practice.

"In one sense, the definition of an LDT is very simple," says Dennis Dietzen, president of the American Association of Clinical Chemistry and medical director of the core laboratory and metabolic genetics laboratory at St. Louis Children's Hospital. "It is any test that has not gone through the FDA approval process." But he points out important details regarding LDTs that come into play. For one thing, he says, "LDTs may be minor modifications of FDA-approved assays or they may be incredibly complex systems consisting of a variety of raw materials and instrument systems that have not been previously deployed in a clinical laboratory setting."

> "These assays are not for the faint of heart."

Despite all the ins and outs of LDTs, a few things hold them all together. Any LDT is developed analytically, validated clinically, and monitored in a single laboratory.

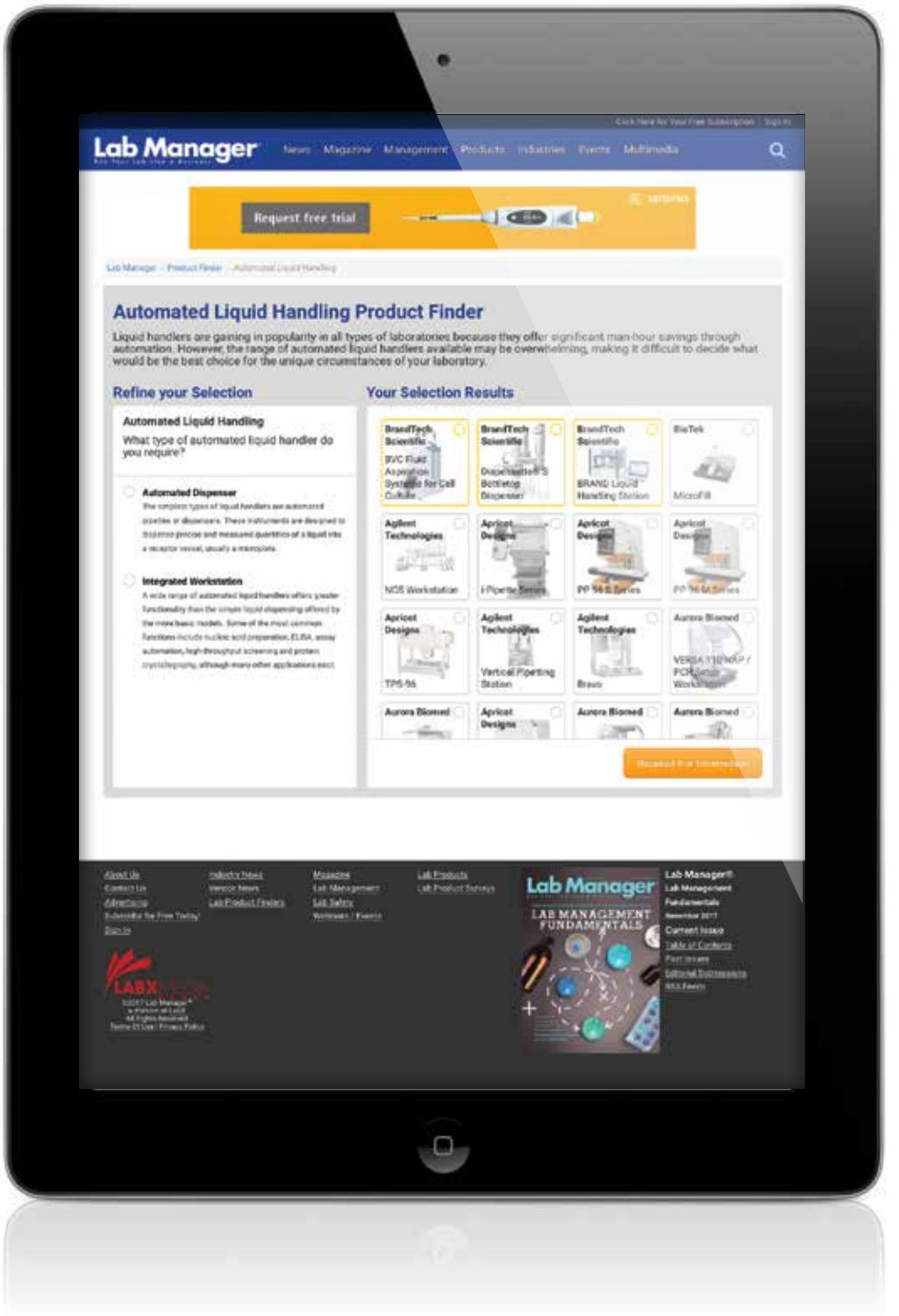
The breadth of LDTs explains, in part, the growth of this market. In June 2017, BCC Research's study on LDTs, "Laboratory-developed Testing: Technologies and Markets," indicated a world market of about US$9.7 billion in 2015 and an estimated increase to $14.9 billion by 2021. This report indicated that the LDT market is changing because of "a variety of technological, financial, and regulatory factors that will shift the testing mix and drive higher usage of these tests within the wider clinical diagnostics marketplace."

MEETING NEEDS

Overall, LDTs can fill the spaces where FDA-approved assays don't exist or fail to meet all of the needs of analytical labs. LDTs "may be designed to meet more unique and/or stringent analytical performance specifications, or alternatively, claims that are not otherwise addressed by commercially available kits," says Jonathan Genzen, clinical chemistry section chief at ARUP Laboratories (Salt Lake City, UT), a national clinical and anatomic pathology reference laboratory. He adds that these tests often embrace emerging technologies and support innovation in healthcare, particularly in areas of unmet need.

A variety of specific features of LDTs also come into play, and one is speed. As medical needs evolve, an LDT can be developed and in use by clinicians long before anything could go through an FDA process. "A good example of this situation is drug screening," Dietzen says. "New illicit compounds often cut with other harmful compounds consistently surface throughout the country." In such cases, a lab with mass spectrometry capabilities could develop an LDT to test for the new compounds that could be used in days or weeks.

LDTs can also be used as a safety measure of sorts. "FDA approval does not mean that a test is perfect," Dietzen



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▲ *A range of technologies and instrumentation can be used in a laboratory-developed test. (Image courtesy of ARUP Laboratories.)*

explains. "Many FDA-approved assays are flawed, and LDTs are an important remedy for these flaws." As an example, he talks about immunoassays designed to target 25-hydroxyvitamin D. These tests also detect a number of closely related compounds that are biologically different in their actions from 25-hydroxyvitamin D. "Multiple LDTs have been developed in local laboratories to improve the analytic specificity of this particular test," he says.

LDTs also play an important role in rare disorders and diseases that lack a commercial diagnostic test. In these cases, the financial incentive is not large enough to attract most of the large diagnostic or pharmaceutical companies. Nonetheless, smaller labs might make LDTs for these conditions.

Take, for example, phenylketonuria (PKU). People with this inherited disorder—appearing in one of tens of thousands of births, varying with ethnicity—lack an enzyme that breaks down the amino acid phenylalanine. So, someone with PKU must follow a strict diet. In many countries, newborns get screened for PKU. "The diagnosis and monitoring of phenylketonuria," Dietzen says, "is exclusively dependent on LDTs in a number of specialized pediatric laboratories."

SIFTING THROUGH REGULATIONS

As with many aspects of regulations, this part of LDTs can be a little cloudy. Some organizations call an LDT a device, but others call it a service. "This argument has been going on for a few decades," says James Boiani, a lawyer in the healthcare and life sciences practice at Epstein Becker Green (Washington, DC). "But at this time, if your device/service is an LDT, you would not need to worry about regulation by the FDA—no FDA premarket approval, no FDA requirements on advertising and promotion, no compliance with FDA quality system manufacturing requirements, etc."

Some of the regulatory actions can depend on how an LDT performs. A safe LDT attracts less attention. "If an LDT poses an imminent and serious risk in [the] FDA's estimation, it may look for ways to assert jurisdiction or at least influence the use to reduce perceived risks," Boiani states.

How samples get collected for an LDT might even impact the role of regulators. For example, if an LDT's collection technology is not FDA-approved, the regulator might use that angle to look into the entire assay. As Boiani explains, the regulator could say the FDA is not regulating the LDT but is regulating the collection device. He adds, "It is something to keep in mind if a lab gets into the business of distributing collection kits."

Lastly, the FDA is not the only regulator involved with LDT processes. States can develop their own processes for reviewing LDTs. "The Federal Trade Commission, which is interested in protecting consumers and protecting fair competition, can get involved if claims are not adequately substantiated," Boiani says. Payment issues can pull in other organizations, including the Centers for Medicare and Medicaid Services and state regulators. These are just a few examples of regulators with potential interests in LDTs.

DETAILS IN DEVELOPMENT

Given such a wide range of potential LDTs, the complexity of making one varies—not surprisingly—considerably. Some can be pretty easy to create, but that's not the case with most of them.

Despite the differences from FDA-approved assays, LDTs still live in a strict regulatory environment. "When developing an LDT, it is important to understand that you are accepting responsibility for establishing all performance specifications described in regulations promulgated under the Clinical Laboratory Improvement Amendments of 1988 [CLIA]," Genzen explains. "Many developers of LDTs have also begun embracing more stringent design controls and quality system requirements in anticipation of additional federal—for example, the FDA—oversight in the future."

Even the existing expectations for an LDT take considerable time and effort to establish and maintain. As Dietzen notes, an LDT maker must evaluate the purity and availability of raw materials needed for the assay. In addition, a lab might need to prepare calibration and quality-control materials, which must be monitored for stability. Any instrumentation that is part of an LDT must be robust and capable of precisely measuring crucial parameters, and the entire process must work as described and over time.

But that's not all. When creating an LDT, pre-analytic variables affecting test results must also be scrupulously defined, Dietzen says. Plus, any limitations of an LDT must be clearly communicated to physicians.

Even the wording in the general description of an LDT matters. For example, what meets the criterion of a "single laboratory"? Does this mean one actual lab space from a physical perspective, or does it mean a lab company, even one with multiple locations? Also, could a lab involve a third party, such as a contract manufacturer? "FDA officials have sometimes taken a very narrow view that the LDT needs to be developed, manufactured, and used in a single brick-and-mortar facility," Boiani explains. "I don't think that's consistent with the historical understanding, however, and that generally a product being developed and used within a single company with CLIA labs arguably meets the definition of an LDT or is close enough that [the] FDA won't raise an issue."

WHY MAKE AN LDT?

Genzen describes ARUP's Automated Core Laboratory as a high-volume laboratory, where the first choice of a test is an FDA-cleared or -approved one. "We develop and perform LDTs when there are not commercial assays available or when we can obtain more desirable performance specifications by developing the test ourselves," he says. As an example, he points out that many mass spectrometry-based LDTs can provide lower limits of quantification than commercially available immunoassays can. Consequently, mass spectrometry is often a preferred method in clinical guidelines. "As a clinical laboratory," Genzen says, "we want to offer testing consistent with these standards of practice." He adds, "I'm also involved in evaluating modified FDA-cleared or -approved assays, which is often required for body-fluid testing, when diagnostic companies usually do not validate specimen types other than serum or plasma."

As these examples show, implementation of LDTs can present unique challenges. As Dietzen says, "These assays are not for the faint of heart." So LDTs should be considered only when the clinical benefits outweigh the burden of development and maintenance. That is, a lab should consider developing an LDT only if the need is there and the lab personnel can complete the necessary steps in creating, testing, and maintaining an assay. In successful cases, an LDT can change and save lives, but an LDT gone wrong can be misleading and potentially harmful to patients.

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Alejandro Amador

ASK THE EXPERT

TOXICOLOGY TESTING IN THE OPIOID EPIDEMIC ERA by Lauren Scrudato

Alejandro Amador, chief operations officer of Ammon Labs, is an ASCP-certified clinical laboratory technologist with experience in chemistry, endocrinology, immunology, microbiology, molecular genetics, and toxicology. He is proficient in liquid chromatography-tandem mass spectrometry (LC-MS-MS) method development, assay validations, and statistical analysis. Additionally, Amador has substantial experience in clinical laboratory management and has been an integral part of Ammon Labs' substantial growth over the past year. Amador is a graduate of Rutgers University in New Jersey.

Q: What kind of narcotics testing does Ammon Labs most commonly do?

A: We are a full-service lab, and we encompass all major disciplines in a clinical lab. However, our main focus since inception has been toxicology. We run the gamut of all toxicology testing, and we use a two-step testing system—homogenous enzyme amino assays to perform presumptive testing and liquid chromatography-mass spectrometry to perform our confirmations.

Q: What key instruments and techniques do you use for narcotics testing?

A: For our instrumentation on the screens, we run enzyme immunoassays on Olympus AU instrumentation. Screens are prone to both false positives and false negatives. They are very sensitive but not very specific. It is not definitive testing; the keyword is that it is presumptive—it separates all your negatives from your presumptive positives. Ideally, from a presumptive screen, the sample gets sent to a confirmation lab and that is run on LC-MS-MS. We use a dilute-and-shoot method for our methodology. The biggest takeaway from LC-MS is that it might tell you a drug is there, but it cannot tell you how that drug got there.

Q: How many samples do you typically deal with in a month? How many staff members are involved in the narcotics testing side of things?

A: We typically do about 30,000 patients a month, and more than 3 million individual tests. We have about 100 employees working on toxicology, and that includes collection staff, pre-analytical staff in the lab, our analytical staff in the lab, our data reviewers, etc.

Q: What have been the major changes/trends in narcotics testing recently?

A: The biggest trend is the emergence of synthetic compounds, and this provides a significant challenge to laboratory testing. Unfortunately, laboratories are always behind [with] the latest drugs people can purchase. Because we are bound by 1) the DEA and FDA making the new drug a scheduled substance, and then 2) having a vendor that can manufacture the standard, the laboratory is always behind. The other issue with synthetics is that as soon as you develop a test, a chemist can just tweak the molecule and now the test is no longer viable.

Another challenge is obviously dealing with the opioid epidemic. Everyone is always asking for different compounds to be tested, so we're making specialized panels that are more challenging to develop. The emergence of synthetic opiates poses a significant risk to the patients who are consuming these compounds, as well as our laboratory staff. So we take precautions to protect everyone, because even just a little amount of a synthetic opiate can be lethal.

Q: How have those changes affected Ammon Labs?

A: It has led to a period of continuous innovation because we are constantly trying to make these new compounds, and as soon as a new compound is available, we want to make sure that we're actually testing it.

We also have a client service branch in our company, so our professionals go out to facilities and ask about new compounds that patients are alerting them to. We're always keeping our ears to the ground. We try to pull as much information [as possible] from our facilities to get ahead of the trend.

Before, you used to test for your basic illicits—marijuana, PCP, heroin—now you have all these new emerging drugs of abuse such as synthetic compounds, behavioral compounds, and even new illicits like bath salts.

Once we get a standard, we revalidate or reoptimize our current method to include

the new compound and figure out how the compound may affect our current method. It is a big process to get going.

Q: What are some of the main challenges you run into when it comes to narcotics testing? How do you handle those challenges?

A: The opioid epidemic has exposed many of our clients, like counselors and clinical staff, to brand new compounds and concepts. There's a ton of misconception when it comes to drug testing and, more importantly, how to interpret results.

We recognize the importance of education and strive to help our clients understand the significance of drug testing. One of my jobs is to actually visit facilities and provide workshops on the basics of drug testing. We also invite clients to our laboratory to take tours, observe our processes, and ask the staff any questions. The best value that any laboratory in toxicology can offer is an analytical line—essentially, your clients need to be able to call your laboratory and talk to the toxicologist whenever they need help understanding the results.

Q: What advice do you have for lab professionals who are interested in getting into narcotics testing but may not know where to start or if it's the field for them?

A: I came from the other area of the clinical lab and have been involved in toxicology for six or seven years, and I can say that toxicology has a very steep learning curve. Significant expertise is needed and the laboratory has to commit to a significant investment to get personnel proficient in toxicology. Here at Ammon, we offer an internship program for recent grads or inexperienced candidates. We take them from the beginning of the lab to the end. We feel that with someone coming in with little experience, teaching them the foundational pieces in each area of the lab helps them understand the whole process better. It can take a minimum of six months of training to become specialized in toxicology.

Toxicology is seen as two different areas—the screening side and the confirmatory side. The screening side is similar to what you'd do in chemistry. Confirmations, on the other hand, use LC-MS instruments, which are unlike any other instrument in the lab. They require a lot of troubleshooting, critical thinking, and hands-on effort.

Q: What is Ammon Labs' plan for the future, in terms of narcotics testing?

A: We're acquiring new instruments every few months. For example, we recently bought the latest instrument from AB Sciex, the 6500. We want to cater it toward research and development.

We'd also like to partner with universities for research initiatives, because most labs use instrumentation in the 4500 range for nanogram levels. But research settings need to get down to the picogram level. This is important, because as more states legalize marijuana, they are looking for ways to detect secondhand smoke in children and determine the potential effects on development. We want to get more into research and development and provide valuable reporting back to universities and government agencies.

We also have a lot of automation in our lab, which is key to toxicology, but we're always trying to automate as much of the process as we can. So we're looking to partner with Tecan to become more automated and reduce human error and improve efficiency. We are also looking to make an investment in screening instrumentations for more throughput and scalable capacity.

And as always, we of course want to be on the forefront of emerging drugs of abuse. We want to continue to develop new methods that our clients ask for in the testing of new drugs.

***Lauren Scrudato**, associate editor for* Lab Manager, *can be reached at lscrudato@labmanager.com or 973-721-4070.*

▲ *Inside Ammon Labs' state-of-the-art laboratory in Linden, N.J.*

MASS SPECTROMETRY

MASS SPECTROMETRY CAN ADDRESS MANY SHORTCOMINGS OF IMMUNOASSAYS

by Angelo DePalma, PhD

Immunoassays span the spectrum of analytical biology, from basic research through medical diagnosis. They work through the affinity of an antibody to the target analyte, an event that activates a light-emitting dye whose emission is the signal or readout.

Dozens of companies sell immunoassay antibodies and reagent kits, but antibodies do not exist for every conceivable analyte. When commercial antibodies are unavailable, investigators must generate their own through a costly, time-consuming process.

Antibodies are known for their exquisite target specificity, but many cross-react with structurally related molecules, which may be metabolites of the original target. Moreover, changes in pH or buffer salt concentration can alter the conformation of the binding site, rendering it unrecognizable.

"As we come to understand the deeper complexities of biology and the capabilities of current analytical technologies, we're beginning to recognize some of the shortcomings of immunoassays," says Andrew Peck, PhD, senior manager for business development at Waters (Milford, MA).

Hence the growing interest in mass spectrometry (MS) to complement or replace immunoassays. MS does not require antibodies or reagents, and its readout directly quantifies a wide range of molecules. The main drawbacks of MS are a high initial acquisition cost, a relatively high-level skill requirement, and, in clinical settings, difficult adaptation to random-access mode.

The protein problem

Proteins often exist in several physicochemical forms, including isoforms and isomers, which immunoassays erroneously report as homogeneous. Modifications also occur that render epitopes unrecognizable. Small-molecule analytes and metabolites are particularly challenging for immunoassays, but this is where MS shines.

Since MS measures molecular weights, operators can tune into a specific weight range to quantify everything within that window, thus identifying and characterizing major and minor modifications in ways that immunoassays cannot.

The major impediment to MS as a go-to replacement for immunoassays lies in the additional workflow needed for large proteins. When molecular weights reach 2K Da and high sensitivity from complex matrices are needed, analysts adopt a surrogate approach involving enzymatic digestion to break large proteins into peptides that are unique to the parent protein. Software deconvolutes the tryptic digest to provide the molecular weights of the major isoform and relevant variants arising from additive and subtractive post-translational changes.

"Sample preparation methods are constantly improving, but it's still an extra step in the MS workflow for large molecules on a typical tandem quadrupole system," Peck notes.

Operational issues exist as well. MS had a reputation for complexity, high cost, and requiring a high skill level for operators. Facing these significant hurdles to adoption, major manufacturers have improved

instrument accessibility and usability, even for previously inaccessible clinical markets. Waters, for example, pioneered MS-based diagnostics and was the first MS manufacturer to obtain 510(k) clearance for an MS diagnostic kit, the MassTrak Immunosuppressants kit for quantifying the anti-rejection drug Tacrolimus.

"But clinical labs have been built around immunoassays, where random access is a huge economic driver," Peck notes.

Random access refers to the ability to run tests in any order from any sample. Currently available MS instruments are incapable of random access and instead run in batch mode, where the system tests for one analyte multiple times. Different configurations would normally be required to run tests for steroids and, say, C-reactive proteins. The requirement for protein digestion also throws a monkey wrench into the idea of routine analysis of medically relevant proteins.

On the other hand, MS can perform multi-analyte analyses, provided the target molecules are similar enough—for example, a drug and its metabolites or steroid hormones plus their precursors and metabolites. Multi-analyte capability provides a powerful means to measure the alterations along a multi-molecular pathway.

From a clinical lab's perspective, one could also imagine several MS instruments in proximity, each covering an assigned region of diagnostic molecular space and together serving some reasonable percentage of a clinical lab's needs.

Strength or weakness

The strengths of MS in this regard are sometimes unfairly portrayed as a weakness. A recent article noted negatively that results using Waters' MassTrak assay for Tacrolimus did not agree with immunoassay results. Although the authors did not state it directly, the implication was that MS numbers are somehow suspect.

"There are many examples of this, a result of the negative bias of MS in these settings," Peck explains.

Negative bias arises from the ability of MS, relative to immunoassays, to distinguish between closely related forms of a molecule. Where an immunoassay might provide one signal for molecule A and its metabolites, MS distinguishes them, thus appearing to under-report levels of the molecule of interest. So, if an antibody recognizes an epitope present in both Tacrolimus, which is active, and its inactive metabolites, the immunoassay will over-report the parent compound.

This raises interesting questions for healthcare generally, and for physicians who currently rely on immunoassay testing to dose patients for chronically administered drugs. "Physicians are used to seeing and dosing patients based on a number, but when you show them what's behind the immunoassay reports, they're surprised. They realize they may be under-dosing patients because immunoassay is measuring not just the drug, but its inactive metabolites as well," Peck says.

Replacing clinical immunoassays with MS will take work, but eventually the technology and application will settle into a comfortable equilibrium. But what about for research applications, currently the largest user base for MS?

Acceptance timeline

In a review of the state of MS in traditional immunoassay territory and the potential to replace the older technology, Timothy Cross of Thermo Fisher Scientific (Waltham, MA) notes that "further developments to the technology are needed" before MS can be considered a general replacement. For routine testing, immunoassays are simpler and cheaper, but objectively, MS is superior, he writes. On that basis, Cross predicts an increase in MS usage over immunoassays.

Peck concurs. "It's all about timelines and the potential for MS to address one aspect of the reproducibility crisis in the life sciences." Peck is referring to the widespread lack of authentication for cell lines and, in this context, antibodies on which the reliability of immunoassays depend. "As Leonard Freedman revealed, bad antibodies are the single largest contributor to the current reproducibility crisis in biomedical research." Or, as noted in a 2015 editorial in *Nature*, "Antibodies are the workhorses of biological experiments, but they are littering the field with false findings."

***Angelo DePalma** is a freelance writer living in Newton, New Jersey. You can reach him at angelo@angelodepalma.com.*

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ARE YOU IN THE MARKET FOR A THERMAL ANALYZER?

Thermal analysis is the broad category of at least 20 techniques that measure some fundamental property of matter as a result of adding heat. For example, dilatometry measures volume changes upon heating, thermomechanical analysis quantifies the change in dimension of a sample as a function of temperature, and thermo-optical analysis detects changes in optical properties upon heating or cooling.

Types of materials requiring thermal analysis used by survey respondents:

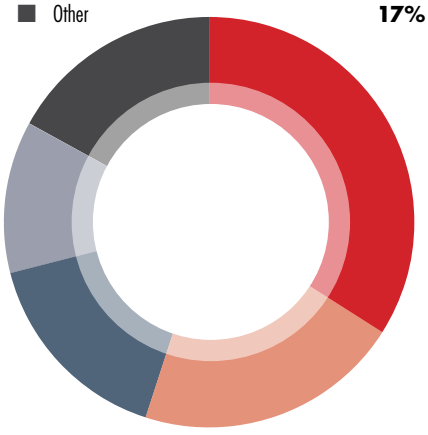
Organics such as lubricants, pharmaceuticals, paints, adhesives, etc.	40%
Polymers	37%
Minerals, inorganic chemicals, and other inorganics	29%
Ceramic / glass/ building materials	12%
Metals / alloys	9%
Other	27%

Physical state of materials being measured by thermal analysis :

Liquid	49%
Powder	39%
Thin film	18%
Fiber	16%
Gel	15%
Paste	11%
Foam	7%
Other	20%

Nearly 58% of respondents are engaged in purchasing a new thermal analyzer. The reasons for these purchases are as follows:

Replacement of an aging system	34%
New application requiring different instrument	21%
Addition to existing systems, increase capacity	16%
Setting up a new lab	12%
Other	17%



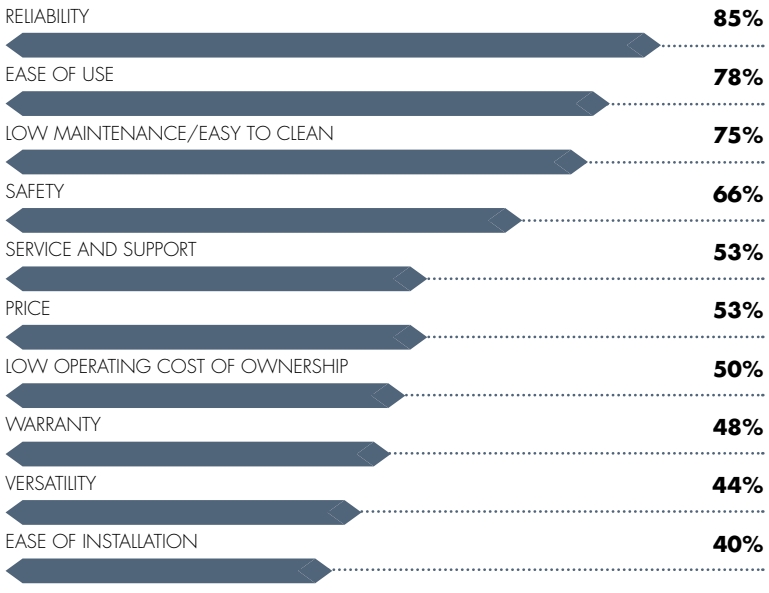
TOP 6 QUESTIONS

You Should Ask When Buying a Thermal Analyzer

1. If you are going to be analyzing x,y,z properties, ask if the company has any customers conducting the same type of work and if you can talk to them.
2. Ask if you can submit a sample for a demo using specified conditions and, if so, how long this will take and whether a report will be provided.
3. What type of post-sale application and technical support does the company offer, and how much will it cost you?
4. What features distinguish the company's instrument from their competitors?
5. What can the company tell you about the quality of the product, i.e., how it was manufactured and tested? This will help you determine the typical lifespan.
6. What can the vendor tell you about the total cost of ownership, including expected consumables, software upgrades, service, and warranty costs?

TOP 10 FEATURES/FACTORS

Respondents Look for When Purchasing a Thermal Analyzer:



For more information on thermal analyzers, including useful articles and a list of manufacturers, visit www.labmanager.com/thermal-analyzers

STARLINE PLUG-IN RACEWAY® – For Flexible Lab Power

STARLINE Plug-In Raceway® is the next generation in raceway systems, created to meet the ever-changing power distribution and data-comm needs of retail, labs, data center and higher education customers.

STARLINE's innovative design offers a flexibility that no other product on the market offers – the ability to add or relocate plug-in modules anywhere on the raceway quickly and easily, eliminating the time and cost needed to reconfigure circuits, receptacles and wiring. Insulated copper bus bars are preinstalled in the raceway sections. Then, with STARLINE Plug-In Raceway, you simply snap the pre-assembled plug-in modules into place on the raceway backplane and the connection to power is made automatically without having to interrupt power.

STARLINE Plug-In Raceway not only offers flexibility and low cost of ownership, additional benefits are:

Reliability – If you know the name STARLINE, you know that reliability is the backbone of design criteria for all of our systems. This system is tested to meet NEC, IEC and UL standards and has the ETL mark. Joints and plug-in units require no maintenance.

Aesthetic Appeal – The electrical raceway is built with a smooth aluminum finish and its compact design requires minimal space. STARLINE Plug-In Raceway is available in white, black or silver. Custom colors are available upon request.

Flexibility and Scalability – STARLINE Plug-In Raceway is an investment that allows you to expand, reconfigure or relocate the system anywhere you need power—improving your ability to meet future changing facility needs and making it one of today's most flexible products on the market.

Reduced Overall Costs – STARLINE Plug-In Raceway makes installation quick and easy, and lowers costs because it takes about one third less time to install, so labor costs are cut dramatically. Also, the modules are so easy to add, that an electrician is not needed.

Safety and Convenience – Allows the user to avoid large panel boards in a remote location and has greater flexibility without the confusion of determining what breaker corresponds to which outlet.

STARLINE Plug-In Raceway Common Applications:

Labs – Medical/Pharmaceutical – Designed to provide reliability, STARLINE Plug-In Raceway helps labs and hospitals run at peak efficiency. And the flexibility of STARLINE Plug-In Raceway allows you to meet the constant changes a lab presents.

Education – STARLINE Plug-In Raceway has a role in facilities all over campus, from cafeterias, labs and vo-tech classrooms, to stadiums, auditoriums and theaters.

Healthcare – The flexibility of the Plug-In Raceway product, as well as the circuit protection each plug-in unit provides, makes it ideal for healthcare environments.

Data Centers – Downtime at data centers can be costly. That's why STARLINE Plug-In Raceway is preferred at data centers and mission critical facilities that need the ability to add power, without shutting off power.

STARLINE® PLUG-IN RACEWAY

To find out if STARLINE Plug-In Raceway is the right fit for your facility, visit www.starlinepower.com/raceway.

Fraser Glickman, PhD

ASK THE EXPERT

AUTOMATION AND ROBOTICS FOR ACADEMIC DRUG DISCOVERY

by Tanuja Koppal, PhD

Fraser Glickman, PhD, research associate professor and director of the High-Throughput and Spectroscopy Resource Center at Rockefeller University, shares some details with contributing editor Tanuja Koppal, PhD, on the work being done in his core facility. He discusses trends in automation and how recent changes have helped translational research in an academic setting.

Q: Can you share some details on the work being done at your High-Throughput and Spectroscopy Research Center at Rockefeller University?

A: We are a core facility supported by Rockefeller University and Weill Cornell Medical College, and we in turn support projects from all over, especially the New York metropolitan area. We support our clients in drug discovery, which involves screening large numbers of compounds to find active lead structures. For refining the understanding of how compounds engage their targets, we also support spectroscopic analysis of various molecules, particularly focusing on interactions between ligands and receptors. We are also involved in training our students and users in high-throughput screening (HTS) and spectroscopic analysis and in the practice of drug discovery. Our work involves miniaturization of assays in microtiter plates. The assay formats require various types of instruments that can read anything from fluorescence, luminescence, and oxygen channeling to high-throughput automated microscopy. The automation we have is aimed in three areas: handling the microplates; dispensing liquids, which is essentially automated pipetting; and handling the compound libraries.

Q: Is there a big difference in terms of how automation and robotics are being applied for HTS in academia versus industry?

A: It's not that much different; it's just a matter of difference in scale. In industry, the labs are larger, but you will see similar types of instrumentation and processes. If you compare screening in a small biotech company with that of a small academic lab, you will see similar types of equipment. There are large academic screening centers that have instrumentation very similar to pharma companies. The pharma companies have more invested in drug discovery so they tend to be early adopters of technology, but often, academics are the original inventors of the technology and are the first to identify useful tools, which are made publicly available.

Q: As the director, can you share your perspectives on some of the challenges in terms of evaluating and investing in new instrumentation and software?

A: What a good lab manager can do is identify needs that different laboratories or people share, and this involves seeing the common problems that people have and being aware of the various technologies that are available. When we are interested in a new technology, we scan the horizon to see what's out there. If a technology comes along that can solve these common problems, then we go out to the company and test the instrument with real samples and controls. Or we invite the technology provider to place the instrument in our lab for a period of time for testing, and we take time in thoroughly evaluating a new technology. We tend to be rather conservative in our approach.

Q: What are some of the common needs that you have identified among your users when it comes to automation?

A: We are looking at ways for automating different biophysical assays. There is a lot of effort these days to do *in silico* drug discovery, which involves entering crystal structures of proteins into a computer program and doing high-throughput docking of compounds. This is done to identify compounds from a large data set that will bind to a certain target. However, to test different hypotheses, we need to perform various biophysical analyses with relatively high speed. So we are looking for technologies that can do such analysis in high-throughput. Examples of such technologies are differential scanning fluorimetry (DSF), surface plasmon resonance (SPR), microscale thermophoresis (MST), and second-harmonic generation (SHG), and they all have potential to test large

number of compounds that come out of *in silico* studies.

Q: Are there any trends in cell-based assays, particularly in terms of automation?

A: The cell-based assays are also interesting to us, and we have a high-content screening platform. These systems have become very robust and reliable in recent years. The software that controls the system has also become easy to use and it's become easier to teach people how to use it too. The new developments in cell-based assays involve growing cells in a 3-D matrix rather than a monolayer so that it's more physiologically relevant to measure cell metabolism and such parameters. There is also interest in growing cells in lower oxygen, which better replicates physiological conditions. In cell-based assays the challenges are more in the techniques for growing and handling the cells, rather than in automation. For example, it is still difficult for us in a small academic setting to screen live cells, which requires automated cell incubators and automated timing of cell-seeding.

Q: What are some of the changes that have taken place in recent years to improve automation and miniaturization?

A: In the past five years there hasn't been much change in the instrumentation, but the systems are becoming more reliable, whereas in the past they were more prone to breakdown and sometimes you would question whether it was worth automating at all. It's become much easier to run processes overnight, monitor them using alarms, and correct them remotely. We are not doing this as much in academia because this type of automation can be quite expensive. However, I do believe it will become less and less expensive over time. In academia, instead of having giant automated systems, you will find a lot of smaller, flexible systems that can be changed as the job changes. Our automated systems are modular and mobile because we built them slowly, one piece at a time. In industry, the automation is built around one process. Being in academia, our processes are always changing and we do things on a smaller scale, so it's easier to do it in a modular fashion. We need to rely more on the laboratory scientists to handle the microplates and program the automation software. Hence, we only automate processes that can be done without the need for specialized software and hardware engineering.

Q: Are there new trends and technologies in automation that you are excited about or you consider to be game changers in the field?

A: There are systems that do automated cell culture, but every time you change the process it becomes a programing hassle, as the systems are quite rigid. Now there are new systems with robotic arms that can mimic the motion of a human arm—and something like that will be a real game changer. Instead of using computer programs and commands, the arm can be trained by physically moving it. For example, the robotic arm, which is articulated like a human arm (called "anthropomorphic"), can be placed in front of the cell culture hood and you can hold it just like a child's hand and move it in ways you want it to move. The robotic arm then remembers that motion and can do it faster, over and over again, as needed. So you train it by simply showing it what to do. You can then use software to revise and simplify the motion. The vision among automation experts is to use artificial intelligence (AI) to refine the movements, so the robot learns by itself. I think that's where we are headed, and commercial products are just starting to come out. If the automation includes AI where you can teach the robot in a more human way, then automation becomes much more flexible and can be adapted to different tasks. It's a human interaction with the robot, almost like dancing with a partner. However, I do understand that a big challenge with AI is in the robots' ability to see and recognize objects and incorporate this in their learning.

Fraser Glickman, PhD, is a research associate professor and director of the High-Throughput and Spectroscopy Resource Center at Rockefeller University. He is interested in discovering molecules that can be developed into biological tool compounds and medicines, and in the technologies associated with drug discovery. He is working with various researchers to identify and develop novel assays for tool compound discovery and then apply screening strategies to identify compounds that can be used to further our understanding of disease. His High-Throughput and Spectroscopy Resource Center conducts a variety of sophisticated approaches for measuring the interaction of small molecules and antibodies with their molecular targets. The information generated is critical for understanding the underlying mechanisms of disease and for beginning to identify drug-like molecules based on this understanding.

***Tanuja Koppal**, PhD, is a freelance science writer and consultant based in Randolph, New Jersey. She can be reached at tkoppal@gmail.com.*

OPTICAL MICROSCOPY

CONSIDERABLE LIFE IN A CENTURIES-OLD METHOD

by Angelo DePalma, PhD

In laboratory environments where advances in science and instrumentation are taken for granted, the idea of stepping backward seems counter-intuitive. Yet that is what biologist David Nguyen, PhD, argues for in his article, "The Advantages of Studying Cells Under a Light Microscope." Nguyen begins by flat-out stating that the "compound microscope is the most cost-effective type of microscope, making it the preferred choice for many life science applications."

> "Scientists have used light microscopes for hundreds of years and developed tens of thousands of methods based on them for studying organs, tissues, and individual cells."

From their names alone one would guess that light or "compound" microscopes—of the type that readers first laid eyes on in high school biology class—are simpler, less expensive, and easier to use than atomic force or scanning electron microscopes.

Today's most advanced imaging platforms provide more information per experiment, in less time, than light microscopes, but their price tags are a hundred- to a thousand-fold higher. It is this value argument on which Nguyen makes his case for light microscopy.

Scientists have used light microscopes for hundreds of years and developed tens of thousands of methods based on them for studying organs, tissues, and individual cells. "The combination of low cost and the large amount of biological information that a light microscope provides makes it an invaluable tool for research and medicine," Nguyen writes.

Optical stains used to visualize features in cells persist long after fluorophores have faded. Light also provides a sort of sweet spot in terms of macro-to-micro field. For example, a pathologist can study the rough texture of cancerous tissue with a light microscope and then, with a flick of the objective lens and refocusing, easily probe the structure's individual cells, and with the aid of various stains, home in on organelles or study the cell's functions or life cycle.

Optical tweaks and modes

That is not to say that optical microscopy is now and forever in its most advanced state. For example, researchers recently reported on a technique that tweaks optical microscopy in a way that assists in imaging the finer aspects of living plant cells.

Plant cells are among the most studied organisms, but complex plant structures disturb light passing through them. Living plant cells are thick, containing colored and fluorescent details that are often destroyed or altered by the microscope light. That is why light microscopy of live plant cells must balance image quality and information content.

Yosuke Tamada and Masayuki Hattori of Japan's National Institute for Basic Biology (Okazaki) applied adaptive optics (AO), a technique developed for astronomy to correct for atmospheric disturbance in viewing far away objects. AO improves optical observations by compensating for "wavefront distortions" using a mirror.

AO is most commonly applied to microscopic examination of animal tissues. For plant cell observations, the researchers devised a type of AO that corrects the disturbed light and enables fine imaging of both plant cell organelles and fluorescently-labeled beads attached to leaf cells. Investigators are looking into another technique from astronomy, 3-D AO, to improve even further the ability to visualize processes within plant cells.

AO has also been applied to detailed observation of cellular life cycles. Physics Nobelist Eric Betzig of the Howard Hughes Medical Institute (Loudoun County,

VA) combined AO with another old but (until recently) unappreciated technique, lattice light sheet microscopy, to create a "movie" of immune system cells migrating within the ear of an embryonic zebrafish.

Light microscopy will always be constrained by the properties of light and the limitations of optics, but the boundaries of what is possible continue to shift. Tandem methods combining two or more microscopic techniques are one way to continue pushing the limits.

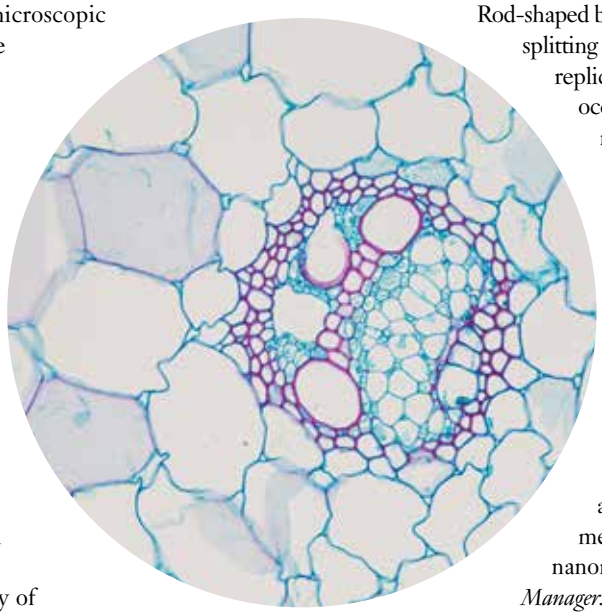
For example, a group at Oxford University led by Robert Ishmukhametov has developed a small, inexpensive add-on that confers on optical microscopy four epi-illumination methods: back-scattering darkfield (BSDF), epi-fluorescence (EF), interference reflection contrast (IRC), and darkfield surface reflection (DFSR). In contrast to diascopic (transmitted-light) microscopy, epi-illumination is the term for various techniques based on reflected-light microscopy of opaque substances, which include many living cells. Epi-illumination is often used as a fluorescence method with hard materials, but Ishmukhametov found a way to apply it to living cells.

In BSDF mode, the device detected malaria parasites inside human erythrocytes without staining. An EF-based experiment visualized stained Leishmania parasites without the use of excitation filters. IRC and DFSR are used mostly for materials analysis.

Stepping backward

What's curious about light microscopy is the number of techniques that combine it with more advanced microscopy methods to acquire microscope images containing more information than either instrument alone could produce.

Last year, a group at Switzerland's Lausanne Polytechnic combined light and atomic force microscopy (AFM) to study the cell cycle in *Mycobacterium tuberculosis*, the bacterium that causes tuberculosis in humans. In an article published in *Nature Microbiology*, Dr. Georg Fantner and co-workers reported on the hybrid microscope system, which is clearly the consequence of necessity being the mother of invention.



Rod-shaped bacteria typically divide by splitting around their middles after DNA replication. A mechanism, nucleoid occlusion, protects genes, and a second mechanism, "minicell," localizes the division site. *M. tuberculosis* doesn't use these mechanisms, so scientists interested in studying its cell cycle must resort to novel imaging tactics—in this instance combining light with AFM.

"The AFM provides very high, nanometer-scale resolution, 3-D topography information of the outside of the bacterium, and the ability to measure mechanical properties and perform nanomanipulation," Fantner tells *Lab Manager*. "The optical microscope allows you to see inside the cells, and with fluorescently labeled markers provides molecular specificity."

Being able to look inside the cell with the help of fluorescent tags, he stresses, is the primary advantage of light microscopy for cellular analysis. "We also use this method for mammalian cells, to track their development during proliferation."

In their paper, Fantner and co-workers noted that the *M. tuberculosis* study was the longest continuous AFM experiment ever performed on growing cells. Fantner explains that "performing long time experiments with AFM is difficult, especially on living cells. We needed to do long-term experiments to track single bacteri[um] through multiple generations."

***Angelo DePalma** is a freelance writer living in Newton, New Jersey. You can reach him at angelo@angelodepalma.com.*

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DO YOU NEED **ELECTROPHORESIS** SYSTEMS IN YOUR LAB?

Electrophoresis relies on a basic process—particles moving in an electric field. Known for more than 200 years, this phenomenon still drives fundamental techniques in many labs and its long history plays a role in the widespread use of the technology. Current interest lies in making the technology faster, more accurate, and more sensitive.

Most common problems users experience when using their electrophoresis systems:

Time to results (not quick enough)	**42%**
Inconsistency in gels	**30%**
Dangers in handling toxic chemicals to make gels	**22%**
Shelf life is too short for gels	**20%**
Not enough control options in the electrophoresis system	**16%**
High labor costs	**15%**
Buffers heating up too much	**14%**
Other	**30%**

Factors that would help users overcome their electrophoresis challenges:

Newer equipment	**44%**
Better training	**26%**
Newer accessories	**23%**
Better technical support	**22%**
Improved maintenance	**15%**
More instruments	**11%**
More staff	**10%**
Other	**25%**

TOP 9 QUESTIONS

You Should Ask When Buying Electrophoresis Equipment and Supplies

1. How many gels per experiment can you run at once in a single electrophoresis cell?
2. Can you run hand cast and precast gels with the same electrophoresis equipment?
3. Can you blot in the same tank as you run the gels?
4. How fast can you run a set of gels with optimal performance?
5. How fast can you visualize your proteins in the gel?
6. Do you need any special buffers or sample buffer to run your gel?
7. Does a precast gel give you the same separation as a hand cast gel?
8. How fast can you transfer proteins from your gel to a membrane?
9. How efficiently can you transfer your high molecular weight proteins from your gel to a membrane?

SOME OF THE MOST EXCITING APPLICATIONS

for electrophoresis, as reported by users:

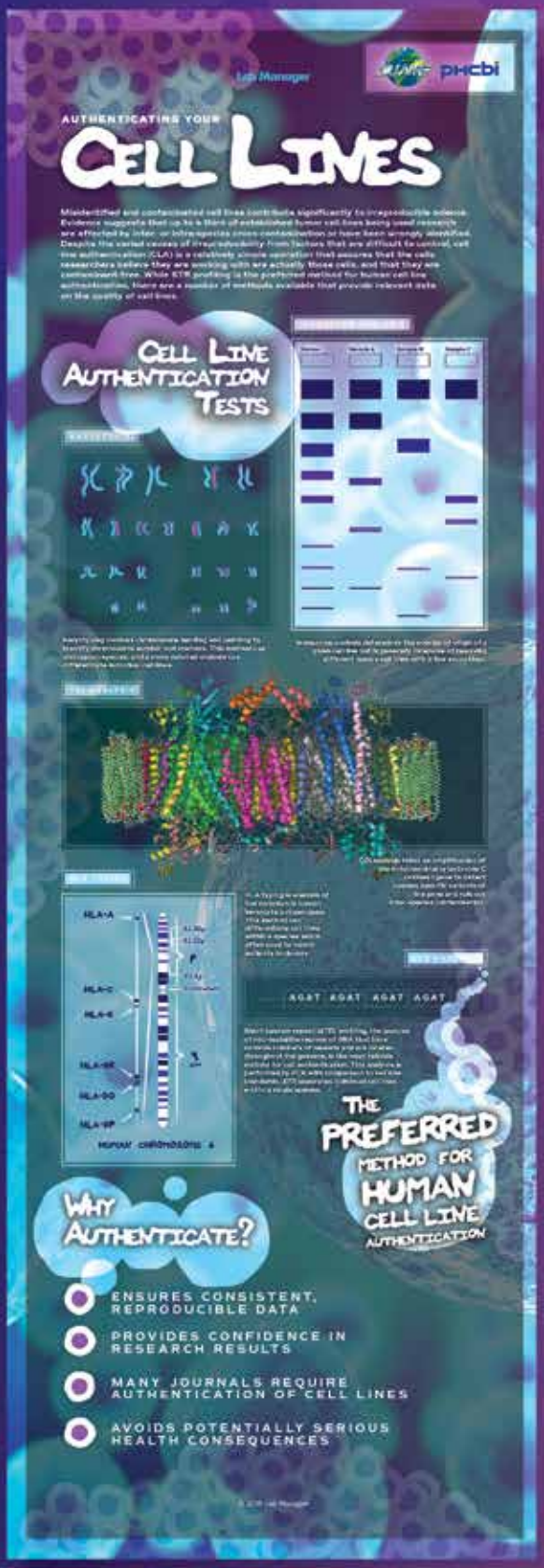
Vaccine Analysis

Several vaccines, including the influenza, hepatitis, and polio vaccines, have been purified, processed, and analyzed through electrophoresis. Capillary electrophoresis is an established technique for vaccine analysis, having replaced a variety of traditional methods because it offers greater precision, resolution, linearity, and ease of use, and it is also less costly.

Short Tandem Repeat Analysis

Short Tandem Repeat (STR) analysis involves amplification of certain regions of DNA by PCR followed by electrophoresis to determine the lengths of short tandem repeats. Forensic scientists commonly use STR analysis to distinguish DNA samples from each other.

For more information on electrophoresis, visit www.labmanager.com/electrophoresis



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CASEWORK

APPROPRIATE FURNISHINGS HELP KEEP CLEANROOMS IN COMPLIANCE

by Erica Tennenhouse, PhD

Despite the name, a cleanroom is much more than simply a room that is kept clean. Cleanrooms are highly controlled, isolated environments where air particulate levels are strictly controlled with the help of HEPA filtration. They are used in a wide variety of industries, including the pharmaceutical, semiconductor, and medical device industries. To ensure these cleanroom environments remain in compliance, furnishing decisions must be made carefully.

Materials of construction

Cleanroom furnishings must be constructed from materials that are easy to sterilize. Plastic Concepts (North Billerica, MA) fabricates most of its lab furniture out of polypropylene and other plastics that, according to the company's president, Michael Thompson, are easy to clean and keep germ free. Stainless steel is also commonly used in cleanroom furnishings, says Andy Sinnamon, a technical adviser for lab products at Mott Manufacturing (Brantford, Ontario). Like polypropylene, stainless steel is a nonporous material, which is an ideal characteristic for use in cleanrooms. However, certain grades of stainless steel can corrode when cleaned with aggressive sterilants. Plastics, on the other hand, stand up better to daily sanitation. "The FDA, which regulates biotech, pharma, and food inspections, prefers when their clients use polypropylene because it helps to ensure they have a sterile environment," says Thompson.

Sinnamon adds that the furniture in cleanrooms must be made of materials that do not harbor or shed dust particles, and careful attention must be paid to coatings. "Regular laboratory furniture does not have these design requirements," he says.

Custom design

Think about the process of having kitchen cabinets installed in your home. Those tasked with the installation would have to measure the kitchen space and consider how many pots and pans, plates, and glasses you have in order to make everything fit. Plastic Concepts goes through the same process when designing custom cleanrooms for biotech labs. "They all have different requirements for holding garments, equipment, products, and materials, and we find a way to accommodate them," says Thompson. While architects and engineers work on the overall construction of the building, Plastic Concepts' focus is on the details of designing the lab and supplying the furniture. "The advantage to our client is we can build anything they need within any space constraint they might have," says Thompson, noting that cleanrooms, in particular, often need to fit a lot of items in a limited space.

Added extras

Cleanrooms require not only specialized furniture, but also lab essentials like storage totes and bins that can withstand the cleanroom environment. Thompson has seen labs struggle to find items as simple as sterilizable document holders. "Nobody knows where to go shopping for this stuff," he says. Plastic Concepts fills that need by manufacturing these types of miscellaneous items out of durable, sterilizable materials, as well as specially constructed furniture, so that they can be used in cleanrooms.

Worth the price

Doing your cleanroom up right may not be cheap. For instance, polypropylene runs at a higher cost than stainless steel, and clients must be prepared to pay if they want a custom-designed lab. When customers first learn the price of Plastic Concepts' cleanroom-friendly containers, for instance, Thompson notes that there is often a bit of sticker shock because they are more costly than off-the-shelf molded containers. "But they're getting an item that is specific for their purpose," he says. In the end, forking over a bit more cash can result in a cleanroom that is better equipped to perform the process requirements.

***Erica Tennenhouse**, scientific content editor for* Lab Manager, *can be reached at etennenhouse@labmanager.com or by phone at 647-500-7039.*

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CENTRIFUGES

STREAMLINED OFFERINGS TAKE GUESSWORK OUT OF PURCHASING DECISIONS

by Brandoch Cook, PhD

Put yourself in the mindset of a new investigator beginning your own biomedical research lab. Most likely, your CV, expertise, and discoveries are inadequate predictors of your continued and future success. Suddenly, your career hinges on your ability to behave like an executive: making a first hire of a competent technician, planning an expansion during your start-up funding period, and implementing capital purchases that will maximize efficiency and stretch your budget.

First, you will require a suite of expensive equipment specific to your discipline. Regardless of your field of study, you will also need reagents, materials, and equipment ubiquitous throughout the life sciences. In particular, you will need a range of centrifuges with the capacity and versatility appropriate to your proposed benchmarks that will ensure the growth and success of the lab. That vision of success probably looks something like going from just you and a tech struggling at year zero to an efficient and productive workspace of seven or eight students and postdocs by the end of year three. Therefore, you will probably purchase one or two large tabletop centrifuges with swing buckets, one or two benchtop microcentrifuges, two temperature-controlled microcentrifuges, and small personal centrifuges for quick spins. There is a lot of potential for variation, depending, for instance, on whether your studies involve exosome profiling or virus collection, which would require capabilities limited to ultracentrifuges.

Your head is probably spinning by now, but you can rest easy. To a large extent, centrifuge providers have eliminated a lot of the guesswork and streamlined their offerings through a combination of adaptability, ease of use, and vastly improved technology.

For starters, providers are a lot more experienced with the lab start-up phase than you are. Although they do not commonly offer specific start-up packages, larger providers such as Eppendorf (Hamburg, Germany) and Thermo Fisher (Waltham, MA) offer their main product ranges with all available rotors, attachments, and inserts under single part numbers to avoid costly and confusing a la carte shopping. According to Hugh Tansey, worldwide product director at Thermo Fisher Scientific, with the exception of floor-model ultracentrifuges, units are typically designed to be "plug and play," with little or no specialized knowledge required for immediate use. He suggests that increased capacity and decreased negative space have reduced energy and size footprints, improving efficiency and savings over the long term.

Additionally, material improvements to interchangeable parts have extended life spans and reduced the need for repair and maintenance contracts. For instance, the move from aluminum to carbon fiber rotors has diminished corrosion problems and allowed for longer warranties, and fast, foolproof rotor-swapping mechanisms have improved safety while helping you avoid the shame of having to find stronger hands than yours to help unscrew the wrong rotor.

These improvements come with an associated initial cost, but if you plan appropriately, the savings over the long term can be substantial. For example, Matthew Lieber, regional marketing manager at Eppendorf North America, notes that the growth in functional assays using RNA and protein samples has prompted a marked shift to refrigerated microcentrifuges. There is a greater initial cost than buying a regular micro and sticking it in the cold room; however, the efficiency and consistency of sample collection will be improved with dedicated temperature control, compared with a motor that generates unregulated heat while only the outer housing sits at 4 degrees. Also, Lieber explains that you can offset the cost by forgoing refrigeration for large tabletop machines—cell cultures will remain viable when spun at low speed and room temperature.

In an era of tightened National Institutes of Health budgets, the market for used equipment, available from some providers, has also grown substantially. Regardless, the diverse menu of ready-to-use options takes a potentially bewildering large purchase and makes it relatively painless and straightforward.

***Brandoch Cook**, PhD, is an assistant professor in the Weill Cornell Medicine Department of Surgery in New York City, NY. He can be reached by email at brandoch.cook@gmail.com.*

WHAT YOU NEED TO KNOW WHEN BUYING A BALANCE

If you choose the correct balance, calibrate it regularly—including any time the balance is moved to a new location—and keep it clean, your balance will reward you with many years of accurate operation.

Types of laboratory balance used by survey respondents:

Analytical balance	89%
Precision balance	64%
Micro balance	18%
Ultra-microbalance	4%
Other	12%

Weighing applications, according to survey respondents:

Differential weighting	51%
Dynamic weighing	49%
Pipette calibration	47%
Mass comparison	32%
Filter weighting	27%
Other	11%

Most common problems users experience when using their balance:

Weight readings do not stabilize	55%
The unit is out of calibration	17%
Display problems	14%
Poor repeatability	13%
Cornerload errors	7%
The unit does not respond to weight addition	6%
Readings moving only down	3%
Other / None	32%

TOP 6 QUESTIONS

You Should Ask When Buying a Laboratory Balance

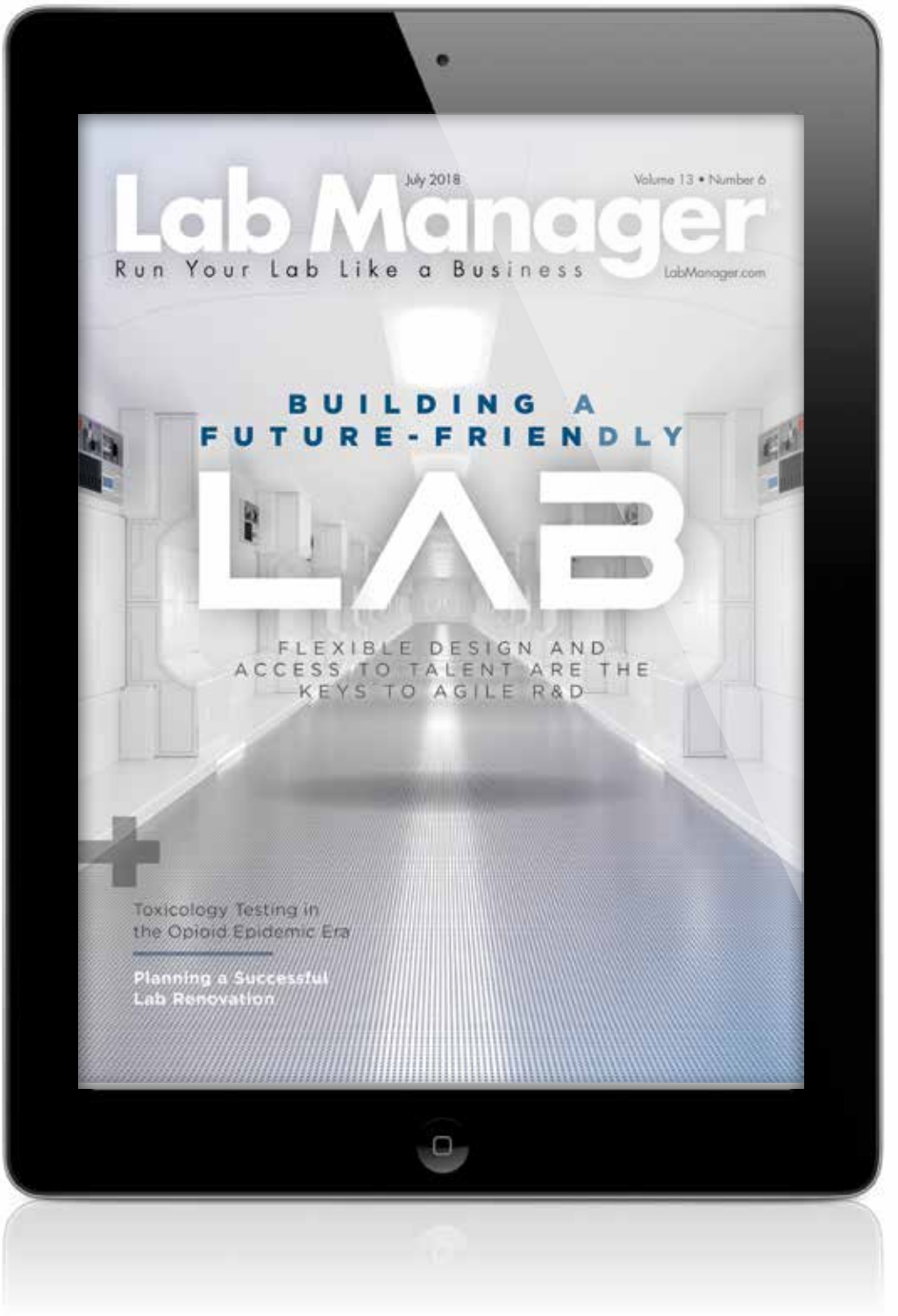
1. What are the heaviest and lightest samples you will weigh (including container weight)?
2. What is the required +/- tolerance of your lightest sample?
3. How many decimal places in grams do you require for the displayed weight?
4. What type of samples will you be weighing and do you need to take into consideration the size of the weighing surface or the securing of a tare container?
5. Is on-site service available from a factory-trained service technician?
6. Do you need to interface the balance to another device such as a computer, printer, bar code reader, etc.?

FACTORS

That Would Help Users Overcome their Weighing Challenges:

NEWER EQUIPMENT	46%
IMPROVED MAINTENANCE	38%
BETTER TRAINING	22%
BETTER TECHNICAL SUPPORT	18%
NEWER ACCESSORIES	14%
OTHER	28%

For more information on balances, including useful articles and a list of manufacturers, visit www.labmanager.com/balances



Get ***Lab Manager*** on the go.
Download a pdf at labmanager.com

Lab Manager®
Run Your Lab Like a Business

WHAT YOU NEED TO KNOW WHEN BUYING A MICROWAVE DIGESTER

Microwave-acid digestion is a common sample preparation step for atomic absorption, atomic emission, or inductively coupled plasma analysis of metals. Microwave digestion takes minutes, compared to hours for conventional hot plate digestion. Because it uses high temperature and strong acids—commonly nitric and hydrofluoric—microwave digestion mineralizes any matrix. For example, EPA method 3052, based on microwave digestion, provides total metal analysis from soil, sediments, sludge, oils, plastics, and biological materials.

Acid types used by survey respondents for microwave digestion:

Nitric acid	57%
Hydrochloric acid	57%
Sulfuric acid	21%
Hydrofluoric acid	29%
Other	32%

Microwave digestion applications as reported by survey respondents:

Analyzing metals	29%
Trace metal analysis	14%
Material analysis	14%
Biological sample analysis	11%
Other	32%

Nearly 55% of respondents are engaged in purchasing a new microwave digester. The reasons for these purchases are as follows:

Replacement of aging system	36%
Addition to existing systems, increase capacity	11%
Replacement of damaged system	7%
Setting up a new lab	7%
First time purchase	4%
Other	36%

TOP 5 QUESTIONS

You Should Ask When Buying a Microwave Digester

1. What is the system's maximum microwave power output? Microwave energy heats substances quickly to high temperatures. The higher the temperature, the faster and more completely substances are digested. Extractions also need sufficient power, as some solvents can act as a heat sink and are difficult to heat.
2. Can the system monitor and control every vessel? Temperature and pressure monitoring and control are extremely important. Inadequate safeguards can result in damaged vessels and equipment, and a lack of temperature and pressure control can pose a safety hazard to lab personnel.
3. How many samples can be processed per run? Though the number of samples processed is dependent upon your laboratory's needs, planning for growth is always a good idea.
4. Does the company offer free applications support? Do they offer dedicated, direct service support and local factory- trained field service technicians? Dependable applications and service support are essential since you never know what may go wrong.
5. How user-friendly is the system? As with many instruments, if a system is very complicated to operate, it generally becomes either a glorified shelf to store things on or a headache to those having to operate it. The easier a microwave system is to use, the better off you will be. Also make sure the vessels are easy to handle and set up.

TOP 10 FEATURES/FACTORS

Respondents Look for When Purchasing a Microwave Digester:

HIGH DURABILITY	61%
SERVICE AND SUPPORT	61%
VENDOR REPUTATION	57%
LOW MAINTENANCE	50%
PRICE	43%
SPEED OF HEATING	32%
INTUITIVE CONTROLS AND SOFTWARE	32%
SHORT COOL DOWN TIME	32%
LARGE CAPACITY	29%
SMALL FOOTPRINT	29%

For more information on microwave digesters, including useful articles and a list of manufacturers, visit www.labmanager.com/microwave-digesters

MARS 6

Better digestions.
Better analyses.

The best technologies for the best results.

iPrep™

The world's most robust vessel

iWave™

Accurate, contactless temperature control

iLink®

Remote system operation

One Touch™

It's like having a chemist in a box

TECHNOLOGYNEWS

ANALYTICAL

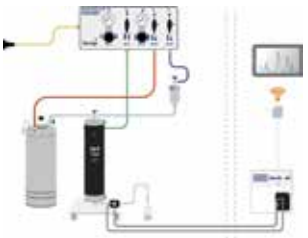
Gas Analyzer

Baseline®9100

- Performs the analysis of residual solvents in air—ethanol, isopropanol, and acetone—that are used in semiconductor cleanroom environments
- Combines the selectivity of gas chromatography with the sensitivity of a photo ionization detector
- The solvents are detected and accurately quantified to sub-ppb levels in under three minutes with ethanol producing no interference

AMETEK www.ametek.com

UV Monitor Kit

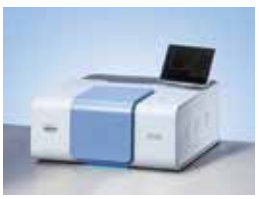


- Utilizes the latest in fiber optic connections and powerful software for post run analysis to give control and confidence in large-scale purification processes
- Combines a robust UV monitor core with a specialist wireless tablet, optimized for use in sensitive environments
- Indicates UV activity of the chromatographic flow eluting from the column, simplifying the workflow whilst helping to reduce solvent consumption, batch processing time, and energy costs through less evaporation

Biotage www.biotage.com

FT-IR R&D Spectrometer

INVENIO™



- The successor to the VERTEX 70 FT-IR for advanced R&D applications
- Combines many innovations with proven Vertex 70 technologies, such as unique FM technology for simultaneous mid and far IR spectroscopy
- New MultiTect™ technology allows for control of up to five internal detectors, covering the spectral range from far infrared to Vis/UV

Bruker www.bruker.com/invenio

Dissolution System Solution

- A METTLER TOLEDO and SOTAX partnership encompasses marketing and sales of a new dissolution system solution based on the METTLER TOLEDO UV7 Excellence spectrophotometer integrated with the SOTAX Xtend™ dissolution line
- Thanks to the system's modularity, the joint solution is very flexible and is designed to meet customer needs, ranging from manual operations to fully automated processes
- Automatic sampling and analyses at predefined intervals can be achieved in real time without operator intervention

METTLER TOLEDO SOTAX www.mt.com/uvvis-dissolution-test

Columns

bioZen™

- Encompasses both proven and entirely new media spanning two particle platforms—core-shell and thermally modified fully porous—along with new biocompatible titanium hardware
- Series features seven chemistries for the UHPLC and HPLC characterization of biotherapeutics such as monoclonal antibodies, antibody-drug conjugates, and biosimilars
- *includes* specific LC chemistries for the analysis of aggregates and total mAb, intact mass and fragments, peptide mapping, and quantitation and glycan mapping

Phenomenex www.phenomenex.com

GC Column

Zebron™ZB-624*PLUS*™

- Compliant with EPA Method 8260 and exceeds system suitability requirements for USP Method 467
- Superior deactivation process enhances peak shape and signal-to-noise ratios with increased sensitivity
- Low bleed mass spec certification makes this column fully compatible with quantification using GC-MS

Phenomenex www.phenomenex.com

Gas Chromatograph

Nexis GC-2030

- Provides users with information at their fingertips through a touch panel interface that features clear graphics that display information instantly
- Ethernet-based communication allows the user to remotely connect to the GC via pc or the operator's mobile device
- Features tool-free column installation and inlet maintenance and a built-in oven light

Shimadzu www.ssi.shimadzu.com

Integrated High Performance Liquid Chromatograph

i-Series Plus

- Offers exceptional versatility and user-friendliness to improve throughput in both R&D and QC environments
- An automatic pretreatment function enables performing operations such as automatic sample dilution, reagent addition, and sample co-injection with an internal standard
- Offers enhanced quantitative performance with a wider linear range and excellent repeatability for the smallest injected volumes of 1 µL or less

Shimadzu www.ssi.shimadzu.com

FTIR Spectrophotometer

IRSpirit

- Offers exceptional reliability in contaminant analysis, identification tests, and quantitative measurements
- This instrument's small-space design allows access from two sides, and its sample compartment is the widest of any other compact FTIR spectrometer
- Comes with an IR Pilot analysis assistant program, an identification test program, and a contaminant analysis program

Shimadzu www.ssi.shimadzu.com

GC-MS Systems

TSQ 9000 & ISQ 7000

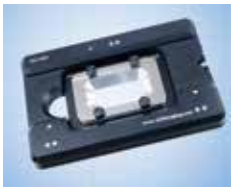
- The TSQ 9000 triple quadrupole GC-MS-MS system is designed to provide exceptional productivity and sensitivity for any laboratory targeting the quantitation of trace compounds in complex sample matrices
- The ISQ 7000 single quadrupole GC-MS system is a scalable platform from base to highly sensitive configuration intended to boost performance when needed and is ready to adapt to continuously changing regulations

Thermo Fisher Scientific www.thermofisher.com/unstoppableGCMS

BASIC LAB

Piezo Z-Axis Top Plate Insert

IPZ-3000 Series



- Fits in any microscope stage with a K-size insert opening
- Offers travel distances of 150 um, 300 um, and 500 um
- Provides Z-axis resolution as small as 2.2 nm
- Accepts several inserts for samples holders such as small dishes, slides, and chambers
- Operates with several microscopy software packages, including Micro-Manager
- Pairs with ASI's CRISP for a retrofit complete autofocus system

Applied Scientific Instrumentation www.asiimaging.com

Reactor Support Stand

QUANTUM

- Designed to be an affordable entry-level system, QUANTUM is easy to set up and provides secure and stable support for all reaction vessels from 100ml right up to 5,000ml
- Fully compatible with all leading brands of overhead stirrers and with reaction vessels already in labs
- Manufactured in the UK using durable stainless steel

Asynt www.asynt.com

Microcentrifuge

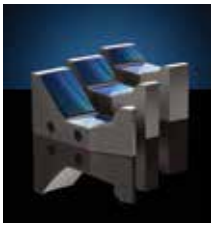
Stuart® SCF3

- Succeeding the SCF2 microcentrifuge, the new device boasts a significant increase in maximum speed—now up to 15,000 RPM from 13,500 RPM—as well as a reduced weight and lower noise levels
- Able to spin a variety of tube sizes and strips via its accessory strip rotor
- Supplied with fixed angle rotor adapters, which enable 0.2ml or 0.5ml tubes to be centrifuged

Cole-Parmer www.coleparmer.com

Monolithic Reflective Beam Expanders (Mark I)

TECHSPEC®



- Ideal for applications that require broadband or achromatic beam expansion
- Feature an all-reflective design and provide λ/10 wavefront error for precision broadband performance for UV, visible, and IR applications from 250nm to 10µm
- An innovative, monolithic design ensures high precision with minimal wavefront distortion, and excellent performance and superior stability, independent of temperature changes

Edmund Optics www.edmundoptics.com

Evaporators

HT Series 3

- Include Inert Gas Purge (IGP) option to enable safe operation even when removing highly explosive solvents, such as diethyl ether
- IGP option proves useful where an inert atmosphere is required to help protect hygroscopic or oxygen sensitive samples at the end of the evaporation or concentration process
- Intuitive touchscreen controls enhance monitoring and review of the whole evaporation process

Genevac www.spscientific.com/HT3

Cleanroom Oven

No. 922

- Electrically heated 500°F cabinet includes 4" insulated walls, aluminized steel exterior, type 204, 2B finish stainless steel interior
- 1500 CFM, 2-HP recirculating blower provides horizontal airflow to the oven
- Controls include a digital indicating temperature controller, manual reset excess temperature controller with separate contactors, recirculating blower airflow safety switch, and solid state contactors

Grieve www.grievecorp.com

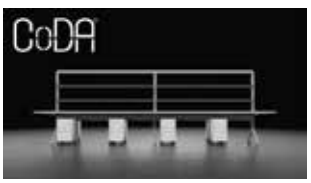
Demonstration Hood

- Ideal for classroom experiments and demonstrations because of its viewing visibility from all four sides
- Hinged viewing window or optional horizontal sliding glass panels allow for easy access and user safety
- Integral exhaust blower safely exhausts fumes and odors
- Wide selection of accessories, including tables and ducting is available

HEMCO www.HEMCOcorp.com

Benching System

CODA



- The modular design, adjustable height surfaces, and moveable shelving can respond to users' specific needs
- Offers greater flexibility for lab layout by spanning up to 10 feet long between structural supports
- Can be manufactured to nearly any configuration to serve the lab needs of users with both new and existing buildings

Kewaunee Scientific www.coda-world.com
Rainlight

Pressure Compensated Control Valves

FLOW-CONTROL

- Designed for extremely precise control of constant flow rates in low flow gas and liquid applications
- Do not require any electrical power source, since the desired flow rate is manually set via the needle valve
- Available in four different models to control flow capacities in a range from 0.02 l_n/min up to 50 l_n/min (N_2-equivalent) and 3 up to 1800 ml/min for water

Mass Flow ONLINE www.massflow-online.com

Lyophilizer

Genesis

- Designed with versatility in mind so that the freeze dryer can meet virtually any research, development, or small-scale production lyophilization application
- Delivers shelf temperatures as low as -70°C, condenser temperatures to -85°C, operate in bulk or stoppering configurations
- Available with up to six bulk drying shelves and five vial processing shelves

SP Scientific www.spscientific.com

Differential Refractive Index (DRI) Detector

- Designed to fit seamlessly with all commercially available MALS and SLS detectors resulting in more accurate and reliable results
- High sensitivity makes the detector the perfect companion for characterization of natural and synthetic polymers as well as protein investigations that demand leading-edge performance
- Operates at the same wavelength as MALS and SLS detectors, enabling determination of both absolute concentration and also total mass balance

Testa Analytical Solutions www.testa-analytical.com

Particle and Protein Characterization

NanoBrook Omni

- Offers labs the versatility to measure samples in almost any aqueous or organic solvent-based suspension
- Utilizes three measurement angles to ensure truly unbiased, high sensitivity particle sizing and zeta potential results
- Provides outstanding reproducibility from sample-to-sample, operator-to-operator, and instrument-to-instrument

Testa Analytical Solutions www.testa-analytical.com

Scanning Electron Microscope

Explorer 4 Additive

- Designed to measure particle size, shape, and composition in AM metal powders, and to inspect finished parts to assure quality
- Automatically and simultaneously analyzes three of the most critical characteristics of powders used in powder-bed and powder-fed AM processes—particle size distribution, morphology, and impurities detection
- High-resolution imaging and micro-analysis capabilities enable quick identification of root causes of process and product failures

Thermo Fisher Scientific www.thermofisher.com

Scanning Electron Microscope

Prisma SEM

- Offers a full range of imaging and analytical options for more complex investigations conducted in industrial and academic R&D, quality control, and failure analysis laboratories
- Incorporates extensive automation and a user-friendly interface that makes it easy to learn and operate
- Features advanced automation, robust support for analytics, a large and flexible stage, and a wide range of optional accessories

Thermo Fisher Scientific www.thermofisher.com

Extreme High-Resolution SEM

Verios G4

- Delivers the capability and flexibility needed to determine root cause defects, yield losses, and process and product failures
- Derived from Thermo Scientific's Helios family of DualBeam (focused ion beam/SEM) instruments
- Offers industry-leading performance across a wide range of conditions, especially at the low voltages required for beam-sensitive materials used in advanced processes

Thermo Fisher Scientific www.thermofisher.com

HPLC Column Oven

EchoTherm™ Model CO20

- Provides a temperature range from room temperature to 90.0°C, readable and settable to 0.1°C
- PID temperature control software regulates temperatures to ±0.1°C
- Temperature accuracy and stability are ±0.1°C with a stable temperature indicator lamp on the front panel that lights when the target temperature is stable to within ±0.2°C
- Holds columns up to 30 cm long by ¼" or 3/8" diameter

Torrey Pines Scientific www.torreypinesscientific.com

Electronic Vacuum Gauge

VACUUBRAND® DVR2pro

- Measures absolute pressures in the rough vacuum range from atmosphere to 1 mbar/Torr/hPa
- Battery door provides easy access to the standard 9V alkaline battery
- Digital and analog displays allow precise measurement, as well as easy trend indication
- Can be easily fit to KF16 small flanges, standard vacuum tubing from 6-10mm ID (1/4"-3/8") or 10/8 PTFE tubing

BrandTech Scientific www.brandtech.com

Sanitary Mixer

- Unique, pre-engineered, ultra-light weight GMP sanitary mixer mounts right on the Tri-clamp connections of poly and stainless steel process vessels
- Operators can easily move the mixer from tank to tank because of its light weight design
- Available in 316Lss, Exotic Alloys like Hast C, and all non-metallic designs, including USP VI Polypropylene
- Includes complete documentation package with 100% traceability

White Mountain Process www.wmprocess.com/autoclavable-mixer

Inverted Confocal Raman Microscope

alpha300 R*i*

- Combines the advantages of data acquisition from below with the established merits of 3-D confocal Raman imaging
- The inverted beam geometry delivers many advantages in sample access and handling
- Standardized liquid sample holder formats can be quickly and easily mounted and measured
- A motorized sample stage also facilitates the mounting of environmental enclosures and other accessories

WITec www.witec.de

INFORMATICS

Microbiology Informatics Solution

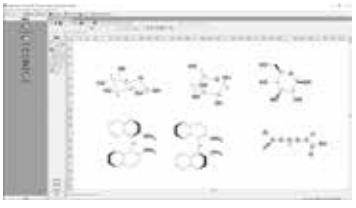
BD Synapsys™

- Provides laboratories with secure connectivity across instruments and locations
- Easy-to-use, browser-based application helps streamline workflows, automate manual processes, and facilitate on-demand actionable insights
- Enables laboratories to improve productivity, simplify compliance, and ultimately get results to clinicians more efficiently

Becton, Dickinson and Company www.bd.com

Chemistry and Spectroscopy Software

KnowItAll 2018



- Offers advanced stereochemical recognition, which is able to interpret structures (drawn or imported) using traditional stereochemical drawing conventions not supported in other available solutions
- Provides an additional 44,000 reference spectra in its library of more than 2.3 million spectra
- Presents a more accurate approach that interprets the original 3-D intent of 2-D drawings, as a chemist would

Bio-Rad www.bio-rad.com

Web App

Freeze Dryer Configurator

- Puts expertise of selecting the right freeze dry system components for users' samples at their fingertips
- Breaks the selection process into five steps. Users answer a few simple questions about the samples they want to lyophilize and the app will help select the right freeze dryer, drying manifold or tray dryer, vacuum pump, glassware, and connectors.

Labconco www.labconco.com/tools/freezone-configurator

LIFE SCIENCE

Cell Sorter

FACSymphony™ S6

- Gives researchers the ability to sort cell populations to better understand cell phenotypes for immunology and multi-omics research
- Offers six-way sorting and supports analysis of up to 30 parameters
- Includes a scalable architecture that could be upgradable to enable greater parameter analysis in the future
- Configurable through the Special Order Research Products (SORP) program

Becton, Dickinson and Company www.bd.com

Parainfluenza Virus Antigens

- Designed for use as integral components within solid phase enzyme immunoassay test procedures, especially ELISA
- Benefit the needs of biopharmaceutical, clinical, drug discovery, and life science researchers, as well as manufacturers of IVD test kits
- Exhibit exceptional purity levels as a result of chromatographic manufacturing techniques, while demonstrating exceptional lot-to-lot consistencies and high degrees of activity and specificity

Binding Site's IMMUNOLOGICALS GROUP www.immunologicals.com

Polyclonal Antibodies

Catalogue Numbers AF003.M & AF004.M

- Two new polyclonal sheep anti-human, affinity purified, FITC conjugated, monkey adsorbed antibodies
- Designed for use as an integral component within a variety of different testing procedures, especially enzyme immunoassays
- Feature exceptional lot-to-lot consistencies and offer extended shelf life stability claims
- Available in compact, standard-sized vials of 1.0 mg; with larger bulk configurations also available

Binding Site's IMMUNOLOGICALS GROUP www.immunologicals.com

Immunoassay

Bio-Plex Pro Human Cytokine Screening Panel

- Accurately quantifies up to 48 analytes linked to heart disease, autoimmunity and allergy, cancer, and many other conditions
- Provides highly sensitive detection—well below sub-picogram per milliliter range—without adding amplification steps to the workflow
- Antigens and antibodies are carefully developed in-house and tested to maximize specificity and minimize signal interference from irrelevant molecules

Bio-rad www.bio-rad.com/HumanCytokinePanel.com

Electrofusion & Electroporation System

2001+

- Able to generate both AC and DC waves, allowing for fast and efficient cell fusion in hybridoma production, hybrid cell formation, and nuclear transfer applications
- Electrofusion experiments are scalable from a few cells in 20 ml microslides up to tens of millions of cells in 9 ml coaxial production chambers
- Powerful enough to yield high transfection efficiencies for difficult to transfect sample types

BTX www.btxonline.com

Electroporators

Gemini Twin Wave Series

- Flexible systems allow universal transfection of all sample types in a single unit
- Pre-set experimental protocols support the latest application areas such as CRISPR gene editing
- Offer both square waveform settings for optimal transfection of mammalian cells and tissues, and exponential decay waveform settings for optimal transfection of microorganisms such as bacteria and yeast

BTX www.btxonline.com

Anti-Vedolizumab Antibodies

- Used to support research into the treatment of Ulcerative Colitis and Crohn's Disease
- Include four recombinant monoclonal anti-idiotypic antibodies that are highly specific for the humanized IgG1 kappa antibody drug, vedolizumab
- Generated using the Human Combinatorial Antibody Library (HuCAL®) and CysDisplay®, a proprietary method of phage display, resulting in highly targeted reagents

Bio-Rad www.bio-rad.com

Quantitative Mass Spectrometry Standards

MaxSpec™ analytical standards

- Provided in solution and formulated to save time when preparing standards and samples for analysis
- Prepared gravimetrically, supplied in a deactivated glass ampule, and sealed under argon to provide consistency and stability.
- Ongoing stability testing is performed to ensure the concentration remains accurate throughout the shelf life of the product
- Available as single standards, mixtures, and sets

Cayman Chemical www.caymanchem.com

Cell Processing System

Sefia S-2000

- Multifunctional technology allows operators the flexibility to conduct multiple cell therapy manufacturing steps with one instrument
- Pairs with dedicated software and disposable kits so operators can set the software to automate an individual cell processing step or a series of steps
- Maintains a temperature-controlled environment, allows operators to perform centrifuge-based processes of up to 10L of cellular product, and features weight sensors that automatically measure product volume

GE Healthcare www.gelifesciences.com

Cell Culture Media

OptiVERO

- A chemically defined, blood- and plant hydrolysate-free cell culture media for vaccine manufacturing that outperforms popular VERO media by enabling robust VERO cell expansion and production of difficult-to-express virus types
- Replaces unrefined components with highly pure and biologically active recombinant human transferrin and albumin
- Improves performance, consistency, quality, and safety of cell culture media for the development of novel cell-based therapeutics

InVitria www.invitria.com

Light-Sheet Microscope

InViSPIM

- Includes full incubation capabilities, as well as flexible illumination and detection optics
- Reduces sampling times over conventional laser scanning confocal microscopes, while reducing phototoxicity and damaging side effects on living specimens
- Enables the fastest scan speeds for volumetric imaging of small organisms, cell monolayers, and cleared tissue

Luxendo www.luxendo.eu

Western Blot Detection Technology

2view™

- Offers two modes of detection from a single antibody
- Allows for fast, visible detection of analytes at the nanogram level and enhanced chemi-luminescence detection down to picogram level
- Easy to use with a single incubation

SYGNIS www.sygnis.com

SUPPLIES & CONSUMABLES

Beam Expanders

TECHSPEC® DA

- Optimized at a wide range of wavelengths for maximum flexibility, ideal for use with demanding tunable laser sources
- Feature a 1940 nm design wavelength to compliment lasers with wavelengths from 1900-2100 nm
- Available in high and low power models with 2X and 3X magnifications

Edmund Optics www.edmundoptics.com

Disposable Control Valve

- Developed in response to the biopharma industry's rapidly expanding requirements for low cost components that can be sterilized through radiation and disposed after use
- Delivers instantaneous control, frictionless operation, superior precision, and exceptionally wide flow rate ranges
- Well suited to control the transmembrane pressure in tangential flow filtration control applications.

Equilibar www.equilibar.com

PRODUCT SPOTLIGHT

SAFE AND SECURE

COMBINED EXPERTISE BRINGS QUALITY AND INNOVATION TO THE RESEARCH COMMUNITY

The new PUREGRIP™ line of borosilicate glass reagent bottles have a closure design that improves a user's ability to safely handle the bottle, and certified volumetric markings that guarantee traceable calibration. Designed to be the safest, most accurate glass laboratory bottles on the market, PUREGRIP™ glassware is available at a surprisingly affordable price. The product line was developed jointly as part of the recent collaboration between Foxx Life Sciences and Borosil Glass Works Ltd. "Both Foxx and Borosil are poised to achieve success on a global scale," said Thomas Taylor, CEO of Foxx Life Sciences. "PUREGRIP™ is the first of many synergistic products we plan to launch," Taylor added.

Commonly used in laboratories, glass reagent bottles have remained unchanged for years—until now. The new PUREGRIP™ bottles incorporate VersaCap® bottle caps, providing a safe and easy way to handle reagent bottles with gloved hands, especially when the bottles are wet. The patented bottle cap has a protruding ridge that provides a comfortable, secure gripping surface for handling and transporting the bottle. The larger cap is simpler to open or close, and has a wide, flat surface for writing and labeling. VersaCap® caps are constructed from certified USP Class VI and animal-free polypropylene resin with a uniform GL 45 thread and the highest maximum operating temperature of any polypropylene GL 45 cap.

Highly durable 3.3 low expansion ASTM E-438 Type I Class A borosilicate glass is used for PUREGRIP™ bottles and flasks. Bottle sizes come in 100 mL, 250 mL, 500 mL, 1 L, 2 L, 3 L, 5 L, 10 L, and 20 L quantities, with a choice of clear or amber glass. Flasks range from 250 mL to 5 L.

For more information, visit www.foxxlifesciences.com, or call 603-890-3699

QUENCHING TISSUE AUTOFLUORESCENCE

Problem: Immunofluorescence is widely used by today's biomedical researchers in their analysis of tissue samples. The technique is highly sensitive, enabling better visualization than other methods. But while immunofluorescence provides excellent subcellular visualization of proteins, glycans, and small biological and nonbiological molecules, inherent autofluorescence—the background fluorescence in tissue sections—can complicate the signal. Fluorescent tissue components like red blood cells and collagen make it difficult to discern between relevant and background signals. Formalin fixation, which is often used to preserve tissue samples, introduces a significant amount of fluorescence as well. This is a particular roadblock with formalin-fixed kidney and spleen tissue, which have very high background fluorescence. Fluorescence due to fixation leads to broad emission over a wide spectral range including blue, green, and red emission. This background autofluorescence is particularly problematic when analyzing green- and red-channel fluorophores. Long wavelength (far-red) fluorophores may partially address this problem, but background autofluorescence may still show up in the 600-700 nm range.

Tissue autofluorescence often comes from native components, including flavins, porphyrins, chlorophyll (in plants), collagen, elastin, red blood cells (RBCs), and lipofuscin. These components are generally fluorescent in the green and yellow portions of the visible spectrum, and green-channel fluorophores are the most commonly used. This means that these native tissue components can significantly affect signal to noise when using these fluorophores.

Various treatments including sodium borohydride, Sudan Black, and photobleaching have been shown to be somewhat effective in diminishing tissue autofluorescence, however there are limitations and problems associated with each of these methods.

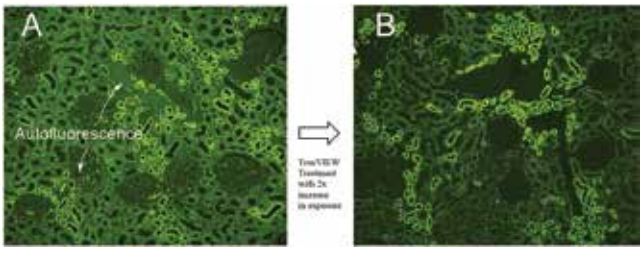
Solution: A new method—the Vector TrueVIEW Autofluorescence Quenching Kit—enables a straightforward approach and dramatic reduction of autofluorescence. The new protocol involves the treatment of tissue sections with an aqueous solution containing a hydrophilic molecule that binds electrostatically to collagen, elastin, and RBCs. This non-fluorescent, negatively charged molecule also binds effectively to formalin-fixed tissue. Once bound, the TrueVIEW reagent significantly lowers the fluorescence of tissue components through a combination of quenching mechanisms.

The treatment only requires a two-minute step at the end of the immunofluorescence assay, and it is compatible with common fluorophores such as fluorescein, Alexa Fluors, DyLight fluors, cyanine fluors, and green fluorescent protein.

The primary concern with any attempt to lower tissue autofluorescence is the effect of the treatment on the desired signal (usually a fluorophore-linked secondary antibody). Ideally, the autofluorescence would be eliminated with no effect on the signal of the fluorescent secondary antibody. With the use of TrueVIEW, there is substantial lowering of background autofluorescence with only a modest loss in the brightness due to the fluorescent secondary. The effect of lowered signal can easily be compensated for by increasing the concentration of the primary antibody or by increasing the camera exposure time when obtaining digital images (Figure 1).

With these considerations, use of the Vector TrueVIEW Quenching reagent leads to a significant enhancement in overall signal to noise in most immunofluorescent assays. This method has broad application for tissue-based immunofluorescence assays and is compatible with standard fluorescence and confocal laser microscopes, enabling the use of formalin-fixed specimens in investigations that were not previously possible.

For more information, please visit www.vectorlabs.com



▲*Figure 1. Antigen retrieved human kidney (formalin fixed), probed with anti-AE1/AE3 (green) without (A) and with TrueVIEW treatment (B). Camera exposure time was increased by two times in B to achieve optimal signal to noise. Arrows in A indicate background autofluorescence that is removed in B.*

Cell Based Screening Array Enhances Drug Discovery

Porvair Sciences has collaborated with **Persomics Inc**. (Waltham, MA, USA) to develop and supply **ANSI/SLAS format Arrays** as an OEM product for their ImagineArray™ platform.

On the Persomics ImagineArray™ platform, traditional microplate wells are replaced with contact-printed spots on a slide which is mounted into an SLAS/ANSI format frame. Each spot is a unique experiment that edits or silences a single gene in cells growing above the RNA spot. Each spot encapsulates an individual or pooled gRNA, siRNA or miRNA and all the reagents needed for transfection. ImagineArrays™ enable researchers to edit or silence thousands of genes on a single slide making them the perfect tool for cell-based screening as well as advanced experiments such as drug/gene interaction screens and synthetic lethality. This proprietary technology reduces the time and cost of drug discovery by double digit factors.

Working closely with Porvair Sciences, Persomics refined their spotted arrays and were able to have them successfully embedded in the frames made and assembled by Porvair to their demanding specification. Steve Knight, Marketing Director commented "This is yet another example of a collaborative development project between Porvair Sciences and a young start-up technology company that enables novel technology to be delivered to the market in the industry-standard microplate format with all the advantages of automation, handling and detection that the format confers".

For further information on custom development and manufacturing please visit https://www.porvair-sciences.com/custom-manufacturing/ or contact Porvair Sciences on +44-1978-666222 / int.sales@porvair-sciences.com. For further information on the Persomics ImagineArray™ platform please visit www.persomics.com.

Porvair Sciences is a leader in bespoke and specialty microplate manufacture based in the UK. Closely examining the needs of clients for special microplate designs, assembly techniques and plate structure, Porvair can deploy more than 30 years' experience in the design, assembly and testing of microplates to deliver a world-class final product that can meet or exceed the most exacting specifications.

Established in 1992, Porvair Sciences is one of the largest global manufacturers of ultra-clean microplates for life science, synthetic chemistry and many other applications. Porvair Sciences Ltd. is a wholly owned subsidiary of Porvair plc.

porvair sciences

For further information:
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ENSURING CONTINUOUS ONLINE DATA COLLECTION

Problem: Working together with the U.S. Department of Energy's ARM Climate Research Facility, Argonne National Laboratory, a multidisciplinary research center where scientists and engineers focus on some of the world's largest energy and environmental issues, is tasked with measuring all types of climate information—from wind, soil, cloud physics, precipitation, and more—often working in some of the world's harshest environments.

With ARM facilities located in remote areas around the world, often in inhospitable conditions in places like Alaska's North Slope and icebreakers near Antarctica, it's not possible to have "normal" data centers with clean power and steady air conditioning for collecting crucial data. The "best" places for data centers in ARM and Argonne's case are sites like sea containers and generator-reliant locations. Remote sites like this are subject to power outages, dirty power, extensive vibrations, temperature fluctuations, and other major challenges. But with crucial research being conducted, Argonne cannot afford for their systems to go down and risk losing vital data. The remote data centers not only need to remain online 24/7, but must also keep up with data-heavy research, so the lab needs to be able to collect data at a rate of 4K to 4GB per hour from a variety of different climate instruments.

At first, the Argonne team attempted to build its own homegrown data storage solution, but the team soon realized that this approach was too expensive, difficult to operate, and unreliable. As a result, Argonne set out to find a storage solution that would meet its very specific requirements.

To make sure their storage system could withstand extreme environments, Argonne was on the hunt for systems that were not only highly reliable, but also durable. The storage needed to have data redundancy and replication components built in to ensure no single point of failure in collecting data. The systems also needed to be able to expand to store hundreds of TB of data within as little space as possible, while also keeping up with multiple streams of data input from a variety of instruments. And, perhaps the most important requirement, if the storage system was forced offline due to the complications that come with being in remote locations, it needed to have the ability to restart at the exact point where power dropped to avoid costly data loss.

Solution: After assessing a variety of options from various storage vendors, Argonne found Nexsan's storage solutions, specifically Nexsan's Unity storage, to be the only system that met all of its unique requirements. Nexsan was implemented in seven different research locations very quickly, with a total of 1PB of raw capacity that includes more than 500 hard drives deployed on Nexsan storage arrays throughout the various locations.

Since deploying Nexsan, Argonne has never had any instance that has caused serious data storage failure or downtime, but even "when there have been small issues, Nexsan support has been able to provide on-site staff to replace hardware, even traveling to our most remote locations like the Azores," said Cory Stuart, Argonne's ARM site data system and cybersecurity manger.

Ultimately, by implementing Nexsan's storage solutions, Argonne has been able to successfully tackle the storage challenges that come with collecting data in places where it's difficult to live, let alone run a data center, and it has been able to achieve this at a cost far less than what they could do on their own or with any other vendor the lab assessed.

For more information, please visit: www.nexsan.com

▲*The Aurora Australis Supply Vessel. Photo credit: ARM Climate Research Facility Flickr*

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LAB MANAGER ONLINE

We look back at our web content since the June issue and look forward to what's in store for the upcoming Product Resource Guide in August.

1 Automation Resource Guide

One of our most recent online exclusives is an informative eBook on lab automation. Automation makes producing data and information faster and less costly. It also enables scientists to analyze, model, and produce better research. The eBook covers trends in lab automation, questions to ask when buying automated systems, and more.

Read more at
LabManager.com/automation-guide

2 Trending on Social Media: Comparing Lab Results

As of June 12, *Lab Manager*'s top June issue article posted to social media was our Business Management article: "Comparing Lab Results." This article discussed the use of paired difference calculations as a method for comparing test results from various sites in a cost-effective manner while still maintaining precise, accurate, and repeatable data.

Read more at
LabManager.com/comparing-lab-results

3 Most Popular Webinar

Last month's top webinar on LabManager.com with 347 registrants was "Optimizing Uptime for KF and Spectroscopy Moisture Analysis," sponsored by Metrohm USA. This Product Spotlight webinar provided tips for identifying sources of error in a KF measurement and offered a basic timeline for maintenance to help users prevent unexpected downtime. Though it ran on May 30, you can still register to watch on-demand.

Read more at
LabManager.com/spectroscopy-moisture-analysis

LabManager.com

NEXT ISSUE ➡ Product Resource Guide 2019

This year's edition of the guide will feature refreshed versions of our "Questions to Ask" lists for buying or upgrading all types of laboratory equipment, safety tips for the main product categories in the guide, and links to related content, including our infographics, Linda videos and comics, and eBooks.

ASK LINDA
COMMUNICATION MATTERS

QUESTION:

Dear Linda,

I have only recently moved into the lab manager role and I am still getting my feet wet. My team of 12 are all highly qualified and committed individuals. However, due to either cultural, personality, or generational differences, I have hit a few stumbling blocks when it comes to communication. Either I am not making myself clear or some individuals aren't comfortable with the back-and-forth of information exchange. As a result, I worry that this communication breakdown might lead to further misunderstandings and bad morale. Any advice for this newbie?

Thanks,
Leonard

ANSWER:

Dear Leonard,

Effectively communicating with staff members is a critical skill for laboratory managers. In particular, staff members have to feel that the manager is providing valid information, is not withholding information, and is available to listen. Supervisors need to understand how communication breaks down if they expect to fix it. Different people require different tactics. Below are a few general rules for improving your communication skills:

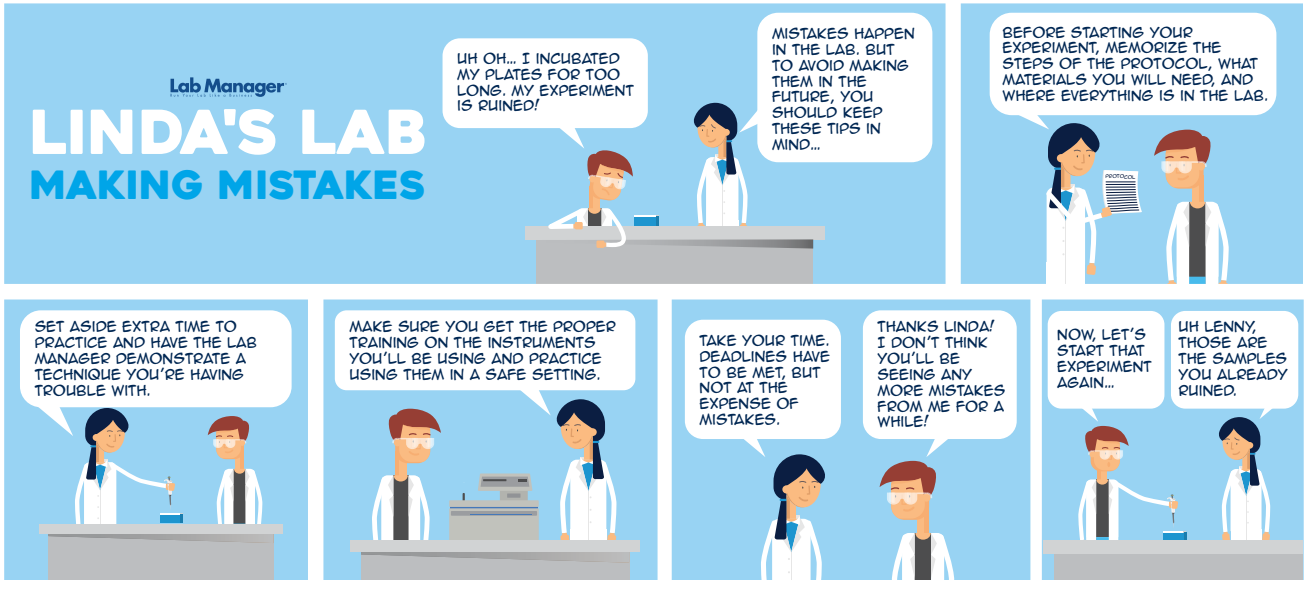
- Pay attention to body language, especially yours.
- Think before speaking. While thinking out loud is okay for brainstorming sessions, it can monopolize a discussion and be quite distracting.
- Train yourself to listen deeply and clarify what you are hearing as you go along.
- Never assume everyone will understand what you mean and why you are saying what you are saying.
- When you do lab evaluations, include the lab members' communication [ability]—with you, with peers, with other staff—as an important item to assess.
- If lab members fall short on their communications, step in and mentor them.
- When you talk to employees, always be honest with them.
- Don't rely on electronic communications, except to back up what you've told people in person.
- Precision and clarity are essential to both oral and written communication.

Good communication will not happen accidentally, but it is a skill that can be learned. Good luck.

Cheers,
Linda

HAVE A QUESTION FOR LINDA?
EMAIL HER AT: *LINDA@labmanager.com*

FOR MORE INFORMATION, SEE "EFFECTIVELY COMMUNICATING WITH YOUR STAFF" AT LABMANAGER.COM/EFFECTIVE-COMMUNICATION.



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