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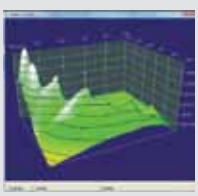

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Lab Manager Magazine® (ISSN: 1931-3810) is published 10 times per year; monthly with combined issues in February/March and July/August, by LabX, P.O. Box 216, 478 Bay Street, Midland, ON Canada L4R 1K9. USPS 024-188 Periodical Postage Paid at Fulton, MO 65251 and at an additional mailing office. A requester publication, Lab Manager, is distributed to qualified subscribers. Non-qualified subscription rates in the U.S. and Canada: $120 per year. All other countries: $180 per year, payable in U.S. funds. Back issues may be purchased at a cost of $15 each in the U.S. and $20 elsewhere. While every attempt is made to ensure the accuracy of the information contained herein, the publisher and its employees cannot accept responsibility for the correctness of information supplied, advertisements or opinions expressed.
WDS Canadian return: P.O. Box 216, 478 Bay Street, Midland, ON Canada L4R 1K9.

POSTMASTER: Send address changes to Lab Manager Magazine®, PO Box 2015, Skokie, Il 60076.

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Five Years and Counting

This month *Lab Manager* celebrates its fifth year as part of LabX Media Group. Our mission—to help managers run their labs like a business—remains our foremost goal. Over the past five years we have worked hard to deliver timely information on the topics that matter most—from changes in workforce demographics, to the advent of social media and laboratory apps, to the economic challenges of the post-recession environment. In addition, we now offer webinars on management, business, lab safety, as well as the latest laboratory technology. Through our annual surveys, we keep you informed on matters of investment confidence, salaries and job satisfaction, lab safety practices, and purchasing trends. And if that wasn't enough, we are currently at work on two new projects. The first, a complete redesign in both look and function of the *Lab Manager* web site, and second, the creation of a new online purchasing tool we call the "Dynamic Product Finder." Look for both of these in early fall.

With the commitment of our parent organization and the support and collaboration of our art and IT departments and support staff, *Lab Manager* continues to innovate and enhance its editorial and online offerings. Commitment, innovation, collaboration—what any enterprise needs in order to thrive. Which brings us to this month's cover story.

Employee commitment, cooperation, and the ability to take initiative is a tall order in any work environment, but especially challenging in the area of scientific research. "Labs are very much the prototypical example of the highly trained, high-ego workforce type," says Vish Krishnan, a professor at the UCSD Rady School of Management. In this month's cover story, he likens the management of such highly independent-minded workers to "the herding of wild cats." The good news is that through metrics, training, economic pressures, and cultural evolution, there is a move toward greater cooperation and less competition in both academic and industrial labs. Krishnan believes that as the pie (essentially research grants and related funding) gets smaller, researchers are realizing that "they have to manage themselves better, learn to address conflicts more effectively, find better ways to work together more cohesively, and develop value systems that stress cooperation as a priority."

On the topic of innovation, this month's Lab Manager Academy presenter, Michael Stanleigh, says, "I started to realize that the successful implementation of ideas was really a form of 'innovation' and that innovation was, in fact, a collaborative process that required people from different areas to contribute to moving from an idea into reality." Turn to page 22 to learn more.

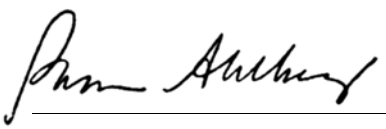
As for collaboration, Mark Lanfear in this month's Science Matters column says, "Real economic pressures in the last several years have meant that when it comes to small, niche labs, or even the world's largest drug developers, we're all having to produce more with less. Whatever the reason for this cultural shift, however, we are all benefiting: More collaboration will mean better development in the future as we pool resources and knowledge to create the truly innovative products."

Greater collaboration however requires greater attention to social conduct, which requires greater attention to laboratory etiquette. Turn to this month's Leadership & Staffing article, "Fostering Good Behavior," to find out how your lab measures up in the manners department.

As always, I hope everything in the July issue helps you keep your lab running smoothly.

Here's to the next five years.

Best,



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HERDING CATS

MANAGING & INCENTIVIZING INDEPENDENT-MINDED RESEARCHERS

by Bernard Tulsi

Leaders in research and service laboratories make no secret of their desire for a bigger serving of commitment and cooperation from and among their staff scientists and technicians. Lab directors have, more often than not, tried to implement reasonable performance metrics and attractive incentives, carefully tailored to their organizations' culture. They painstakingly nurture and monitor such motivators in an effort to encourage staff to participate more fully. Despite such efforts, however, cooperation and commitment often appear to be available only in meager portions.

> "Metrics should be formulated to measure not only performance but also intangibles."

Vish Krishnan, a professor at the Rady School of Management, University of California, San Diego (UCSD), says that such initiatives fall into the routine, normal four-step PDCA (plan-do-check-act or plan-do-check-adjust) improvement cycle in most organizations. "This is not rocket science, but it is hard to implement and keep on track," says Krishnan, who adds, "Labs are very much the prototypical example of the highly trained, high-ego workforce type." He likens the management of such highly independent-minded workers to "the herding of wild cats."

Successful PDCA implementation in the lab setting requires three key elements—training, metrics, and incentives, according to Krishnan. "Training is essential to make sure people understand how to perform their tasks and functions and for them to know that the organization values them and their skills," he says. Metrics should be formulated to measure not only performance but also intangibles such as cohesiveness in working together. "Incentives change behavior, by and large," says Krishnan.

Turning to factors that impede cooperation and commitment in a laboratory environment, Krishnan says, "The challenge in a lab management setting is that we are dealing with a highly trained and knowledgeable workforce—so you can't use hierarchical management techniques." He is careful to point out, "This is not exclusive to the lab but can be seen in other types of knowledge-oriented businesses as well."

"These workers are highly capable and extremely talented, and that is an important part of the challenge in getting their cooperation and commitment," he says. For Krishnan, one key question is how to find the alignment between cooperation and commitment goals within a horizontal workforce as opposed to a more vertical one, where hierarchical or command methods have been known to generate positive outcomes.

Krishnan sees a mix involving the pursuit of individual interests, heightened competitiveness, and turf protection as definite impediments to cooperation. "In grant funding, for example, there is very little room at the top, and competition is heavy. These are highly competitive people, often with strongly held points of view, who have acquired advanced degrees and training, experiencing inherent competition along the way—so there is that competitive spirit."

"Unfortunately, their scientific training may not have prepared them to be team players. There could be a diversity of perspectives, which can actually be a strength." Krishnan says better integration will help diversify the risks but lab staffers are "not taught that way."

"We are taught that the world is convergent, that there are unique results, and that we need to pursue them. I think that is in part the competitive attitude, partly the training, and partly the convergent mindset—all of these pose problems," says Krishnan.

"Individual interests, heightened competitiveness, and turf protection [are] definite impediments to cooperation."

In entities where there are inadequate levels of cooperation, Krishnan says, "Progress is generally slower, and we may not be getting the best from individuals. Their fullest effectiveness is not realized because operational skills are not optimized; the entity is not firing on all cylinders."

Rutgers University management and global business professor Deborah Dougherty notes that laboratory researchers tackle complex questions, typically seeking innovative solutions. She points out that in the case of drug discovery, one of her research specialties, researchers use different, even competing, methods to sift through enormous amounts of complicated, unpredictable, and often interdependent data to arrive at therapeutic solutions for hitherto unmet medical needs.

In a September-October 2012 article in *Organization Science*, Dougherty and co-author Danielle Dunne, a professor at Fordham University, reported findings from their research, which included interviews with 85 scientists and managers engaged in drug discovery. The authors noted that drug discovery is currently tackled by at least two disparate types of scientists who target the same goal—safe and efficacious therapies. There are the therapy scientists, who work in traditional laboratories and investigate physical materials, and digital scientists, who utilize computer technology to manipulate digital signals. The latter group is focused on bioinformatics, genomics, proteomics, and metabolomics, among others, that would be impossible absent advanced computer technologies. In essence, each group deals differently with the complexities of drug discovery.

The authors noted that such differences interfere with cooperation. Part of the solution, they suggested, entails the development of ways to transform innovative activity. Their work suggests that the creation of new common ground would facilitate the integration of knowledge and help overcome the challenges associated with complexity.

In an interview with *Lab Manager*, Dougherty adds, "Strategy shapes the innovation process, which is very complicated," and it is

important that researchers and scientists understand the underlying strategic goals of the entity in which they conduct research or carry out other activities.

She says it is essential for administrators to create work environments in which the staff can become energized, motivated, cooperative, and committed. She notes, however, that it is hard to commit to a place where what is required is unclear and where punishment is meted out for not completing tasks that workers never expected to do and did not know they were required to complete.

"If you want commitment, you have to foster an engaging, motivating work site," says Dougherty. Much of the available research suggests that scientists are motivated by the pursuit of new knowledge, which they can use to figure out better, more innovative processes and improved products, she notes.

"This is what draws scientists and researchers and is an important motivator available to lab managers," she says. It is also an automatic driver of collaboration, which could readily be observed not only within organizations but also among scientists and researchers across entities and around the world.

"When we look at people who are ultimately successful, it requires a combination of technical and social skills."

Krishnan says, "There is strong recognition at UCSD that we need to train our graduate students, post docs, and junior faculty more broadly, in a multidisciplinary way." He also cites recent calls for proposals from the National Institutes of Health (NIH) that require universities and institutions to train people more broadly as part of this overall recognition.

"Even in the lab setting, there is a need for principal investigators (PIs) to have a broader approach. Typically their technical skills are great, but technical skills will only take you so far. When we look at people who are ultimately successful, it requires a combination of technical and social skills. These are the two halves of success," says Krishnan.

He says that the next generation appears more acutely aware of the value of these skills and is likely to embrace them more eagerly. "There is great motivation to change the curriculum to move beyond technical skills, and some students in our institution are really making the case that we need to make room for some of these more pragmatic skills as opposed to narrow technical skills. It will, of course, take some time before it permeates the curriculum, but there is definitely a trend in that direction."

With respect to where the problems with cooperation and commitment seem most severe, Krishnan, who also consults for private sector businesses, says, "From my experience, academia seems to have a worse problem than corporate entities."

He notes, however, "It really depends on the culture of the organization and how it is managed. For example, at UCSD we have the Clinical and Translational Research Institute (CTRI), headed by Gary Firestein, who has a lot of industry and practical experience. As a result, he manages the center professionally and has instilled a mission-focused culture. So even in academia we have settings in which people work together very well—and in some companies in the private sector we see dysfunction."

Krishnan explains, "In general, it may be that in companies having a profit-maximizing role, and subject to quarterly and other stringent financial measures such as investor pressures, they may have the incentive to put aside their differences and work together.

Even in academia, the pressure of funding is ratcheting up so much that people are realizing that they have to work together. In a number of cases, grants require multifunctional perspectives, so there is really a strong incentive to find ways to work together."

Krishnan believes that as the pie (essentially research grants and related funding) gets smaller, researchers are realizing that "they have to manage themselves better, learn to address conflicts more effectively, find better ways to work together more cohesively, and develop value systems that stress cooperation as a priority."

With respect to practical advice on concrete steps laboratory leaders can take to improve cooperation, Krishnan says the first is diagnosis: "Find out what is causing the problem. Are there some bad apples, people who are particularly hard to work with and who consider whatever you do a problem? Or are there systemic cultural issues within the organization? This is the kind of diagnostic assessment that you do up front."

He says that training works in some cases. "Train people about the value of diverse perspectives. Sometimes this could be couched as project management because people may not want to take classes or training. Project management seems to get to the fine line between technical and social; it is really a balancing act, and people can really see the value." He says that positioning training as project management allows for the incorporation of a range of topics including how to work in teams, how to run meetings, how to manage time, and how to manage conflict, among others.

"Eventually metrics—measuring people not only on their technical performance but on their ability to work together—can help elicit cooperation. We know that people respond to metrics and incentives, so if we have the right metrics and incentives, people should be able to move in the right direction."

"Measuring people not only on their technical performance but on their ability to work together—can help elicit cooperation."

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MANAGING QUALITY

THE LAB MANAGER'S ROLE IN BUILDING A ROBUST, RELIABLE ANALYTICAL QUALITY SYSTEM

by Wayne Collins

It can be said that a laboratory's reputation must be like Caesars's wife—beyond reproach. One of the laboratory manager's top priorities must be to ensure that testing quality is handled impeccably and honestly to safeguard this reputation. Responsibility for the quality of work coming out of the lab rests squarely on the lab manager's shoulders—tasks can be delegated but, in the end, the buck stops with the manager. So how can a manager be sure that the results coming out of the lab are correct when business responsibilities leave so little time to oversee the science? The answer, of course, is to build systems to protect the quality and to monitor measures of system performance in order to react quickly to any indication of a failure.

"Responsibility for the quality of work coming out of the lab rests squarely on the lab manager's shoulders."

Analytical quality is ultimately defined by the client, whether internal or external to the organization. The basic expectations that can reasonably be applied to any lab are listed in Figure 1. The manager has several options as to how to meet these expectations, but all systems have certain elements in common—a robust calibration program, well-defined methods, well-trained analysts, and so forth. The elements are typically defined within the framework of a quality assurance program that is meant to fulfill management responsibility for the quality of the lab's outputs, assure analysts of the quality of their work, inform clients of the quality of data, inspire confidence in the lab's results, provide documentation for present and future use, and protect the lab's interests.

CUSTOMER'S EXPECTATIONS FOR LABORATORY QUALITY

Analytical Measurements should be made to satisfy an agreed requirement

Analytical Measurements should be made using methods and equipment which have been tested to ensure they are fit for purpose.

Staff making analytical measurements should be qualified and competent and able to demonstrate that they can perform the analysis properly

There should be a regular independent assessment of the technical performance of the laboratory

Analytical measurements made in one location should be consistent with those made elsewhere

Laboratories should have well defined quality control and quality assurance procedures

Laboratories should use validated methods

▲ *Figure 1. Customer's Expectations for Laboratory Quality.*

The first step in establishing an analytical quality assurance program is so basic that it is sometimes overlooked by the laboratory—it is to simply define what quality means for the particular test. Quality is not a universal concept but is a relative determination based on the requirements of the end user of the results. Test quality always includes two aspects: qualitative identification beyond a reasonable doubt and numerical accuracy. But the specifics for each test are determined by the intended use of the result.

For each test, if sensitivity, consistency, and uncertainty are adequate compared to end-use requirements, then quality is acceptable; however, what is considered high quality in one situation could be unacceptable in another.

For example, a measurement at the parts-per-million level for a client who simply needs a result to the nearest percent represents a case in which testing quality is very high although perhaps not the best choice if it adds extra costs for the client. If the same parts-per-million measurement were made for a client that required parts-per-billion level results, then the testing quality would be considered low since it would not meet the client's expectations.

Many factors determine the correctness and reliability of the tests and/or calibrations performed by a laboratory. These include contributions from human factors, accommodation and environmental conditions, test and calibration methods and method validation, equipment, measurement traceability, sampling, and the handling of test and calibration items. The extent to which the factors contribute to the total uncertainty of measurement differs considerably between types of tests and between types of calibrations.

"Properly validated procedures are another essential element in managing the quality of laboratory testing."

The fundamental premise of analytical quality assurance is that measurement may be established as a process that may be brought to a state of statistical control with a characteristic precision and accuracy that can be assigned to the data output. The basic requirements for applying statistics are that the measurement system is stable, individual measurements are independent of one another, and individual measurements are random representatives of the general population of data. Unfortunately, it is nearly impossible to confirm that these conditions are met, so the solution is to look for evidence of nonconformance. This is typically done through a statistical process control scheme in which a well-characterized reference material is routinely analyzed over time, with the result plotted in a control chart. By analyzing the chart using the specified set of rules each time, a new result is entered, nonconforming results are easily identified, and corrective action can be taken if needed. Specific details of such a system have previously been described.[1]

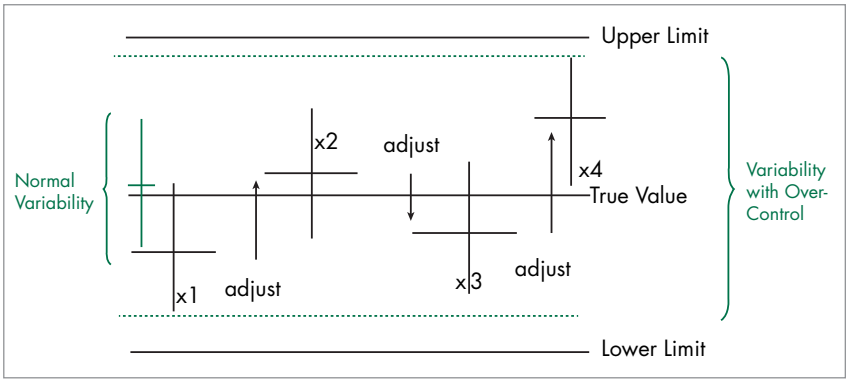
Properly validated procedures are another essential element in managing the quality of laboratory testing. Nearly all labs have implemented a system of controlled written methods that specify exactly how each test is to be performed; these may be backed by a policy requiring all analysts to follow these procedures exactly (without any deviation). While this system might be sufficient to ensure consistency, it might still hide a weakness if the validation of the procedures was not performed properly.

Method validation is the process of verifying that a procedure is fit for its purpose, i.e., for solving a particular analytical problem; it includes verification that a method is suitable for its intended purpose, establishes performance characteristics and limitations, identifies influences that might change characteristics, and identifies the extent of changes from possible influences. Thus, the demonstration of scientific validity under a given set of circumstances that is the focus of most method development is a necessary but not sufficient condition—it must also be shown that the method is reliable and appropriate for all circumstances relevant to the particular purpose for which it was developed. Analysts charged with method development for their own internal use sometimes fail to maintain the rigor necessary to complete the full validation of the method due to time constraints. Since method development is typically included in an analyst's performance objectives, lab managers can ensure that appropriate rigor is achieved by reviewing each element of the validation process with the analyst during periodic evaluation sessions.

A calibration program is a primary element of any laboratory quality plan. Calibration is defined as the process of establishing how the response of a measurement process varies with respect to the parameter being measured. The usual way to perform calibration is to subject known amounts of the parameter (e.g., using a measurement standard or reference material) to the measurement process and then to monitor the measurement response. The two major aims of calibration are to establish a mathematical function that describes the dependency of the system's parameter (e.g., concentration) on the measured value and to gain statistical information for the analytical system (e.g., sensitivity, precision). Calibration methods typically define acceptable tolerances and give instructions on how to make the instrument adjustments, but they often neglect to describe how the data are to be treated or to define the rules for when an adjustment should be made. When a calibration standard is measured and the instrument is adjusted, it is rare that the measurement is centered on the exact value of the calibration standard.

Chasing exact agreement with the standard by continuing to adjust the instrument is an exercise in futility. Surprisingly, many analysts fail to grasp this concept and continue to "tweak" the instrument each time they measure the standard, even if the measurement is within the tolerance range. This actually increases the error, due to an effect known as "overcontrol"—as illustrated in Figure 2. The preferred way to manage calibrations is to institute the same type of statistical process control system previously described for monitoring test quality. The rules of the system then dictate when to make an adjustment to the instrument rather than relying on the analyst's judgment.

"It is not uncommon for labs to introduce errors by failing to consider this calibration bias correction when reporting results."



▲ *Figure 2. Illustration of increased variability in measurement due to overcontrol*

By charting the calibration standard measurement, limits are based on actual instrument precision rather than on arbitrary tolerances, the graphical presentation reveals potential problems not easily discoverable by other techniques, and the defined rules for when to make an adjustment eliminate the excess error introduced by overcontrol. If the standard is measured perhaps 20 to 30 times while making no adjustments to the instrument, the data can be used to calculate the average measured value, which can then be compared with the specified value for the standard. The difference between these values is the bias, which should then be added or subtracted from every subsequent measurement; however, it is not uncommon for labs to

introduce errors by failing to consider this calibration bias correction when reporting results. Ideally, the bias correction should be applied to measurements of the calibration standard prior to charting as well as in reporting sample results.

The next element in managing test quality is participation in an organized proficiency testing program to demonstrate that measurements made in the lab are in agreement with measurements made by the majority of labs performing the same test. While labs can collect statistical data to determine the precision of their tests, proficiency testing adds the extra dimension of accuracy to help detect and repair any unacceptably large inaccuracy in their reported results. The process consists of many labs measuring samples drawn from the same population; using the identical method; and reporting results to the organizer, who evaluates the data using statistical tests.

Most schemes convert the participant's result into a "z-score" that reflects two separate features—the actual accuracy achieved (i.e., the difference between the participant's result and the accepted true value) and the organizer's judgment of what degree of accuracy is fit for purpose. While proficiency testing serves a vital purpose within the lab's quality management program, its limitations must also be recognized. It cannot be used as a substitute for routine internal quality control, is not a means of training individual analysts or a way of validating analytical methods, and does not provide any diagnostics to help solve testing problems, and success in a proficiency test for one analyte does not indicate that a laboratory is equally competent in determining an unrelated analyte.

The product of laboratories is data—measurements that can be applied in some manner to solve a problem, build a new product, control a process, or otherwise contribute value toward the objectives of the client. The unimpeachable integrity of these data increases the lab's value by allowing the client to proceed toward its objectives with confidence while enhancing the lab's stature. The lab manager's time in building a robust, reliable analytical quality system is well spent.

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CHANGING WORKPLACE EXPECTATIONS

By Mark Lanfear

It wasn't so long ago that we lived in a world without the Internet, without social media, and without such convenient ways to communicate and interact with others in both our personal and professional lives. This was a time when classic etiquette rules still applied—when people cared about social graces—and when first impressions truly mattered.

> "It can't be denied that technology has changed the etiquette game in many situations."

Of course we all still want to be polite in our daily lives and to live by basic rules of decorum. But it can't be denied that technology has changed the etiquette game in many situations. And in some sense, though the Internet has been around for about two decades, we're all still getting used to a world where the way we interact with other people is often changing and morphing according to the new situations in which we find ourselves.

In the lab—as in most workplaces in the 21st century—we've seen etiquette dramatically change over the last several years, too. But it hasn't changed in the way you might expect. I'm not talking here about the simple ways we find to be polite to each other while on the job. In a much larger sense, because workplace expectations on the part of both employees and employers have changed so dramatically, I'd like to argue that lab etiquette should now be all about knowing how to recognize those changes—and being able to alter our styles of management in meaningful ways to accommodate them.

It's not surprising that the way we interact with our colleagues in the science workplace has changed, considering how dramatically the industry has shifted focus from a culture of secretive development to one of extremely open collaboration, often with surprising partners. This isn't just because we've all become more "social" beings through technology. Real economic pressures in the last several years have meant that when it comes to small, niche labs, or even the world's largest drug developers, we're all having to produce more with less. Whatever the reason for this cultural shift, however, we are all benefiting: More collaboration will mean better development in the future as we pool resources and knowledge to create the truly innovative products that we are all so passionate about in the life sciences.

The cultural shift at work is the driving force behind the new expectations that workers have on the job. Time and again, in survey after survey, data shows that people aren't expecting to come to work anymore to just silently sit and do their jobs. Even in the life sciences, where solitude has in the past been seen as a virtue, science professionals are opening up and wanting to better connect with their colleagues.

> "The cultural shift at work is the driving force behind the new expectations that workers have on the job."

For instance, according to the latest Kelly Global Workforce Index, soft skills lead the pack in the types of skills that workers see as most valuable to their careers. In fact, 88 percent of responders from this global survey of science professionals consider cooperation and teamwork to be among the most important soft skills to take with them to work every day. This is followed by such skills as active listening, good verbal communication, and the ability to organize and pay attention to detail.

Those working in the sciences today also are very aware that they—not necessarily their employers—are the ones who will be moving their careers forward. So workers are now more attuned to finding opportunities to advance their skills on the job. But science workers aren't just in it for themselves. They also want their work to be meaningful, and they want to be appreciated for the technical skills they bring to an organization.

"Science professionals are opening up and wanting to better connect with their colleagues."

It is crucial that we as managers stay on top of these types of things, which may seem intangible but are nevertheless very important aspects of today's workplace. Especially in the sciences, managers can take this type of information, such as knowing that today's workers highly value collaboration, in order to build a workplace culture that reflects these new values. The potential for building loyalty by doing so is high, and you may find that your best employees are willing to stay with you for the long haul if they know that their employer values their priorities, too.

By following these new rules of etiquette on the job, we will all be able to build relevant and competitive workplaces that are more open and sustainable—and that employ and keep the best people.

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M. Emilia Di Francesco, PhD Pamela Halpin, PhD

ASK THE EXPERT

CHOOSING THE RIGHT ELECTRONIC LAB NOTEBOOK: TIPS FOR EVALUATION AND IMPLEMENTATION

by Tanuja Koppal, PhD

Contributing editor Tanuja Koppal, PhD, talks to two chemists, who are both users of electronic lab notebooks (ELNs), about their experiences and what they've learned. They discuss the reasons behind transitioning from a paper notebook to an ELN, what factors they considered important to have in an ELN, how they went about choosing the right vendor, and how they implemented the ELN to suit their needs.

Excerpts from an interview with M. Emilia Di Francesco, PhD, group leader for Medicinal Chemistry at the Institute for Applied Cancer Science (IACS) at MD Anderson Cancer Center

Q: As a medicinal chemist, why do you need ELNs for your work?

A: Currently we use ELNs to track the experimental procedures used for chemical synthesis as well as for analytical characterization of the quality and purity of the end product. I first came in contact with ELNs while working at Merck, and like many big pharma, they transitioned to using ELNs many years ago for all the advantages it offered. So when it was time to move out of big pharma, I wanted to invest in and implement ELNs in the lab, although I was moving into an organization with a much smaller operation.

Q: Can you mention some of the advantages that ELNs offer you?

A: On a daily basis ELNs simplify the overall operations in terms of detailing experimental procedures, and you can preselect certain features, so that the regular maintenance becomes quick and routine. Beyond that, ELNs offer a way to share procedures and knowledge across the team. Within a drug discovery organization, you have chemists, biologists, and pharmacologists, and the features of the ELN can be tweaked so that it fits everyone's needs. With ELNs, you have the ability to access the primary data generated by other labs on the team, which is very useful. It's a fantastic tool not only to collect text and procedures but also to collect primary data in multiple formats. For instance, I can import imaging data that a biologist generates, along with the NMR spectra from my chemistry group and other types of data, in a PDF or in Excel sheets. I can work on my notebook off-line and synchronize it later.

Q: Do ELNs offer any particular advantages for a chemist?

A: For chemists, the ELN offers a chemical structure drawing interface that affords a clear understanding of the chemical reaction taking place. There is also access to a small, searchable database of widely used commercial reagents that can be added to your notebook, which eliminates the need to draw it. The ELN is also searchable for text, and you can search by chemical structure or reaction. It's easy to set up an experiment in your notebook and it's much easier for everyone to then read and duplicate it. When it comes time to upload your data into a publication or patent, it's easy to export the information, whether into a Word document or any other format. For patentability, all notebook entries must be complete with a time stamp and must be countersigned by someone knowledgeable in the lab. The time stamp is an automatic feature of the ELN, and it helps us all track and stay within the time frame of our projects. What I hated most about lab notebooks was creating the index, where I had to enter the experiment and yields manually. In ELNs, the index is an automatic feature of the software.

Q: Is the interface simple and user-friendly?

A: The interface is a single page of the notebook and you can work your way up to see the data entered by you and your colleagues across teams. Every change is recorded and makes its way into the history of the page. A page is closed when all ancillary data has been included and has been signed and countersigned by a witness. It is then sent to the long-term archive on the server. However, the data can always be accessed and modified, if needed. We have a secure server and hence, data security is not a concern. We have set up our ELN as an open-access system in order to share knowledge and access all the primary data. With open access, we can get to the primary data even after a colleague has left the company, which makes it easier for publishing a paper or patent. It's also highly customizable.

Q: What features would you like to see added to it?

A: The ELN we had at Merck had a lot more bells and whistles, some of which I do miss, but it's all a matter of having the budget to make the investment. For instance, at Merck every piece of analytical data that was sent to the printer was also saved as a PDF and could be directly

M. Emilia Di Francesco obtained her master's degree in chemistry from the University of Rome La Sapienza, and soon after joined the Merck Research Laboratories, working as a medicinal chemist in both their Italian and UK research sites. After a few years, she moved to Cambridge, UK, for her PhD studies, and then returned to Merck (Rome, Italy, and Boston, Massachusetts, USA), where she led medicinal chemistry projects in several different therapeutic areas, including antiviral and oncology. In 2012, she joined the MD Anderson Cancer Center, Houston, Texas, USA, as the group leader for the medicinal chemistry team in the newly founded Institute for Applied Cancer Science (IACS). Together with the team at IACS, she is focusing on metabolism and epigenetic targets and leveraging the clinical and basic research expertise at MD Anderson, with the goal of developing novel therapies for cancer patients.

Pamela Halpin obtained her PhD from Northern Illinois University and completed a post-doctoral fellowship with the FDA in Cincinnati. She has worked in R&D, analytical, and quality control labs, using a varied array of chemistriesn, from silicon at Dow Corning to complex inorganic pigments at Shepherd Color to surfactants and lubricants at BASF. She has been the Quality Operations Manager at the BASF production site in Cincinnati since 2010. This site has a variety of chemistries and methodologies that require both a depth and breadth of knowledge that makes for an interesting and fast-paced day.

imported into the notebook and archived. Now I have to manually import that piece of data into my notebook page. Another aspect that we don't have for budget reasons is the synchronization and access to a large commercial database of reagents. So we end up having to draw a lot of chemical structures ourselves. But it's still very helpful, and once you are used to it, you cannot live without it.

Excerpts from an interview with Pamela Halpin, PhD, Quality Operations Manager at BASF.

Q: What drove your decision to transition to an ELN?

A: We are a central quality control (QC) laboratory, and the way we are set up is that we have our lab in one location but receive samples from two different locations. One set of samples comes from the building we are in and the other half come from our production plant across the river. We had no clear way to get the data from our lab to the production area. We were either faxing results from the instrument log or populating a spreadsheet and then calling people to tell them that the results were in. This was really cumbersome and the chemists in my group were functioning as transcription clerks. Sometimes there were errors in transcription and hence, we wanted the data to flow in an automated fashion to reduce the errors and get the chemists working as chemists, and not as clerks. This journey to acquire an ELN started in the fourth quarter of 2010, while we were still a part of Cognis Corporation. In 2011, we were purchased by BASF and we had to wait until our systems were integrated to figure out what we needed before we could make any changes.

Q: How did you determine what you needed in an ELN, in terms of its features and offerings?

A: We are a 24/7 operation with a team of nine chemists. I talked to all the chemists and asked them to identify their bottlenecks. Then I talked to the folks in production and asked them about issues that they were facing with the data. So I talked to all the people who were going to be using the ELN, from every aspect that it could be used, and developed our wants and needs based on that input. Essentially, we just wanted one system that would take the data from the instruments and put it where it needed to go. We wanted the ELN to perform certain calculations and access standard operating protocols (SOPs) and maintenance and calibration records and integrate with systems like SAP that we already had in place. We wanted the data to flow reliably and accurately and be located in one central system. Otherwise, the chemists would turn into electronic clerks.

Q: How did you go about picking the right vendor and product?

A: We picked a system that was a one-stop shop and integrated nicely with the systems we already had, to provide the connectivity that we needed. We first determined our wants and needs. For our needs, we drew a line in the sand and essentially eliminated all the vendors who couldn't provide that. We then had three vendors come and demonstrate what they could offer. One of the things that I wanted was to be able to make changes on the fly, as is the case in a QC lab. Only one of the vendors could show us how to do that. We did a pilot run in November 2012, which was wildly successful; we then purchased the system in April of this year. For the pilot, we took data from one of our gas chromatography instruments and put it into a worksheet. We then had the ELN perform all the necessary calculations and we could check all the calibrations and inventory and access all the SOPs. The system is very user-friendly and fairly configurable. When we didn't like the way it was initially set up, the vendor changed it and they were able to show us how to make the changes ourselves. We now can get all types of data-training data, calibration data, and such, so much faster than we previously could. We can also search the data by date, batch, instrument, or technique. We are planning to kick off our implementation project during the second week of June.

Q: What advice would you offer to people evaluating and implementing ELNs?

A: You really need to talk to all the people who are going to be using the system and put together a clear list of needs and wants. When you go out and talk to vendors, definitely have a script detailing what you want them to demonstrate, so you can compare apples to apples. If you have a clear list and a script ready, then you can make a very good decision. Once you have made your selection, you need to be in constant communication with the vendor. I would also recommend doing a pilot project, so you can find out more about the vendor's customer service and the flexibility of the ELN.

WHAT IS INNOVATION?

By Michael Stanleigh

The word "innovation" means different things to different people. Organizations struggle with determining what is meant by innovation. What is it? How is it defined? How is it different from invention? So let me explain what innovation really is and why it is considered a major driver of the economy.

What is innovation?

Too often, our understanding of innovation is based on our experience with inventions such as the Internet, cell phones, and other new technologies. True, innovation led to the development of these new products, but innovation is much more than that. Innovation goes beyond technology.

IBM's global CEO study in 2006 defined innovation as "new ideas or current thinking applied in fundamentally different ways resulting in significant change."

David Neeleman, founder and CEO of JetBlue, said "Innovation is trying to figure out a way to do something better than it's ever been done before."

Innovation is invariably about bending, if not breaking, the rules. It is about change—not repetition; about daring—not submission. So maybe, it's also about exceptions and not definitions." *Amit Mayer, SIT (Systematic Inventive Thinking, Tel Aviv)*

The traditional model for launching an innovation was to look at the cost and then add the profit. This would create a market price. Current thinking is to identify the market price, subtract the profit required, and then determine how to create the product or service to match that total cost to market. This model drives innovation in a very different way. It no longer assumes the market will pay any price.

> "Creativity is about coming up with ideas, while innovation is about bringing ideas to life."

The difference between invention and innovation

According to Jan Fagerberg, professor of economics at the University of Oslo, where he is affiliated with the Centre for Technology, Innovation and Culture, there is an important distinction between invention and innovation: "Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice."

Innovation and creativity

We often use the words "creativity" and "innovation" interchangeably, but we should not. Creativity is about coming up with ideas, while innovation is about bringing ideas to life.

According to Teresa Amabile, author of a number of books about the social psychology of creativity, creativity is typically seen as the basis for innovation, and innovation as the successful implementation of creative ideas within an organization. From this point of view, we can conclude that while individuals may display creativity, innovation occurs in an organizational context only, by bringing creative ideas to life.

Innovation as a collaborative process

Over the years I have worked with many different organizations and conducted research in a number of operational areas, including idea generation—sometimes referred to as "suggestion systems" or "quality

LABCAST Be sure to attend Michael Stanleigh's Lab Manager Academy webinar "How Innovative Is Your Organization?" on Wednesday, August 7 (or afterward at www.labmanager.com/igniteinnovation, to watch the archived video).

circles." I have observed how different organizations generated ideas, what happened with these ideas, and how they were moved forward in the organization. I started to realize that some individuals and some organizations seemed to be great at managing ideas and others were miserable at it. Part of my research included exploring whether great inventions are driven by individuals who are just more creative and persuasive than the average person or whether these individuals have some system to their approach.

> "Organizations that do not innovate effectively may be destroyed by those who do."

I started to realize that the successful implementation of ideas was really a form of "innovation" and that innovation was, in fact, a collaborative process that required people from different areas to contribute to moving from idea into reality. Furthermore, I learned that this cooperative process, if properly implemented, is a very powerful strategy for achieving organizational advantage.

The lone inventor is a myth. During his lifetime Thomas Edison patented 1,093 inventions. However, he did not work alone—this is a misconception. His team of talented workers assisted him all hours of the day and night. They had the skills to take his ideas and, through the process of innovation, bring them to reality. His laboratory at Menlo Park was referred to as an "invention factory."

Summary

Innovation is much more than just new-product development—it can go beyond technological advances and may be applied to operational improvements and service strategies as well.

Innovation is linked to performance and growth through improvements in efficiency, productivity, quality, competitive positioning, and market share. It typically adds value by changing old organizational forms and practices. Organizations that do not innovate effectively may be destroyed by those who do.

Innovation does not just happen—it is a team effort. Most successful innovation occurs at the boundaries of organizations and industries, where the problems and needs of users and the potential of technologies can be linked together in a creative and collaborative process that challenges both. To take the first step on the journey of reshaping your culture to be more innovative, you must understand what innovation is.

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For more information about the ideas in this article, please contact Michael at mstanleigh@bia.ca.

FOSTERING GOOD BEHAVIOR

BASIC ETIQUETTE, LIKE GOOD SAFETY PRACTICES, REQUIRES TRAINING AND REINFORCEMENT

by Lina Genovesi

Lab environments are complex and include staff comprising a diverse spectrum of age, gender, and ethnic backgrounds. Most labs operate as multidisciplinary operations with an open floor plan and shared spaces. Adding to their complexity, labs operate in the midst of an onslaught of new electronic technologies and personal electronic devices that have been accepted enthusiastically by some and rejected vehemently by others.

A lab etiquette survey conducted by *Lab Manager* and followed by discussions with all involved parties unearthed a broad spectrum of issues, opinions, and positions on lab etiquette rules.

"Labs can be proactive in fostering a good attitude by providing cooperation and teamwork training."

Most labs, including those situated in universities and in clinical and industrial settings, have developed etiquette rules guided by the need to provide a safe work environment. Clear rules have been defined relating to the labeling and handling of chemicals and reagents, the maintenance of work areas, and the disposal of biological materials such as used surgical gloves, needles, and tissues. Clear rules have also been defined relating to proper attire, phone etiquette, eating in the lab, excessive noise, blaring music, and behavior with visitors. Differing generational and cultural views on etiquette leave these rules open for debate.

Etiquette lapses relating to attitude, housekeeping, safety practices, equipment care, e-mail and phone practices, and the use of personal electronic devices rank high on the etiquette priority list and require the implementation of a new set of lab etiquette rules.

Maintaining a good attitude ranks highest. A bad attitude is defined by a lack of basic manners (rudeness, inappropriate social behavior, inappropriate attire, and the use of profanities), lack of cooperation, cultural or religious insensitivity, sexism, the spreading of harmful information, bullying, harmful phone and e-mail practices, and misuse of cell phones and electronic devices.

Various options are offered for fostering a good attitude

Labs can be proactive in fostering a good attitude by providing cooperation and teamwork training. "Our lab has taken steps to create an environment where lab etiquette is not only understood but actively followed," says Amy Parkhurst, lab manager and technician at The Jeffrey Lab, University of Maryland. "We provide a short training on the rules of the lab, observe a non-mandatory morning coffee break to foster interaction, and encourage the practice of honest gratitude such as saying 'thank you.'"

Parkhurst observes that the lab is functioning as a team. "We've gone from being a lab where no one asks for the input of the others on their individual projects to one where all projects are openly discussed. I believe our team environment has made our science stronger."

Cultural and religious diversity is on the rise, and cultural and religious differences are issues that need to be addressed. Some labs are proactive in fostering a good attitude and respect for others within a diverse group. "It is not unusual for staff from a particular culture to speak in their own language, causing English-only-speaking staff to feel uncomfortable, not understanding what is being said," says Mary N. Clancy, laboratory

manager, University of California San Francisco at San Francisco General Hospital and Trauma Center. "A good attitude is fostered by speaking a language that everyone can understand."

For Clancy, cultural diversity training is one step in the process, but the training must be followed to foster a good attitude. "Staff are not legally forbidden from speaking in their own language," says Clancy. "We can encourage staff to use English but not mandate it."

A good attitude in terms of open communication and courtesy are especially important in labs with shared spaces. In most labs that consider themselves well-run, coworkers notify each other when equipment is needed and the shared areas are modified in order to share equipment. In these situations, the lab manager is in the communication loop.

In labs with shared spaces connected to patient care, labs have adopted a formal approach for training and coaching. "Enforcing customer service and communication are a high priority for us, and we provide training to improve customer service, phone etiquette, and communication," says Deborah Atlas, quality and safety coordinator for laboratory medicine at Lahey Hospital & Medical Center. "We use the AIDET (A=Acknowledge, I=Introduce, D=Duration, E=Explain, and T=Thank you) method to train hospital-wide."

For Atlas, training is not all there is to it. The lab manager plays an important role. "Basic etiquette rules seem obvious to follow, but surprisingly, they need to be reinforced," says Atlas.

Spreading rumors is a sure recipe for fostering a bad attitude and creating a hostile work environment. Some labs have experienced the effects of the rumor mill, with employees in fear of losing their jobs, a decrease in productivity, and an increase in absenteeism.

"Curbing the rumor mill is one of our biggest challenges," says Russell Baldwin, senior forensic scientist at OC Crime Lab. "The director tackled the problem head-on by addressing it at leadership meetings and even had the staff watch a play to demonstrate how damaging rumors can be. The rumor mill seems to have died down."

The onslaught of cell phones and electronic devices in the lab has brought with it its own set of issues. These devices have been accepted with mixed reactions: Some staffers accept them enthusiastically, whereas others reject them as a nuisance. Whether accepted or rejected, answering cell phone calls, scrolling through e-mails, and texting during meetings is viewed as unprofessional, and walking around the labs with ear buds is not only viewed as unprofessional but also can create a safety issue.

> "A good attitude is fostered by speaking a language that everyone can understand."

Labs have attempted to provide etiquette rules for the appropriate use of electronic devices. "We are considering working on what we call peer coaching for the use of electronic devices," says Daniel J. Scungio, laboratory safety officer at Sentara Healthcare. "We have created a team to discuss the use of items such as cell phones and MP3 players to bring us within the CLSI guidelines."

Etiquette rules governing the use of electronic devices are a work in progress. Scungio states that although wide-ranging discussions are under way, a final decision has not yet been made.

Although not an etiquette issue per se, observing safety practices is a high priority from a rule-making standpoint. Good safety practices go a long way toward fostering good lab etiquette and a professional work environment.

Various options are offered for fostering safety practices

Outside the lab, key stakeholders in health care professions, government, and industry have taken lab etiquette to the next level. In association with the Clinical and Laboratory Standards Institute (CLSI) and utilizing a formal consensus process, these stakeholders have developed formal guidelines for what is considered safe in a clinical lab context. These guidelines are embodied in a safety document titled "Clinical Laboratory Safety: Approved Guideline (GP17-A3)."

> "The onslaught of cell phones and electronic devices in the lab has brought with it its own set of issues."

"These guidelines describe general recommendations for implementing a high-quality laboratory safety program," says Glen Fine, chief executive officer at CLSI. "They are intended to address safety issues affecting the quality of patient testing, and they reflect on the whole the agreement of key stakeholders involved in clinical laboratory medicine."

Fine states that these guidelines address the essence of the issue of safety in clinical labs. "They are considered good lab practice in terms of safety, housekeeping, equipment care, and the use of electronic devices. However, following these guidelines is not mandatory."

Whether a lab follows the CLSI guidelines or internal guidelines, most labs provide training and coaching to their employees. "We provide training to our employees on a recurrent basis to broaden their knowledge on the recognition, avoidance, and prevention of safety and health hazards," says Scungio. "We follow CLSI guidelines, Occupational Safety and Health Administration (OSHA) requirements, and the College of American Pathologists (CAP) regulations to train our employees. We also follow internal guidelines that are specific to our own hospital system and have morphed from CLSI, OSHA, and CAP.

"One should always consider the physical environment when thinking about safety. Developing and utilizing your 'Safety Eyes' can help you spot and correct safety issues as they arise, not just when you conduct safety audits," says Scungio.

Management can play a key role in the fostering of proper etiquette and safety. "Positive relationships bloom when people know their coworkers and lab manager care and are looking out for their personal safety," says Scungio.

Setting standards for safety procedures in university labs is notoriously difficult. The process can be challenging due to inexperienced students, busy faculty schedules, and budgets that do not allow for training outside the academic curriculum. Having an ethnically diverse population of students, faculty, and staff from outside the United States, where the standards may be different for both housekeeping and safety, adds to the challenge.

"Faculty are charged by the university with maintaining the safety of their individual research laboratories, but time is limited because of teaching, research, and other responsibilities," says Barbara A. White, research operations manager in the Department of Forest Biomaterials, North Carolina State University. "Because of lack of supervision, lab instruments are often broken, misused, or incorrectly calibrated, and frustration builds up among students who do know how to observe proper safety procedures. The end result is a greater likelihood of an incident or accident occurring that could have been avoided if proper procedures were followed.

"We are charged with both teaching and enforcing safety procedures and must find ways to accomplish these goals in an efficient and cost-effective manner. Increasing awareness for faculty on how to incorporate safety procedures into the curriculum would go a long way in resolving the issues," says White.

"A few years ago, our department developed a safety inspection training program. Each month for about one hour, teams comprising both faculty and students are given a checklist containing the same criteria used by 'real' inspectors to review our labs for safety compliance," says White. "As the teams perform the activity, both the professors and the students learn what the expectations of U.S. regulatory agencies are and then work together to improve the culture of safety. Our compliance has improved significantly compared to where we were before instituting this program," says White.

White states that partnering programs between industry and academia, such as the one initiated by the Dow Chemical Company, are beneficial in terms of safety procedures and lab etiquette rules. "Such programs would ensure that future scientists and engineers have not only the scientific knowledge but also the safety and the lab etiquette to work efficiently and effectively," says White.

"Good safety practices go a long way toward fostering good lab etiquette and a professional work environment."

Fine states that there is an increased interest in lab etiquette and safety due to a common goal of improving health and patient care.

"Good etiquette and enforcing safety procedures are a genuine expression of an employer's concern for its employees and, by extension, lead to better health care for patients."

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NEW TRENDS IN LABORATORY DESIGN

WHAT LAB MANAGERS NEED TO CONSIDER WHEN BEGINNING A BUILDING PROJECT

by Jennifer Webb, AIA, LEED[AP]

Last December's "INSIGHTS on Laboratory Design" focused on laboratory planning and the lab manager's role within that process.[1] When faced with an infrastructure project, managers have to keep the end result in mind. Currently there are six leading trends in the scientific community that impact laboratory design. Lab managers need to be aware of these design considerations when faced with a building project.

Sustainability: Saving energy

This year's April cover story showcased sustainability as a hot topic in the scientific community, and with good reason. Labs use a lot of energy to keep tissue samples frozen for decades, to move air for fume hood exhausts, to run specialized equipment, and to flush effluent waste. Labs21® (cosponsored by EPA and DOE), the International Institute of Sustainable Laboratories (I2SL), and the NIH have made a concerted effort to identify opportunities that encourage sustainable practices in laboratory design. Architects and engineers struggle to incorporate lab equipment and furnishings into LEED criteria, which don't address these issues fully. LEED identifies Labs21 measures as an innovation "credit," which undermines the extent that equipment and furnishings comprise a lab facility.[2] The NIH and I2SL are developing a checklist to make lab equipment selection easier for designers and scientists.[3]

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Economy: Maximizing resources

Research funds are declining, and the NIH has noted that grant funding success fell to an all-time low in 2011—to 18 percent. Scientific organizations are therefore curtailing their spending any way they can to keep research efforts moving forward.[4]

Lab architects are responding by designing to the function of the lab, creating more shared spaces and equipment, and reducing the number of PIs with their own dedicated space. Bench space and offices are shared as well, to accommodate another building trend called "hotelling," which discourages the practice of having any dedicated space.[5] This enables organizations to make bench space more flexible and dense. In addition, computers reduce the need for wet lab space and plumbing connections, making lab design even more flexible.

▲ *Example of an office suite with seats that are not dedicated, a trend called "hotelling" in the AEC industry. Image Source: Lublin, 2013*

Renovating existing laboratories is more cost-effective than creating new buildings, and improving what you currently have is a key to using resources wisely. Lean design, a carryover from the manufacturing industry, develops the most efficient ways of conducting business, utilizing resources, and minimizing waste. It has been adapted in health care settings because one of its advantages is increased safety due to standardized methods that prevent accidents and misdiagnoses, which can also apply to laboratories. Operational savings combined with energy savings frees up money to pay for researchers that would otherwise be spent on facilities.

Integrated project delivery: It's not you, it's us

Integrated Product Delivery is a result of the evolution in building design from Computer Aided Design (CAD)

to Building Information Modeling (BIM), coupled with the AEC industry response to how designs are documented for construction. In CAD, building elements are drawn as two-dimensional objects that represent three-dimensional elements. The computer is the drafting board. When you draw a wall, you draw lines that represent the wall with a designated layer that will determine the line thickness when it is printed.

With BIM, to draw the same wall, data is associated with an element in a model, which creates a level of complexity that goes beyond regular drafting. The computer is the building simulator. The wall in our model tells us how it interacts with adjacent objects and materials like doors, ceilings, and structural elements, and will generate the details automatically. Because the model is fully integrated, one revision in the model will affect other drawings and sheets associated with it. Revisions therefore affect everyone on the project team, and the project process must respond to a variety of players who all have a part in how the model is created. This is where Integrated Project Delivery comes in. Architects, engineers, and contractors are still figuring out how to work directly with this new technology. Larger organizations have utilized this methodology for nearly 10 years now, while smaller firms are still adapting ways to incorporate BIM technology into their projects. Contractors use the model to develop detailed and accurate estimates and advise on constructability. Subcontractors develop detailed shop drawings with minimal errors, reducing construction costs.

▲ *Drawing a wall in BIM. Image Source: Cunha, 2012.*

The American Institute of Architects' definition, in their Integrated Project Delivery Guide, is: "Integrated Project Delivery (IPD) is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction."[6]

"Computers reduce the need for wet lab space and plumbing connections, making lab design even more flexible."

What this means for the lab manager who is going to undertake a new building effort is that the interaction with the design team is more comprehensive. Lab managers won't meet with only the architect or lab planner, but might also meet with the general contractor and engineers. Interaction is intended to be seamless. It is critical to identify the overall goal of the building effort, conduct detailed inventory of current lab conditions, study experiment processes, and review current space adjacencies before

meeting the design team. The earlier in the process the background information is acquired, the better it will help the design effort.

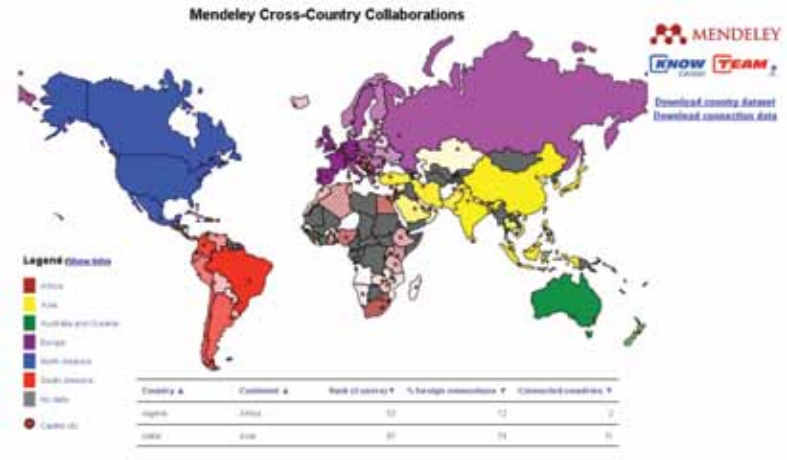
Following are common BIM terms that are industry standard and identified in the GSA BIM Guide for federally supported projects.[7]

- 3D: The three-dimensional representation
- 4D: 3D model plus time analysis
- 5D: 4D model plus cost
- Clash Detection: A model analysis to identify any conflicts within the model
- Energy Modeling: A model analysis to study the building's energy efficiency

The biggest benefit of BIM for lab managers is the utilization of facility management software that assigns data into the model. You can track each lab—who occupies that space, the experiments they are working on, the equipment and chemicals located within. The possibilities are endless when you think about how data can be used to integrate the facility with regular scientific operations in such a way that not only enhances the visualization of the lab before it's built, but also enables the scientist to actively manage the lab throughout the life of the building.

International collaboration: We all work together

We live in a time when true collaboration and open sharing of science is the norm. The Mendeley website has a fully interactive map that shows how scientists in every country interact with other scientists throughout the world.[8] A scientist working on a new treatment for breast cancer can find scientists with similar specialties located worldwide that can assist with various studies and develop comprehensive data to support the findings. It is expected to have break-out spaces or conference rooms with facilities for impromptu meetings via the Internet. Having a whiteboard in the corridors is nice, but if you can capture that image and e-mail it to your research partners in Shanghai, Miami, and Vancouver at the same time, then that collaboration becomes instantaneous when that "eureka" moment arrives. Facilitating distance learning for parts of the world where scientific education is lacking opens the doors to the next generation of scientists. Much collaboration is data driven, and accessibility to data makes the bench space secondary and not necessarily where the science occurs.



▲ *Mendeley Scientific Cross-Collaboration website. Image Source: Mendeley, 2013.*

Lab design responds by placing a further emphasis on shared core facilities, flexible lab design, and the full integration of data and technology within the lab and the equipment. Collaboration on diverse teams in remote locations means that rather than having one large group in a single location, research groups become smaller at more diverse locations. Having appropriate data storage rooms in the facility or remotely is critical to fulfill the need for copies of the same data at various locations. The research associate working in San Diego has to have the same data as the other associates in Boston and London. If your London associates lose their data due to unforeseen circumstances, backups are available.

Lab openness: Show them what you've got

While privacy is still a valid reason to ensure the safety of intellectual property, the reality is that more and more laboratories are embracing the idea that the more the inside of the lab is shown, the more the research organization benefits.

There are three primary ways that labs show what they've got.

1. Regulators can directly view the labs without disturbing the process within.
2. The lab is a showpiece to demonstrate the lab's capabilities.
3. Labs bring in natural light to the center of the laboratory to enhance productivity.

"Having appropriate data storage rooms in the facility or remotely is critical."

▲ *Use of glass partitions to bring natural light into the laboratory while separating bench space from team space. Source: Sanford Burnham Research Institute, Orlando, Florida*

▲ *Open spaces allow visitors to see directly into the bench space, making it a feature of the building. Source: Sanford Burnham Research Institute, Orlando, Florida.*

Privacy is not necessarily compromised when a clear partition replaces a full-height opaque wall. Acoustic engineers test partition designs, and there are resources available allowing designers to create private spaces with visibility.[9] Acoustic engineers rate walls on their Sound Transmission Class (STC), and there are three methods to improve acoustic separation: adding mass, adding air space, or adding absorptive material within the partition.[10] A drywall partition with no interior insulation has a rating of 38, where normal sound is unintelligible and loud speech is audible but not understandable. Acoustical sealants or framing around glass partitions can obtain the same rating while enabling full viewing. An added benefit to using glass instead of solid walls is the ability to bring natural light into a workspace, which improves productivity and enhances individual well-being.[11]

Lab as social center: Playtime is brain time

The development of regional research centers like those in San Diego and Boston started this trend. Economic development creates sustainable, well-paying jobs and utilizes the community's best talent. The laboratory as center of development creates the opportunity to integrate public spaces that aren't typical in a lab building. At first, having a café or food kiosk within a lab building seemed excessive, although a nice thing to have. Over time, the cafés have turned into meeting spaces where presentations or receptions are held that bring the community into the lab building. The science building becomes a destination that brings the scientific and business communities together. The Wisconsin Institute of Discovery in Madison, for example, brings the community into the lab as much as possible. In addition to laboratories, the community is encouraged to come into the building. Presentations on the latest research findings are open to the public as well as colleagues. You can reserve a room for your club at the building's website, impress your business clients by taking them to the new trendy restaurant at the research center, or buy a book or a shirt while you're there.

▲ *Central atrium is open to visitors and is a main reception area for functions and events with its adjacent auditorium. Visitors have direct views to the labs, which emphasizes the scientific focus of the facility. Source: Sanford-Burnham Research Institute, Orlando, Florida*

What the six laboratory trends mean for science

The evolution of the laboratory has changed from the closed lab module design, which was the standard in the past, into a fully open and integrated element in scientific research. It reflects the change in our economy, our environment, and the relationship that science has with the community at large. In the end, each of these six trends will lead to improved and efficient facilities that contribute to the communities they serve and bring science to more people, which in turn, benefits everyone.

"The laboratory as center of development creates the opportunity to integrate public spaces that aren't typical in a lab building."

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ENSURING CHEMICAL COMPLIANCE

A CONVERSATION WITH DR. MICHAEL COURNOYER

by Tanuja Koppal

Large organizations involved in research and production typically handle large volumes of chemical inventory that require different types of storage and tracking. When a laboratory environment is part of the mix, managing the chemical inventory used by the lab presents a challenge to lab managers and environment, health, and safety (EHS) professionals, who must submit regulatory reports that accurately reflect the status of chemicals on-site. Ensuring that the chemical inventory data is accurate is challenging; providing that information in regulatory reports can be a time-consuming and frustrating task if it is not automated.

In March 2013, *Lab Manager* hosted an "Ask the Expert" webinar titled "Five Checklists You Need to Verify Compliance with Lab Chemical Management Requirements." During the webinar, Dr. Tanuja Koppal, contributing editor for *Lab Manager*, interviewed Dr. Michael Cournoyer, a scientist with Los Alamos National Laboratory (LANL), about the system of checklists he developed to effectively address different regulatory standards.

KOPPAL: Why is it so difficult to prove that the lab is managing chemicals in compliance?

COURNOYER: It's difficult because many organizations today handle and store a number of different chemicals that must be managed safely. There are lubricants, solvents, flammable materials, and corrosives, to name just a few, so the scope is enormous. It's not enough to ensure that you know where chemicals are, provide training and information about correct handling procedures, and ensure that chemicals are stored and disposed of appropriately. There are many rules and regulations to ensure that these minimums take place. Because of all these requirements—some of which conflict—it is extremely important to ensure that your organization is able to pass chemical management audits to prove that your system works both well and safely.

You can't just work through the lab standards [for] OSHA. For instance, researchers often tell me that the OSHA lab standards do not state that you have to do a chemical inventory. And they're absolutely right. On the other hand, we don't just do work based on the requirements of the lab standard; we also have to perform tasks according to EPA requirements. The EPA specifically requires the lab [to] do a chemical inventory at least once a year. That's one of the difficulties: there are many regulations that require compliance, and just because one doesn't require something doesn't mean you don't need to do it.

KOPPAL: Some of the webinar attendees say they've never had a chemical management audit. How does that process work?

COURNOYER: I can only speak from my experience, but if you have chemicals on-site, you may be subject to a chemical audit at some point, so you want to be prepared. Typically, the regulatory agency notifies you prior to an audit. The easiest way to be prepared is to show that you are meeting each of the particular regulation's requirements, and that's where the checklists come in.

KOPPAL: What are some of the solutions you have developed to ensure that chemicals and safety processes are in compliance with regulations?

COURNOYER: You need to look at each requirement that applies to your site and try to figure out how to address it in a way that documents it. As I went through the regulations, I found that if I had an excellent chemical inventory management system, I could address 80 percent of chemical-related audit questions. For example, one of the requirements

concerns training for working with beryllium. If you have beryllium in your inventory, the system can flag it and indicate that using it requires specific training. A good chemical container inventory system can easily track a number of criteria associated with your chemicals.

Now, there are many steps involved in managing chemical inventory. First, if you only have 10 chemicals, you can do that by yourself. If you have 200 chemicals, I recommend that you get a chemical inventory software program. That way you'll spend most of your time working on your chemistry and only a small percentage of your time managing your chemicals.

KOPPAL: A poll taken during the webinar asked the audience what they found to be the most difficult aspect of chemical management: tracking, storage, reporting, or ensuring compliance. Based on the results, 48 percent found tracking to be the most difficult task. Do you find that surprising?

COURNOYER: Surprising? No. These are the same issues that I'm concerned with. Now, tracking depends on the number of chemicals you need to manage, and if you get into the hundreds of chemicals, you need a chemical inventory system that tracks not only the chemical container, but also the chemical location. This is because if you have to write down every room, every cabinet, every shelf for each chemical, it can be very tedious. On the other hand, if you come in with a bar-code reader and scan the location and then scan all the chemicals, it doesn't take that long. For example, I had an inventory of 27,000 chemicals in two major facilities, and I was able to do inventory reconciliation in less than two weeks. When you have a chemical inventory system that tracks both the chemicals and the location, ensuring compliance is 80 percent done, and for the chemicals themselves it's probably 90-95 percent [done].

KOPPAL: The five checklists you developed have been broken into categories: chemical inventory and tracking, chemical storage, chemical purchases, on-site chemical transportation, and hazards analysis. Can you tell us about them?

COURNOYER: Because many of the regulations approach chemical safety from different perspectives and contain provisions that overlap and are sometimes contradictory, I created a series of activity-based checklists to govern chemical-related work activities. I divided the checklists into five categories to consolidate core safety and health requirements—such as those from OSHA, ANSI, and the NFPA—that companies engaged in chemical-related activities are required to [comply with].

A key reason for creating the checklists is to track hazardous materials, and a large part of hazardous materials tracking is proving that you are under certain threshold levels that require extra controls. Therefore, while there are checklists specific to hazardous materials, how those hazardous materials are tracked, stored, and disposed [of is] also addressed on other checklists. The questions on the checklists are the questions that the auditors ask. So when an auditor asks where your chemicals are, your chemical inventory report should list the facilities and the chemicals in those facilities, and your checklists will confirm this data.

KOPPAL: What benefits can labs expect after implementing the best-practices checklists you developed?

COURNOYER: By using the checklists, you can prove you're in compliance with the regulations. It's a very thorough way to ensure that you are addressing the requirements and that you have a time stamp on your documentation to prove you're in compliance. And if your supervisor signs off on the checklist, it shows that he or she is aware of the compliance as well.

TO WATCH THE WEBINAR, PLEASE VISIT
WWW.LABMANAGER.COM/CHEMEXPERT

FOR A COPY OF DR. COURNOYER'S CHECKLISTS, REQUEST CHEMSW'S WHITE PAPER "HOW TO SURVIVE A CHEMICAL MANAGEMENT AUDIT" AT
WWW.CHEMSW.COM/WHITE-PAPERS.ASPX

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LOOK WHO'S ALL WET NOW

HARDWARE, MAINTENANCE AND TRAINING REQUIREMENTS FOR SAFETY SHOWERS AND EYEWASH STATIONS

by Vince McLeod

I am one of the safety guys. I was not at work. I was at home. A few months back I purchased a couple of gallons of muriatic acid to clean up some floor tile after a poor grouting job. I used up one jug and set the other at the side of the house away from pets and people. I forgot about it until I spotted it while I was doing yard work last weekend. I was hot and sweaty, in shorts and without any gloves but decided to move the container anyway. When I picked it up, the sun-brittled plastic crumbled and the gallon of acid covered my right hand and forearm and my right shoe. Luckily, a garden hose with a drench nozzle was just across the driveway because I was preparing to wash the car. My hand and arm began to heat up quickly as I ran to turn the hose on myself. No one else was home, and I alternated drenching my hand and arm while trying to remove my shoe and sock. Fortunately, this was only a weak acid and my foot was not affected. I continued to flush my hand and arm until there was no hint of burning or heat, and there was no serious injury. But this got me thinking.

"[The] ANSI standard is very detailed in defining what is appropriate for safety showers and eyewash stations."

I remembered the tragic UCLA accident just a few short years ago that resulted in a fatality from chemical burns.[1] And then we had a string of chemical burn accidents at our university this spring, including boiling paraformaldehyde and sodium hydroxide solution, spilling a vial of 15 molar nitric acid, and pouring waste TRIzol®. So, maybe now is a good time to refresh all you laboratory folks on the use of safety showers and eyewash stations.

We are all familiar with OSHA and have heard the general requirement many times, but it doesn't hurt to read it again. In 29 CFR 1910.151 Medical Services and First Aid, it states that "where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use."[2] OSHA doesn't give any more specifics regarding what *immediate* means or what constitutes *suitable*. How do we know if we are meeting the intent of the law? Fortunately, we have the American National Standards Institute (ANSI) and its consensus standard Z358.1, last updated in 2009. This ANSI standard is very detailed in defining what is appropriate for safety showers and eyewash stations. In fact, OSHA uses this reference as a guide when inspecting facilities.[3] So let's review what is "recommended" for acceptable safety equipment.

Check your installations – OSHA will

We begin with the hardware recommended by Z358.1. For safety showers, the showerhead must be capable of flowing 20 gallons per minute at 30 psi and able to produce a 20-inch diameter spray pattern at 60 inches above the surface where the user stands. The center of the spray head pattern should be at least 16 inches from

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SAFETY TIP

PROVIDE INCENTIVES TO STAFF FOR SAFETY PERFORMANCE

By James. A. Kaufman

Everyone likes to receive a reward for good performance. It can be a merit raise, it can be a promotion, or it can be praise from a superior. Good performance deserves to be recognized and rewarded. Safety performance is no different. When it's done right, it should be recognized.

If you do staff evaluations, make safety one of the written criteria. Let staff members with good safety performance get recognized, appreciated, and generally treated in a way that would make others want to behave similarly.

Make sure the folks who get promoted are good safety performers. Otherwise, you're giving a very mixed signal.

See if you can get the department head, or president to put on a special cookout for everyone if the organization can set a special record of days without an injury to anyone. Post the goal and keep visible track of your progress. "Our goal is an accident-free month, etc."

Source: Kaufman, James A., Laboratory Safety Guidelines - Expanded Edition, The Laboratory Safety Institute, www.labsafetyinstitute.org.

any wall, door, or obstruction. It is recommended that the showerhead be mounted between 82 and 96 inches off the floor, with the valve no higher than 69 inches.

Eyewash stations target just the eyes and therefore have a lower flow requirement. ANSI Z358.1 recommends a flow of 0.4 gallons per minute also at 30 psi. The nozzles should be at least six inches from any obstruction and mounted between 33 and 45 inches above the floor. An eyewash gauge should be used to verify and test the flow pattern.

Requirements for all hardware

Both safety showers and eyewash stations must be capable of providing the recommended flow for at least 15 minutes. This usually translates into having the equipment plumbed in with hard connections to the water supply. Self-contained or personal wash devices are allowed but considered supplemental units that can provide immediate flushing while transiting to the permanent fixture.

If the local climate presents potential for freezing conditions, the equipment must be designed to avoid freezing or protected against that. Activation valves must open within one second and remain open until intentionally closed or turned off. It goes without saying that these safety devices should be constructed of corrosion-resistant materials.

"Eyewash stations target just the eyes and therefore have a lower flow requirement."

The 2009 update to Z358.1 added two important criteria. The first is that the requirement for tepid water is now defined as having a temperature between 60 and 100 degrees Fahrenheit (15 to 37 degrees Celsius). The second change addresses simultaneous operation for combination units. This means that if you have a drench shower combined with an eyewash station, both devices must provide adequate flows and be fully operable at the same time.

Finally, and most important, let us look at the location of the equipment. I know you have the ten-second rule etched into your brain, or you should have, as that is the most critical element when it comes to safety showers and eyewashes. For all hazardous areas that need this equipment, travel time to the unit should be under ten seconds, which is about 55 feet. In addition, the drench shower or eyewash must be on the same level as the hazard, and there must be a clear path for travel. We recommend painting or marking the floor area underneath the shower to help keep it clear. Z358.1 also recommends that equipment be installed in a brightly lit area and marked with a highly visible safety sign.

Don't forget about maintenance and training

Maintenance and training are often overlooked. But the last thing you want is to rush to the eyewash or shower only to be drenched with nasty, sediment-laden water. ANSI recommends flushing all equipment weekly to verify proper flow and clear the plumbing of any deposits. Remember to bring a large plastic trash can to catch the water, as these units are usually installed without any drains. The weekly flushing can also provide a great training opportunity to refresh the operation and travel paths for your employees.

If you are new to the laboratory, this article should get you thinking. If you are an experienced lab manager, then hopefully there is some useful information here to help you review your current equipment. We look forward to lots of reader feedback. Until next time, Stay Safe!

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BIOLOGICAL SAFETY CABINETS

SAFETY AND ENERGY EFFICIENCY MATTER THE MOST

by Mike May, PhD

Biological safety cabinets show up in more places than ever. In addition, this equipment comes with an increasing number of improvements and options. The question is, if you buy a new biological safety cabinet (BSC), what benefits will you gain?

BSCs vary depending on where you buy them. "A company in, say, Europe that wants to sell a cabinet in the United States might need to make a completely different cabinet to meet the US standards," says Dave Phillips, technical applications specialist at Thermo Fisher Scientific (Waltham, MA). "We make our cabinets in three locations around the world to meet the US, Chinese, and European standards." In the next decade or so, Phillips expects the different standards groups to get together on one set of rules. To economize on cabinets, hopefully these standards groups will harmonize the standards better than pharmaceutical regulators have.

Beyond global differences in BSCs, they are being used in new ways. "There's a trend toward biological safety cabinets being adapted for use in other disciplines, [such as] animal husbandry and vivariums," says Brian Raymond, sales and marketing manager at Microzone (Ottawa, Canada). Manufacturers might not recertify BSCs when modified for a new application and therefore might not meet the NSF international standards in these particular cases.

Time for the junkyard?

If you expect your BSC to last forever, you're not alone. As Phillips says, "I started in 1981 with cabinets, and we thought they'd last forever." He adds, "The NSF standard now says the life of a cabinet is fifteen years, and most customers probably think it's fifteen to twenty years."

The first indication that a BSC should be replaced comes during an annual certification. "If a customer maintained a cabinet and had it certified once a year as we recommend, that's the best way to keep track of how it's performing," Raymond says. "As age increases, parts become less available." Nonetheless, Microzone still supports its first generation of BSCs, which were produced in the early 1990s. "But it's getting more difficult to source the parts that are starting to fail," Raymond says.

Still, more than one lab has a twenty-year-old BSC that works great. "The 'cost' of an old cabinet is losing out on advancements," says Phillips. "A cabinet coming off the line today consumes one-quarter of the electricity of an older cabinet. Plus, the filters last at least ten percent longer, and there's probably a higher level of protection because the cabinet was tested more rigorously." He laughs as he adds, "It's like an old Volkswagen; it works fine, but there are no airbags."

Jennifer Branum, an associate biosafety officer at the University of Virginia, says, "If a BSC is past the lifetime support of a company and no additional parts can be ordered, then the user should begin looking into replacing the BSC." She adds, "The features that matter most for me when shopping for a new BSC are energy efficiency of the motor, quietness of the motor, and ergonomics of the BSC as well as the company's quality."

> "Customers don't want fancy stuff, but they want something very efficient in terms of energy."

"A twenty-year-old BSC [is] like an old Volkswagen; it works fine, but there are no airbags."

Jean Fallacara, president and CEO of Z-SC1 Biomedical (Westmount, Canada), notes that many customers would agree with Branum. "Customers don't want fancy stuff, but they want something very efficient in terms of energy," Fallacara says.

Raising your return

Some of the benefits of an updated BSC remain to be seen. Filters make a prime example. "We used to think that filters lasted five to seven years," says Phillips, "but the data says that is way too conservative." He points out that data from a large facility—with more than 1,000 BSCs—showed that only 3 percent of them needed a filter change at the annual certification. Those BSCs might get worked harder than most, so they might need filter changes more than the majority of cabinets do. So maybe the filters can go a decade. "We need a better handle on that data," Phillips says. Some BSCs now include indicators that keep track of the filter's condition. As the filter gets more loaded, some BSCs increase the blower speed to maintain the necessary airflow.

The motors on modern BSCs also add to the return on an investment. Motors on older BSCs might have lasted 15,000 to 30,000 hours. "Today's most common DC [direct current] motor lasts 50,000 hours, and ours last over 100,000," Phillips says. "So motors are lasting much longer than they used to."

To get even more efficiency, some BSCs can run at lower blower speeds. "Instead of a motor turning at X rpms," Fallacara says, "if it can run 70 percent lower and maintain efficiency and safety, that's the perfect world." So more efficient motors and more advanced controls reduce BSC energy use.

In some cases, the return on updating a BSC comes from unexpected places, such as improved ergonomics. For example, Raymond says, "We offer forearm supports mounted on the outside of the containment zone, thereby preventing contact with potentially contaminated surfaces within the work volume." He adds, "Modern hoods offer more flexibility in regard to work surface height adjustment."

Fallacara adds, "We even provide a remote control to open and close the window so that the user doesn't have to make too many movements."

So if your BSC is reaching the end of its life, the replacement can bring a range of benefits to your lab and lab workers. A new BSC will be easier and safer to work in, all while using less energy.

Mike May *is a freelance writer and editor living in Texas. You may reach him at mike@techtyper.com.*

FOR ADDITIONAL RESOURCES ON BIOLOGICAL SAFETY CABINETS, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/BIOSAFETY-CABINETS

CENTRIFUGES

SMARTER SPINNING SAVES TIME AND MONEY

by Mike May, PhD

Modern centrifuges offer many new features. Not surprisingly, dials gave way to digital panels. Beyond just adding convenience and accuracy, digitization brings enhanced capabilities. "Customers can create their own programs and save them," says Matt Lieber, product manager at Eppendorf North America (Hauppauge, NY). "Digital controls also offer better interfacing from a maintenance and service side, because you get better metrics on the use of the centrifuge."

Centrifuges also keep shrinking in size. "Units with a smaller footprint provide the same or better performance as yesterday's larger systems did," says Peter Will, product manager for centrifuges at LabNet International (Edison, NJ), a Corning life science company. Despite the smaller size, modern centrifuges offer more options in the rotor. "Rotors have been redesigned to accommodate more tubes in the same amount of space or by increasing the tube angle to provide a better pellet," says Will. Today's rotors even handle multiwell plates.

An increasing number of customers also want an aerosol-tight centrifuge. "As the interface between academic and pharmaceutical research gets blurred more and more," says Lieber, "more academic researchers work with hazardous materials, [such as] infected cells."

Many customers also look for sustainability in a new centrifuge, says Randall Lockner, marketing manager for centrifugation at Beckman Coulter Life Sciences (Indianapolis, IN). In general, sustainability means a more energy-efficient instrument. "Market pressure is driving manufacturers to make centrifuges that are quieter, use less energy, and incorporate recycled materials in manufacturing."

To improve efficiency, some companies employ novel approaches. For example, Lockner says, "We implemented regenerative braking, similar to that used in hybrid cars, by taking energy from the slowing rotor and converting that into current that can be returned to the electric grid." He adds, "This is not just reducing the carbon footprint of a centrifuge but actually creating power."

Some smart features of modern centrifuges also improve efficiency between uses. As Lockner explains, "We built in features to the software that can recognize when a system is idle." At those times, the system uses 60 percent less energy than previous generations of centrifuges did, just from a software improvement. Lockner also points out that his company's centrifuges can be controlled from a smartphone.

Beyond repair

It's not always easy to know when to replace instead of repair. "It's hard to give a fixed number of years," says Lockner. "It

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depends on the usage profile of the instrument and how it's been taken care of and what maintenance it received." On average, though, Lockner expects a centrifuge to last 15 to 20 years.

According to Steven W. Wilhelm, professor of microbiology at the University of Tennessee at Knoxville, "A couple of parameters go into centrifuge replacement. One is safety. If an instrument becomes unsafe, then it is time to replace it." He adds, "In many ways this is also coupled [with] reliability. Some of our oldest instruments—twenty to thirty years [old]!—still work great, while others simply fail over time." Wilhelm also points out the attraction of increased flexibility in new instruments. He says, "If we need to collect samples from certain volumes, often simply getting a new rotor will not suffice." When Wilhelm goes shopping for a new centrifuge, he looks for "the combination of safety, flexibility with regard to rotors/samples that can be processed, and price." He adds, "Price is the third of these, as we do not want to compromise the first two."

Depending on the use of a centrifuge, lack of maintenance can lead to earlier-than-usual replacement. That maintenance even includes regular cleaning. "Most customers don't give cleaning a centrifuge a second thought," says Lieber, "but lack of cleaning can lead to replacing one earlier than expected."

In some cases, a perfectly fine centrifuge gets replaced to improve the technology. "Maybe something comes along that can really make a customer's experience that much better or easier," Lieber says.

A new centrifuge will also be more efficient. It could come with a better rotor design that is lighter and that saves energy. Today's motors also run more efficiently. The compressors on refrigerated centrifuges cool more efficiently. In addition to a better compressor, some of today's refrigerated centrifuges include a pressure regulator that controls how much coolant goes in it. "There's a sweet spot where the amount of coolant is optimal," Lieber explains. "A pressure regulator will add something to the manufacturing cost, but it also extends the life of the centrifuge and decreases the amount of electricity that it uses."

"Most customers don't give cleaning a centrifuge a second thought, but lack of cleaning can lead to replacing one earlier than expected."

Beyond saving energy, today's centrifuges can save time. "More efficient designs can achieve the same separation in a shorter period of time," says Lockner. "Time saved can be applied to grant writing or getting data together to publish faster." He adds, "Time is the biggest return on investment of upgrading to a new centrifuge."

Savings also come from spinning more tubes. "If you can spin more tubes at the same price, you get more for your dollar," Will says. To get the most from spinning options, most scientists use more than one kind of rotor. Different rotors, though, come with different limitations on spinning rates, but some centrifuges identify the rotor and automatically handle any performance restrictions.

Smarter centrifuges make for smarter science. Moreover, today's instruments make science more efficient in both time and money. Replacing an older centrifuge can also create a safer lab environment. There's more to consider than just spinning samples.

***Mike May** is a freelance writer and editor living in Texas. You may reach him at mike@techtyper.com.*

FOR ADDITIONAL RESOURCES ON CENTRIFUGES, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/CENTRIFUGES

HPLC COLUMNS

FOLLOWING TRENDS IN END-USER MARKETS

by Angelo DePalma, PhD

Véronique Marceau, product manager for chromatography and purification at SiliCycle (Quebec, PQ), says that trends in HPLC column technology closely follow those in the pharmaceutical industry. Specifically, vendors continue to develop stationary phases that are suitable for analyzing biomolecules—peptides, proteins, and genes—in complex matrices.

"The industry has had to come up with new materials, stationary phases, and formats," Marceau says. SiliCycle specializes in functionalized silica-core column materials.

For example, pore sizes must reflect the large sizes of proteins and peptide digests. Small molecules can easily fit into conventional pores, whereas proteins do not.

According to literature from Sigma Aldrich (see http://bit.ly/18IyqLT), the HPLC analysis of peptides and proteins differs significantly from that of small molecules. Reverse-phase (RP) columns are the modality of choice, with C18 bonded to silica as the usual starting point. From there, investigators might try C8 or C5 to obtain the desired selectivity.

But large molecules do not exhibit a "finite partitioning equilibrium" between stationary and mobile phases. Instead, analytes adsorb into the stationary phase through differences in the molecules' hydrophilicity. Elution occurs when the solvent strength is sufficient to overcome the attraction between analyte and column. That is why peptides and proteins are almost always run under gradient conditions. Peptides and proteins will eventually elute under isocratic conditions, but their peaks will be broad.

The other "stealth" trend noted by Ms. Marceau is the use of three- and five-micron columns in UHPLC systems designed for high-pressure, sub-two-micron particle column operation. "People love their UHPLC, the systems, the software, but three-micron columns persist. Not everyone has switched to sub-two-micron technology."

UHPLC systems are perfectly capable of running columns designed for older systems. In fact, many UHPLC setups are routinely used in both standard and sub-two-micron HPLC. More important, laboratories are reluctant to invest time and resources for redeploying and revalidating legacy methods, particularly in regulated industries.

"UHPLC is popular, but it takes time for an entire group of analysts to switch to new technology," Marceau observes.

Protect your investment

Stationary phase constituents and columns represent the largest ongoing costs for HPLC. For columns, the operative consideration is usable lifetime. Modern HPLC columns are sturdy, robust, and operate fine as long as users stick with recommended buffers and solvents.

Yet all chromatography columns degrade over time due to buildup of impurities, degradation of column chemistry, and plain old wear and tear. According to J.T. Presley, brand manager for consumables at Phenomenex (Torrance, CA), smaller particle sizes increase the likelihood that sample matrix or other impurities will cause degradation in performance.

"The vast majority of the time, column lifetime is a function of the sample and matrix," Presley tells *Lab Manager*. Therefore, the secrets to long column life are sample preparation and column protection.

Sample preparation should be designed to maximize sample recovery while minimizing injection of "gunk." Filtration is the minimum preparation. Many methods call for solid-phase extraction or other cleanup methods. In some instances, target analytes may be concentrated during this process.

Another strategy involves the use of guard columns, which protect columns from the nastiest contaminants. "The point is to improve the balance of performance, value, and price," Presley advises.

Angelo DePalma is a freelance writer living in Newton, NJ. You can reach him at angelo@adepalma.com.

FOR ADDITIONAL RESOURCES ON HPLC COLUMNS, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/HPLC-COLUMNS

LABORATORY WATER

DEFINING CONSISTENCY FOR LAB OPERATIONS

by Angelo DePalma, PhD

Lab workers tend to treat water systems like utility or house water—open the spout and pour it out. That is partly true, as water systems have become ultra reliable. What scientists often fail to note is how thoroughly lab operations depend on water quality. There may be some leeway in certain operations, such as cleaning glassware that will wind up in an autoclave, but even there delicate techniques such as atomic absorption and polymerase chain reaction are extremely sensitive to impurities.

Many labs, including college facilities, still use double or triple distillation as their pure water system. Mark Lockwood, president of LabStrong (Dubuque, IA) takes issue with the notion that distillation is a "dinosaur" that refuses to accept extinction.

Lockwood notes that distillation remains the simplest, most reliable, and consistent water source. Water picks up carbon dioxide within the condenser, so the product in the beaker or flask is the same as what exits the distillation unit. "If you take a type 1 system and draw water off it, the meter may say 18.2 megohm. But within seconds of standing in a beaker it will drop to 10 megohm because it is drawing in carbon dioxide."

Distillation has several other benefits. Stills may be shut down during long breaks or facility closedowns and be up and running minutes after they are turned on. "You don't need to find or purchase consumables to restart a distillation system."

Distillation generally produces type 2 water, which can serve most lab functions as well as provide feedstock for type 1 deionization systems.

In addition, distillation removes microorganisms, toxins, and all nonvolatile contaminants without requiring expensive filtration or adsorbents; the process that produces the water also purifies it. Finally, distillation requires no consumables. "If it's boiling, you'll get the performance you need," Lockwood adds.

More from less

Working under tight budget constraints, today's laboratories strive to get the most out of precious resources. Economizing extends to every aspect of running labs, including "utilities" such as pure water systems. "Labs are much more conscious not only of capital costs but of ongoing or operating costs," observes Julie Akarna, PhD, product manager for lab water at Thermo Fisher Scientific (Asheville, NC). "They do not want to replace water systems."

Akarna notices an increase in users interested in generating type 1 water from tap water. In the past this involved purchasing multiple systems for pretreatment, water storage, and polishing. "These days they want one system that does everything," Akarna says. This allows them to maintain one set of cartridges, for example, and saves both space and maintenance. Akarna describes space as a factor that lab designers often overlook. At one time most lab water systems were quite large; today they tend to be more compact.

A variation on this involves maintaining one type 2 water system for both general lab water use and to feed a type 1 system. Here, an appropriate storage container feeds the type 1 system and serves as a reservoir for glassware rinsing, media and buffer constitution, instrumentation, and other noncritical applications.

Related to space savings is the growing trend toward remote location of water systems, often completely out of sight in a passageway or utility area. That configuration not only saves space but also allows several rooms to share pure water systems. Thermo's take on this is "remote dispensing," which also distributes water volumetrically.

Labs are especially cognizant of maintenance and repairs, often eschewing service contracts for instruments or systems for which outside service is now considered a luxury.

Luckily, most water systems today are easy to maintain by laboratory personnel. "They're relatively simple systems," Akarna says. Most maintenance consists of changing cartridges, filters, and ultraviolet lamps on schedule. Vendors have specifically designed water systems for low maintenance, with consumables as plug-and-play components. Thermo has rewritten its product literature to reflect the evolution toward simplicity.

Other than consumables, users need to remember to perform only what Akarna calls a "spring cleaning"—actually a periodic system purge and rinse. Some water systems feature a sanitization cycle that Akarna advises users to run each time they change the deionization cartridge. The process involves adding a cleaning solution and employing a dummy cartridge where the deionizer is usually installed. For certain Thermo devices, the user selects a "Clean System" command from the menu. The process takes about 20 minutes.

Here come the regs

One does not normally connect water systems with the regulation of electronic records, but that time has arrived.

During the early 2000s the U.S. Food and Drug Administration promulgated 21 CFR Part 11, a regulation that seeks to ensure the security and trustworthiness of electronic records in the pharmaceutical and biotechnology industries. Since then, vendors have sought to make their instrument and manufacturing systems compliant with this regulation.

According to Jean Mahooti, global product manager for Lab Solutions–Labwater at Merck Millipore (Guyancourt, France), the prominence of lab water in ensuring quality, particularly during preclinical "GLP" exercises, demands the rigor of a fully robust recordkeeping system.

"Pure lab water is used extensively during pharmaceutical development and for both quality assurance and quality control," Mahooti says. Labs must demonstrate control over water quality and be able to trace its origins and possible contaminants. "They spend a lot of time checking each water system, then acquiring and recording records on paper. All this takes time."

Problems also arise when companies run the same assay using water of ostensibly the same quality but originating in two different parts of the world. Standardization and harmonization across labs and continents are possible only with CFR-compliant systems.

CFR Part 11 applies in both manufacturing and development. Labs operating with paper records need not comply. "But as soon as they go to electronic records they must and in some cases [must] store the data for up to forty years." A CFR-compliant system all but guarantees that water-related records will not be tampered with.

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

FOR ADDITIONAL RESOURCES ON LABORATORY WATER, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT WWW.LABMANAGER.COM/LABWATER

pH METERS

MEASURING ACIDS AND BASES WITH NEW ACCURACY AND RELIABILITY

by Mike May, PhD

An old analog pH meter seemed accurate enough, as long as the task didn't require much accuracy. Today's meters must be more accurate and provide more reproducible results. In some cases, pH meters do even more.

Christine Brink, market manager for electrochemistry at Mettler-Toledo (Columbus, OH), points out that some customers want multifunction meters. A device might measure various parameters, including pH, conductivity, ion concentration, and oxidation reduction potential.

Beyond accuracy and flexibility in today's pH meters, some features make measurements much easier to obtain. For example, yesterday's clunky electrode stands gave way to multisegmented arms that more easily position the electrode in the sample.

Modifying the meter

"We subscribe to the pH meter that is not just a pH meter," says David Minsk, president of Hanna Instruments (Smithfield, RI). "We try to understand the nuances of the wide range of applications where pH meters are used and then optimize them for those applications."

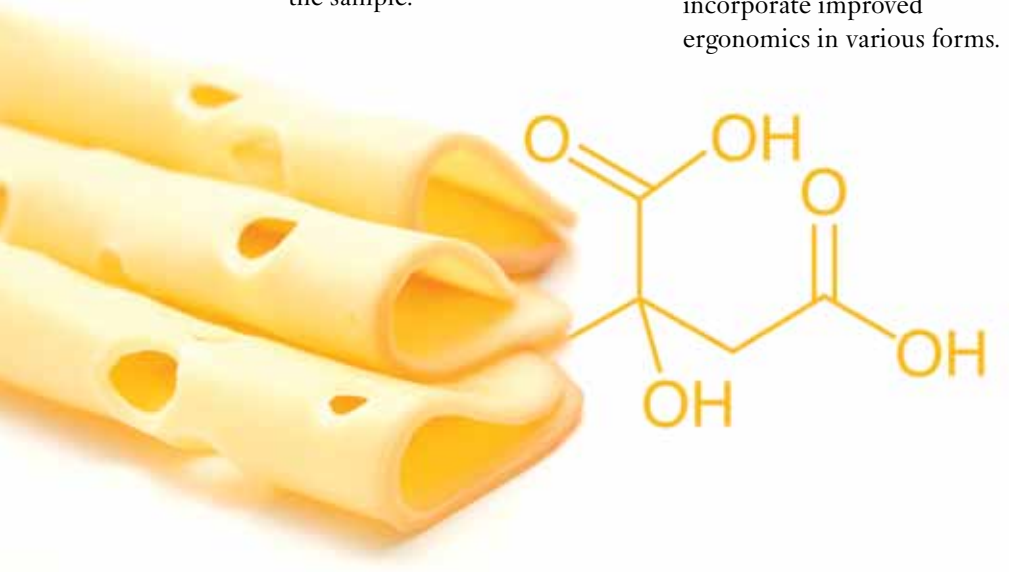
For example, Hanna Instruments offers pH meters for use in the food and beverage industry. This includes the development of specific electrodes for food. "Most standard lab-grade electrodes cannot penetrate semisolid samples like food," says Minsk. So Hanna Instruments developed pH electrodes that go in samples such as cheese and sauces, all without diluting the sample. "We also use nontoxic materials for these electrodes so they do not tarnish the sample."

Today's pH meters also incorporate improved ergonomics in various forms. "For a portable pH meter," says Brink, "that means being easier to hold and use." She adds, "Today's benchtop systems include easier menus and simpler ways to make corrections or change methods."

Measuring a meter's life

"A pH meter should last a couple years at a bare minimum," says Minsk. "The consumable is the electrode." The life span of a pH meter electrode depends on the samples being tested. "With a high-temperature sample, the electrode will last only three to six months," Minsk says. "For clear water at ambient temperature, the electrode could last twelve to eighteen months if properly maintained by the customer."

For the meter itself, new features drive some replacements. For example, any company working on drug development and production will want a meter that offers good laboratory practices (GLP). GLP allow the user to record the meter's last calibration date and time. This is especially beneficial when the meter is used by various users who are required to maintain a specified accuracy standard. "Meters that record and store data in an Excel file are also becoming more prominent," says Minsk, "and that might prompt someone to upgrade."



Brink adds that someone might upgrade a pH meter to obtain added security features. "Incompatibility between the sample and electrodes could also lead to replacement," she says. "The right electrodes can make all the difference in accuracy and reproducibility."

At the University of North Carolina, Pembroke, chemistry laboratory teaching assistant Shanna May Harrelson likes a pH meter to provide "ease of use for students and ease of maintenance when needed." She'd also like to see pH meters that provide "step-by-step directions for calibration for students" and "trouble-shooting directions when needed."

When buying a new pH meter, make sure to consider the meter's features as well as the available electrodes. It's the entire platform that determines the range of applications and overall fit with your needs.

"Today's benchtop systems include easier menus and simpler ways to make corrections or change methods."

Mike May *is a freelance writer and editor living in Texas. You may reach him at mike@techtyper.com.*

FOR ADDITIONAL RESOURCES ON pH METERS, INCLUDING USEFUL ARTICLES AND A LIST OF MANUFACTURERS, VISIT **WWW.LABMANAGER.COM/PH-METERS**

ARE YOU IN THE MARKET FOR A... MICROPLATE HANDLER?

Microplate handlers are specialized robotic devices that transfer microtiter plates in three-dimensional space from one location within a workflow to another. The "locations" are actually operations such as solvent addition (through liquid handling), aspiration, heating, shaking, incubation, washing, reading, and storage.

Types of Microplate Handlers currently used by survey respondents

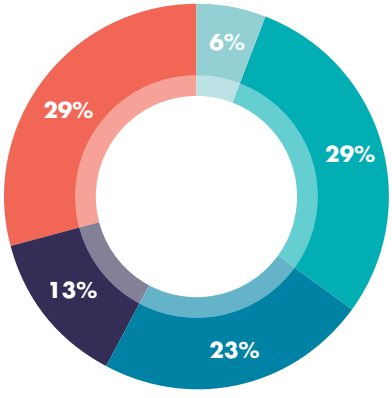
Microplate Reader	48%
Microplate Centrifuge	35%
Microplate Washer	12%
Microplate Stacker	4%
Microplate Sealer	9%
Microplate Labeler	2%

Top 5 Microplate Handler industries as reported by survey respondents

Biotechnology	25%
Clinical / Diagnostics	24%
Education, Research	18%
Pharmaceutical	13%
Chemical Industry	5%

Nearly 50% of respondents currently using a Microplate Handler plan on purchasing a new or additional system in the next year. Budget ranges for these purchases are:

- $1000 - $2000
- $2000 - $4000
- $4000 - $8000
- $8000 - $16000
- $16000+



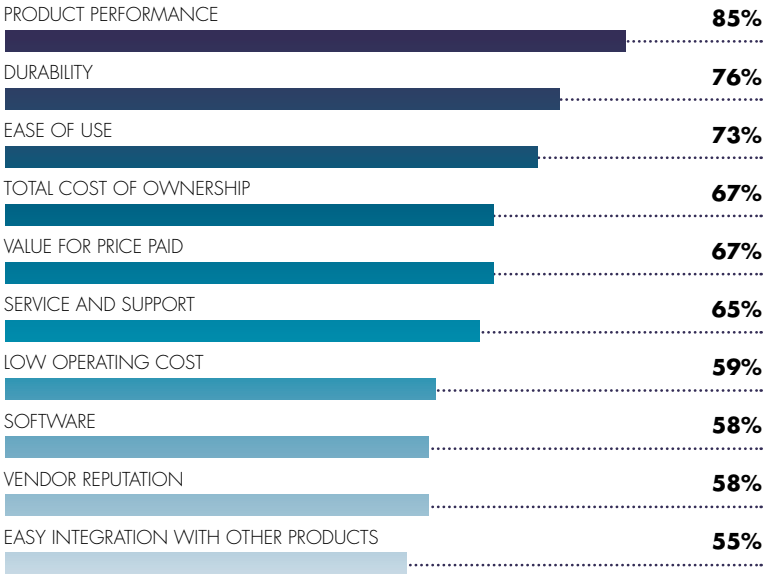
TOP 6 QUESTIONS

You Should Ask When Buying a Microplate Handler.

1. **How many plates and plate types can the handler accommodate?** An ANSI-compatible handler provides increased flexibility for those using multiple plate densities (ex. 96-, 384-, 1536-well) or low-volume plates, and interchangeable plate stacks accommodate varying throughput requirements.
2. **What is the transfer speed?** Transfer speed is especially important for increased throughput. Adding a dual plate carrier keeps two plates in process, thus further increasing assay efficiency.
3. **Can the handler operate in portrait and landscape configurations?** A rotational gripper option optimizes positioning of the microplate handler with its mating instrument, thus improving flexibility and efficient operation.
4. **Does the handler fit into a hood or biosafety cabinet?** Placing a microplate handler within a hood or biosafety cabinet allows users to maintain personal safety and protect samples.
5. **Is the handler compatible with a wide variety of other instruments?**
6. **Does it come with a barcode reader for easy microplate identification?** Barcode scanning is especially useful for increased throughput.

TOP 10 FEATURES/FACTORS

respondents look for when purchasing a Microplate Handler



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

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ARE YOU IN THE MARKET FOR A... VACUUM PUMP?

Vacuum pumps are an essential piece of equipment and are used in a wide variety of processes in most laboratories. Over the past 25 years, it has become apparent that vendors have made significant innovative improvements to vacuum pumps, with important developments in high vacuum technology, corrosion resistance, vacuum control, and improvements in the efficiency and ecological impact of vacuum pumps.

Types of Vacuum Pumps currently used by survey respondents.

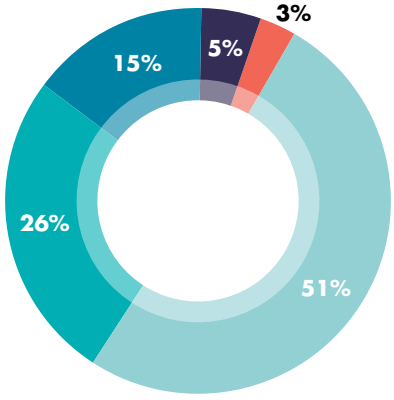
Oil-sealed direct drive pump	25%
Oil-free diaphragm pump	22%
Oil-sealed belt drive pump	15%
Central vacuum to bench turrets	10%
Compressed air systems	9%
Water jet aspirator vacuum	8%
Oil-free-scroll pump	6%
Other type	5%

Top 5 Vacuum Pump controls as reported by survey respondents.

No control – just turn it on	35%
Manual adjustment of knob	24%
Electronic control on pump	16%
Central Vacuum – on/off control	13%
Electronic control on vacuum application	12%

Nearly 45% of respondents currently using a Vacuum Pump plan on purchasing a new or additional system in the next year for the following reasons

- Replacement of an aging pump
- Addition to existing system – increasing capacity
- Setting up a new lab
- First time purchase
- Back-up system



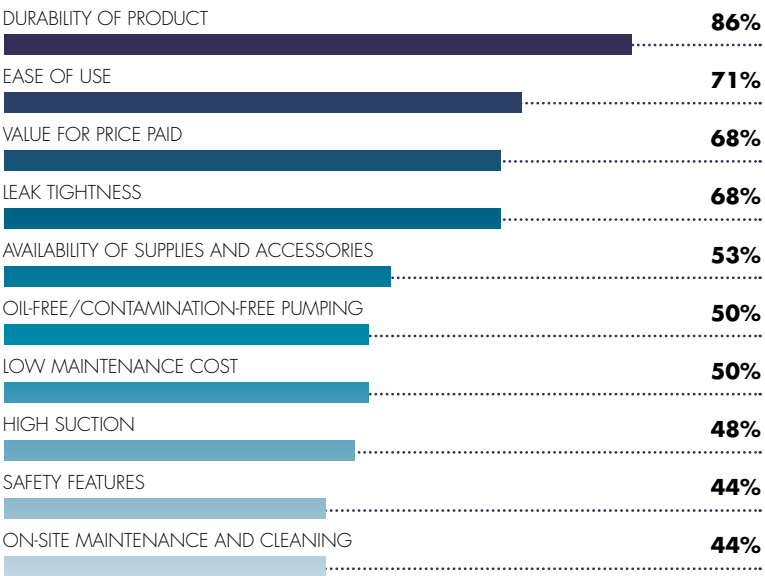
TOP 6 QUESTIONS

You Should Ask When Buying a Vacuum Pump.

1. **What will you be using the vacuum for?** Filtration needs modest vacuum. Evaporation requires deeper vacuum. Molecular distillation requires even more. Match the pump to the use.
2. **Can you use a dry (oil-free) vacuum pump?** Oil-free vacuum pumps can support most lab applications. For the service advantages, choose a dry pump where possible.
3. **What is the pumping capacity at the intended vacuum level?** Actual pumping speed declines from the nominal speed as depth of vacuum increases. The rate of decline differs among pumps.
4. **Do you work with corrosive media?** Standard duty pumps have lower purchase costs, but corrosion-resistant pumps will have lower lifetime costs if working with corrosives.
5. **Should you invest in vacuum control?** Electronics can improve reproducibility, protect samples and shorten process times when specific vacuum conditions need to be maintained.
6. **What is the lifetime cost of operation?** Include purchase cost, service intervals, servicing cost, pump protection (e.g., filters, cold traps), and staff time for operation.

TOP 10 FEATURES/FACTORS

respondents look for when purchasing a Vacuum Pump.



For more information on Vacuum Pumps, including useful articles and a list of manufacturers, visit www.labmanager.com/vacuum-pumps

ARE YOU IN THE MARKET FOR A... CHROMATOGRAPHY DATA SYSTEM?

Chromatography data systems (CDSs) — the data "back end" for gas, liquid, ion, and supercritical fluid analytical chromatography — have evolved over the decades from simple chart recorders to onboard processors with minimal storage and analysis to personal computer-based and, finally, to connectivity with "peer" instruments and supervisory software systems.

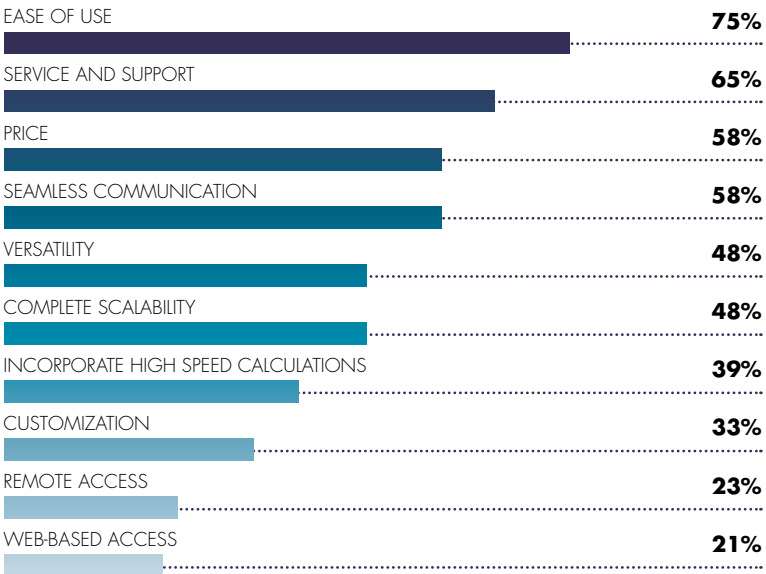
TOP 7 QUESTIONS

You Should Ask When Buying a CDS.

1. What are the key elements you need to have from the data system?
2. What differentiates the vendor's software from others offered, in terms of chromatography data handling, customization and powerful analysis?
3. How do you validate the specification claims presented by the vendor?
4. Has the data processing software been designed for enhanced analytics, with lab workflow in mind and does it support critical compliance requirements?
5. What are important price points to keep in mind when selecting a GC software package?
6. Laboratories need fast and effective services. This includes an effective distribution of installations, help desk, education, and service personnel. How does the company serve these needs globally?
7. Is validation, like support for 21 CFR Part 11, critical for you?

TOP 10 FEATURES/FACTORS

respondents look for when purchasing a Chromatography Data System



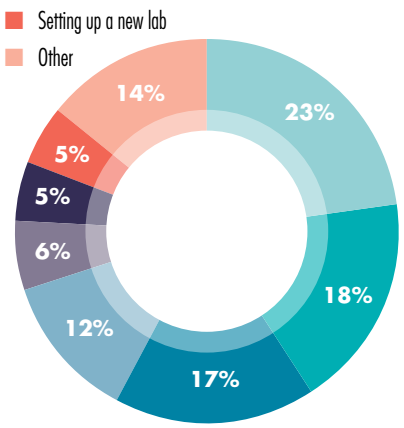
Types of Chromatography Data Systems currently used by survey respondents

Stand-alone	54%
Client/server	31%
Web-based	11%
Thin client	3%

Primary purposes for a CDS as reported by survey respondents

Infrastructure for capturing, accessing, and sharing experimental information	18%
Centralized data repository	15%
Improved productivity	14%
Improved communication between instruments and software	10%
Accelerating documentation and reporting	7%
Streamlined regulatory compliance	6%
Enabling scientists to collaborate effectively	2%
Workflow coordination across geographic and business boundaries	1%
All of the above	27%

Nearly 38% of respondents plan on purchasing a new or additional CDS in the next year for the following reasons



For more information on chromatography data systems, including useful articles and a list of manufacturers, visit www.labmanager.com/cds

NEVER A DULL MOMENT

FOR LAB ADMINISTRATOR PRAMILA SOOD, TEAMWORK IS THE ONLY WAY TO GET WORK DONE

BY SARA GOUDARZI

Its logo—MD Anderson Cancer Center—strikes through the word "~~Cancer.~~" Its tagline, "Making Cancer History," is indicative of its mission: to eliminate cancer in the world.

Through research, testing, care, and education, The University of Texas MD Anderson Cancer Center, located in Houston, Texas, takes an integrative approach to cancer, a group of diseases that affect millions worldwide.

Pramila Sood works on the clinical side—she is the lab administrator for the Department of Laboratory Medicine, in the division of Pathology and Laboratory Medicine. Sood oversees the operation of seven laboratories.

"Our laboratories provide clinical diagnostic information to our physicians, for treatment of their patients," she explains. "Thus, as a cancer laboratory, we are not different from other clinical laboratories—what makes us unique is that we do extensive testing compared to non-cancer hospital laboratories."

"For example, in our Special Chemistry Lab, we do electrophoresis and look for abnormal protein peaks, followed by immunofixation," Sood continues. "For immunofixation, we identify the immunoglobulin peaks and do dilution studies to tease out the abnormality."

Sood and her team also test for circulating tumor cells, where they look for epithelial cells produced by metastatic tumors. The test, which provides information on how effective chemotherapy is for the patient—along with analyses such as one that looks for optimal levels of chemotherapeutic agents to prevent organ damage—helps physicians determine the proper course of action for cancer patients.

Lab structure

Sood administers the CORE, Microbiology, Transfusion Services, Donor Center, Histocompatibility (HLA), Specimen Processing, and Point of Care (POC) testing labs.

Each lab specializes in one aspect of cancer research. The CORE lab is dedicated to hematology and chemistries. In the Microbiology lab, technologists identify aerobic and anaerobic microorganisms and perform susceptibilities, with a specialization in mycology, mycobacteriology, and virology.

THE UNIVERSITY OF TEXAS MD Anderson ~~Cancer~~ Center

At the Transfusion Services lab, technologists type and screen blood to provide for transfusion. At the Donor Center, researchers collect blood and manufacture blood products—MD Anderson has the largest hospital-based transfusion and donor center in Texas. Specimen Processing is responsible for receiving all specimens in the laboratory, aliquoting samples, and distributing the

Technologist working in the glove box in Microbiology.

samples to other laboratories.

The technologists provide histocompatibility testing in the HLA laboratory. The high volume of HLA testing utilizes liquid handling automation for each of the testing steps, with database management tools that include built-in quality control and quality assurance programs.

"The high volume of HLA testing utilizes liquid handling automation for each of the testing steps."

"All our laboratories provide excellent client service to bone marrow and stem cell transplant programs and cord blood banks," Sood explains. "We have more than 15 sites in the hospital where we provide POC testing. We train over 1,200 nursing staff to do POC testing and maintain quality control and instruments. POC testing is the fastest-growing service in our hospital."

Each of the seven labs occupies approximately 3,000 to 5,000 square feet of space and is run by its own manager, except for the CORE lab and Special Chemistry lab, which are run by the same person. Sood oversees all the managers, who supervise some 270 employees.

"I report to the chair of the department, the division administrator, and the director of operations," she says. "Six managers report to me—they provide supervision and guidance to lab coordinators and supervisors. Medical technologists and laboratory technicians receive direct supervision from supervisors, who also work side by side on the bench with the technologists and technicians."

Sood is a microbiologist. Her staff comprises chemists, hematologists, microbiologists, and virologists, among others. Together, her highly specialized team processes about nine million tests each year.

Instrumentation

The staff at the Department of Laboratory Medicine utilize a variety of instruments typically used in hospital labs, such as Vitros, Sysmex, PRISM, and STAGO, among others. In each lab, the equipment is set up to achieve maximum efficiency.

"We have to look at the workflow and how we're going to get our results out as quickly as possible," Sood says.

Another aspect of maximizing output is keeping up with advances in technology. One way to achieve this is to ensure that instruments are upgraded as equipment changes are made in the market.

Sood and her managers try to upgrade instrumentation every five to seven years. But this is not a hard-and-fast rule; it depends on the instrumentation and technology.

Technologist working at a scope.

"We keep some instruments for 10 to 15 years because they work well," Sood says. "For example, we haven't upgraded Vitros in 10 to 12 years. If the technology doesn't change or the methodology is pretty steady, then we keep that instrument as long as we can."

MD Anderson Cancer Center –Houston.

Automation is another aspect of improving workflow and efficiency. The CORE lab is entirely automated, while the other labs are approximately 50 percent automated.

"There's always been automation in the CORE lab," Sood explains. "It's just that over the years, it has gotten more sophisticated: Instruments are performing at a higher capacity, and turnaround times are getting better and better."

Other labs, such as Microbiology, are still not fully automated, because they require more human involvement. Still, tasks such as streaking plates, which some years ago would have been performed by a person, are now automated.

"Today we can streak using an instrument called an Isoplater, which saves us time by allowing the personnel to focus on other tasks while the plates are being streaked by the instrument."

"Together, her highly specialized team processes about nine million tests each year."

Such automation also improves turnaround times—the team's biggest challenge.

"Today, turnaround times are very important," Sood says. "Physicians in any hospital want their results within an hour and a half from the time the blood is drawn. We have to be very effective and very efficient to get that work out, and you do that through automation."

"For example, we recently installed middleware for our Sysmex instruments," she adds. "This has allowed us to improve our turnaround time for complete blood count (CBC) results to within 15 to 30 minutes from the time the sample is received in the lab."

To ensure that all instrumentation and equipment are properly working, lab administrators have contracted service technicians from instrument vendors for routine maintenance and emergency repairs.

"Sood and her managers try to upgrade instrumentation every five to seven years."

Inventory and hiring

The seven labs need to be resupplied regularly to ensure that a lack of supplies doesn't halt workflow. The task of taking inventory is the responsibility of designated personnel. Once they take stock of what needs to be replenished, they notify a member of the administrative support staff, who will then place orders.

▼ *Technologist pipetting in the Special Chemistry Lab.*

"Supplies are received by the supervisors or designated staff," Sood explains. "We would like to move to an electronic inventory system and are currently exploring an inventory system that will work for us."

With so many tasks to be completed and hundreds of employees working together at the various labs, it's important for each individual to fit in within the organization. For this reason, finding the appropriate personnel is key. Individual lab managers, therefore, need to evaluate their team's requirements and decide what kind of expertise would complement their laboratory.

"Each manager takes care of hiring for his or her laboratory," Sood says. "Our Human Resources department takes care of the recruiting; managers interview applicants and hire the best candidate."

Fortunately, the lab managers often don't have to look too far to find the right fit.

"We would like to move to an electronic inventory system."

"We have a medical technology school in our institution, and we fill our vacant positions with graduating students," says Sood.

Nonetheless, as at other institutions, the labs managed by Sood face short-staffing and budgetary constraints, among other challenges. But a good workforce allows the team members to get through the hard times. "We work together and support each other to meet these challenges," she says.

"Laboratory work is challenging, overwhelming, and stressful," Sood adds. "We are successful when we seek help from direct reports, peers, and superiors. Teamwork is rewarding and is the only way to get the work done and face the challenges of the workplace."

To keep her workforce motivated, Sood and others in administrative positions reward employees with monetary performance awards.

"Quarterly, we have a Service Awards ceremony, where we present Service Awards for the number of years that the employee has worked," she says. "We also present awards to our outstanding employees from each laboratory and welcome our new employees."

"For National Laboratory Week (NLW), we participate in fun games, and [there is] an outdoor hot dog party for the Fourth of July," Sood says. "[Also], the institution has an Employee Recognition Day, and we are invited to an ice cream social by our division."

For the winter holidays, Sood's department hosts a dinner and dance party, sponsored and funded by the department chair, giving the labs' personnel a chance to enjoy one another's company outside of the work environment.

Number one

Sood works hard, wears many hats, and at times spends long hours at the institution. In addition to attending meetings with managers and staff, she is constantly working to solve both administrative and technical problems.

"Each manager takes care of hiring for his or her laboratory."

"There is never a dull moment. I work in a very dynamic institution," she says. "My day involves making sure that I am available for my managers, to help them when needed."

It's not an easy job, but the overarching goal—to provide first-rate care for the institution's patients—gets Sood out of bed each day to come to work.

"We do excellent work in our laboratories, and we provide the best care for our patients," Sood says. "We are proud to be one of the top hospitals in the nation. To remain number one is what makes me come to work every day."

Top Instruments

Vitros • Sysmex • TOSOH • STAGO • Vitek II
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INSIGHTS
LAB TECHNOLOGY BUYER'S REPORT

INSIGHTS ON ANALYTICAL CHROMATOGRAPHY

A LAB MANAGER TECHNOLOGY BUYER'S REPORT

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All articles by **Angelo DePalma, Ph.D.**

THREE TECHNIQUES TO THE FORE

Chromatography remains the go-to analytical method for so many industries. Although the "big two" chromatographic modalities—high-performance liquid chromatography (HPLC) and gas chromatography (GC)—are mature, innovations continue in hardware, software, detection, and particularly in stationary phases. This *INSIGHTS* also covers an emerging technique, supercritical fluid chromatography (SFC), which is expected to give both HPLC and GC a run for their money. Although SFC installations are small in number compared with the more established methods, three top instrument makers now offer SFC systems that are nearly indistinguishable from these vendors' flagship HPLC systems.

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July 2013
VOLUME 2
NUMBER 5

Solid Core HPLC Columns / Accucore
Thermo Fisher Scientific / www.thermoscientific.com

HPLC/UHPLC System / Nexera X2
Shimadzu / www.ssi.shimadzu.com

DETECTOR, FEATURES DRIVE OPTION CHOICES

Nearly a decade after the debut of high-pressure, sub-two-micron-based liquid chromatography, the trend toward UHPLC (ultra-high-performance liquid chromatography) persists. "This is amply demonstrated by our sales numbers, as well as by independent market studies and customer surveys," says Michael Frank, senior director, LC Global Marketing at Agilent Technologies (Santa Clara, CA). The principal advantages of UHPLC are faster separations and higher resolution.

However, many UHPLC customers still use conventional column diameters such as 3.0mm to 4.6mm ID for their sub-2µm particle columns. "Narrower column IDs are primarily seen in LC-MS setups," Frank explains. Only a few UV-LC labs have moved on to narrow-bore columns. "The reason is probably that the larger ID columns are still more forgiving in point of sample preparation (i.e., less susceptible to clogging)."

On the system side, Frank sees a "higher loading" compared with the past—more users per system, more samples, and longer system operation times—to the point of overnight and weekend operation. "We know several big customers who continuously examine the loading of their analytical systems with the goal of improving them—an exercise that is purely cost-driven." This leads to higher demands on instrument uptimes; for example, in total solvent volumes pumped through before exchanging out a seal or in a higher number of valve switches before initiating maintenance.

Since Waters' (Milford, MA) debut of its branded UPLC®, the trend toward columns employing ever-smaller particle sizes has continued. "Users were looking for speed and efficiency, with resolution equal to or better than older methods," says Michael McGinley, bioseparations product manager at Phenomenex (Torrance, CA).

According to McGinley, the more recent trend is toward "geometrically designed" stationary phases. Available from many vendors, these are known as superficially porous, porous shell, or fused core, or as Phenomenex's own variety, Core-Shell.

The general construction of these columns is similar: a homogeneous porous shell is grown around a solid silica particle. Materials diffuse only into the shell, versus into the core of the particle as in traditional HPLC. The result is more rapid, efficient mass transfer into and out of the particle, thus faster separations. Proponents claim that superficially porous columns provide many of the advantages of UHPLC without the extremely high backpressures.

An interesting aspect of porous shell technology is that columns are available for all pressure regimens, from older HPLC models up to the most modern UHPLC systems. Phenomenex, for example, produces Core-Shell columns with particles as small as 1.3 microns. "We've gone past the issue of higher pressure," McGinley explains. "Users can pick a column that's appropriate for the pressure their system can handle, even down to 200-bar."

Users are still restricted by the laws of physics, however: smaller-particle porous shell columns work only on high-pressure systems, while large-particle columns work on any system.

According to Simon Robinson, HPLC product manager at Shimadzu (Columbia, MD), HPLC is experiencing something of a lull in terms of radically new technology. While fused core columns are emerging with novel bonded phases, Robinson says this platform is underutilized. "It could one day live up to its promise, but the customer base has not embraced it as enthusiastically as it could have. It looked like it was really going to take off two years ago, but now it appears to be holding steady." Robinson says that most users he encounters employ either legacy methods at five microns or sub-two-micron but have not had the opportunity to explore superficially porous technology.

HPLC PURCHASE DECISIONS

HPLC purchase decisions depend strongly on the application. However, since chromatographic equipment is typically a sizable investment, users expect a long service life. Practically speaking, users should consider the ease with which they upgrade systems as newer technologies are commercialized. "Performance is typically a key decision point, but here it is critical to look at the big picture; for example, 1200 vs. 1300 bar pressure capability translates to approximately 2 percent higher chromatographic efficiency," says Agilent's Michael Frank. "Whereas more sensitivity or linear range on the detector might make a difference in terms of hours of analysis time spent per samples, since additional runs or other detectors might be involved."

▲ *HPLC System / Alliance / Waters / www.waters.com*

System flexibility is another factor, as many labs demand rapid changeover between different chromatographic conditions, to the point of unattended changes.

Especially for regulated labs, the capability to run legacy methods and obtain exactly the same results as with conventional HPLC is critical. This means new methods, utilizing the increased power of new systems, that run on the same system as legacy methods, without the need for expensive method changes and revalidations.

Robinson believes that potential buyers should consider pressure flexibility as a significant feature when performing due diligence on new HPLC instrumentation. Systems capable of both high- and low-pressure operation can save direct costs and minimize the use of precious laboratory space. "You're looking at one set of parts, one software platform, and a single set of service and technical knowledge." In modern labs, particularly high-throughput establishments, the issue is not necessarily instrument productivity but getting more from limited benchtop space.

"An LC-MS system dedicated to high-pressure operation is a very expensive investment," Robinson observes. "The time and cost of method revalidation is another concern for many companies, which is why many HPLC methods are specified for standard pressures below 5000 PSI."

Lest one assume that the trend toward faster, higher-pressure, more expensive instruments has left labs of modest means in the dust, Eric Anderson, general manager at Buck Scientific (East Norwalk, CT) assures us that the market for entry-level LC instruments is alive and well. "Our niche market is for the little guy who doesn't need everything," Anderson says. "People who buy from us are more concerned about their budget than anything else."

Customers include smaller schools and laboratories, some of which require three or four instruments but lack the resources for more than one or two. High-end users, for example, pharmaceutical and biotech companies, are not typical purchasers of Buck's HPLCs.

Buck sources components like pumps and detectors from the 15 to 20 OEMS who specialize in these parts. It then assembles HPLC systems into systems run and controlled by Buck's proprietary software. "The software interface is everything," Anderson says. "Anyone can put a system together. Making all the pieces work well together is much more difficult."

Buck can customize in terms of detectors and pumps, but it does not get involved with very high-pressure systems or with mass detectors. Over the years the company has fashioned rebuttals to most arguments for sourcing only top-of-the-line LC systems. "It should come down to whether our specifications accommodate your application," Anderson advises. "It's pretty rare when they don't."

NEW KID ON THE BLOCK

In 1964, University of Utah chemistry professor J. Calvin Giddings enunciated a theoretical platform, "unified separation science," that could confer the resolving power of GC to LC.

Giddings' model combined the higher mobile phase diffusion and efficiency of GC with LC's higher selectivity via orthogonal separation modes. His vision has been made a reality through supercritical fluid chromatography (SFC), which uses supercritical or subcritical carbon dioxide as the mobile phase.

Professor Larry Taylor at Virginia Tech has described the continuum between, or "unification" of, GC and open-column LC as follows:

- High-pressure GC
- Solvating gas chromatography
- Supercritical fluid chromatography
- Subcritical fluid chromatography
- Enhanced fluid chromatography (high pressure)
- Liquid chromatography

Supercritical CO_2 is an inexpensive, low-viscosity, highly compressible, green solvent that improves chromatographic efficiency for a given stationary phase particle size and linear velocity.

SFC is greener than any form of HPLC, even low-volume UHPLC. Before it is cooled and squeezed into its supercritical or subcritical physical state, the carbon dioxide mobile phase is extracted from the atmosphere, to which it is subsequently vented. Thus, despite it being a "greenhouse" gas, the extraction and evaporation of carbon dioxide contributes zero net greenhouse gases.

By contrast, conventional HPLC solvents are toxic and expensive in both their acquisition and disposal. Acetonitrile, the most-used organic solvent in HPLC, has become prohibitively expensive in recent years. Users pay "both ways" for the luxury of using it: more than $100 per liter for HPLC-grade material, and approximately the same amount for disposing of the diluted eluent.

Waters has recently adapted SFC to its ACQUITY® instrument platform in a product branded UltraPerformance Convergence Chromatography (UPC²®).

CHIRAL, NORMAL-PHASE-LIKE SEPARATIONS

Waters' original target market was chiral analysis, where SFC already enjoyed a solid reputation. Waters has demonstrated chiral SFC separations that require one-thirtieth the time and consume one-eighth the solvent compared with standard normal phase HPLC. "When you consider this savings on the scale of hundreds to thousands of injections, the financial impact to an organization can be quite exceptional," says Waters' John van Antwerp.

Preparative HPLC and SFC Core-Shell Media / Kinetex® Phenomenex / www.phenomenex.com

Yet SFC may not remain king of the hill for chiral separations. Christopher Welch, PhD, who manages Merck and Co.'s (Rahway, NJ) New Technologies Review and Licensing Committee, has commented that reverse-phase chiral LC is improving. "It is not bad—it's something to watch," he advised *Lab Manager*. Chiral Technologies, Sigma, Phenomenex, Regis Technologies, and other vendors supply reverse-phase chiral columns.

Since its selectivity overlaps significantly with normal-phase chromatography, SFC is orthogonal to reverse-phase LC. The technique is applicable to a diverse range of compounds, including most organic-soluble compounds, most salts of organic acids and bases, strong organic acids and bases, small lipophilic peptides, and nonpolar solutes (e.g., waxes and oils). In addition to being the go-to method for chiral separations, SFC also separates positional isomers and diastereomers and is compatible with most popular detection modes.

"UPC² is the combination, or convergence, of GC and LC," says Ken Fountain, director of Chemistry Applied Technology and Global UPC² Applications. It exploits the advantages of carbon dioxide-based mobile phases in either supercritical or subcritical mode, while retaining the ability to run gradients with common organic solvents such as methanol or acetonitrile.

INSTRUMENTALIZING SFC

The most formidable hurdle to "instrumenting" SFC in the form of UPC² was to make the new platform as

robust and reliable as traditional analytical chromatography. "Laboratory scientists know deep down that GC and LC are robust. They trust those technologies. We wanted to bring that same level of trust to SFC," Fountain says.

Martin Vollmer, SFC product manager at Agilent Technologies, describes SFC as "a sleeping beauty" that has been grossly underutilized considering its analytical capabilities. Reasons for this were lack of sensitivity, low instrument robustness, and absence of appropriate knowledge and infrastructure for supercritical fluids.

That, says Vollmer, is why SFC was mainly restricted to chiral analysis or used as an alternative to preparative LC. "With the launch of next-generation analytical SFC instruments, the boundary conditions changed dramatically," he adds. Sensitivity and robustness are on par with LC, and operation is similar to that of leading UHPLC systems.

Analytical instruments require a standard CO_2 flask, which can be installed in any lab. "This is a door opener for a much wider application space beyond chiral analysis, where SFC is known to provide superior selectivity," Vollmer adds. SFC has become an "intriguing alternative" for replacing lengthy and toxic normal phase separations, and the most dependably orthogonal method to reverse phase analysis. Fat-soluble vitamins, sterols, food additives, organic light-emitting diodes, pyrethroid insecticides, petrochemicals, and vegetable oils are some analytical targets for which SFC provides robust analysis.

Robustness, ease of use, and performance are key elements of an instrument to be accepted as a mainstream analytical tool. The Agilent and Waters SFC systems are based on proven LC platforms, with the added twist of employing CO_2 as an additional solvent. Not much extra knowledge is required, and safety issues in analytical mode are minimal.

"SFC is no longer considered an academic-only instrument," says Martin Vollmer. "Many pharmaceutical, food, and chemical companies are investing in SFC technology and anticipated growth rates are higher than for other analytical instruments."

Lab managers are beginning to view SFC as an alternative to normal-phase HPLC. Some growing areas for SFC include fuel analysis, including traditional petroleum products and biofuels. Pharmaceutical companies are beginning to notice that SFC works not just for chiral separations, but for non-chiral normal-phase separations. "CO_2 behaves similarly to hexane or heptane; they use the same columns and modifiers," notes D.J. Tognarelli, chromatography product specialist at JASCO (Easton, MD). "People are going out of their way to exploit the method's speed and environmental benefits. The ability to switch from chiral columns to non-chiral normal-phase columns, on one instrument, is a big plus."

Vendors still have work to do to educate potential buyers about the advantages of SFC for many applications. "Many lab workers know the term supercritical fluid chromatography, but to them the instruments are like black boxes. They have no idea how they work," says Tognarelli.

▲ *SFC/UHPLC System / 1260 Infinity Hybrid / Agilent / www.agilent.com*

▲ *Preparative SFC System / Prep-2088 / JASCO / www.jascoinc.com*

JASCO convinces customers through dialogue, training, and education. "SFC sounds complex, but when you explain that the only significant difference is replacing hexane with carbon dioxide, and that you still retain the ability to use polar modifiers, they begin to understand," Tognarelli says. "Bridging the gaps in knowledge and understanding is our main focus."

Like the other major SFC system vendors, JASCO relies heavily on its already successful HPLC platforms to sell its SFC systems. The column, oven, autosamplers, co-solvent administration, and modifier pump are identical, and the detector is "virtually the same," according to Tognarelli. The main operational differences are that SFC systems are cooled and the system maintains pressure throughout.

INSIGHTS ON ANALYTICAL CHROMATOGRAPHY

HYDROGEN, MS DETECTION, MODULARITY

▲ *Gas Chromatograph / Tracera Shimadzu / www.ssi.shimadzu.com*

"Fun new tools," particularly in mass detection, have encouraged a new conversation among separation scientists, says Nicholas Hall, national sales director at LECO (St. Joseph, MI). "Every time this occurs, the instrument vendors engage in the equivalent of an arms race, where the battles are fought over specifications—more resolution, greater fragmentation capability."

But the real discussion has recently involved the very nature of chromatography, Hall says. "Just as important as the tool used for detection on the back end is the time and optimization that goes on at the front end." Thus the resurgence of basic chromatography optimization, the application of solid analytical chemistry, and a focus on chromatography as the optimization of mass spectrometers. "If you have good separation and good sample preparation, and that goes into the MS, then you're really optimizing the mass spectrometer's capabilities."

One tool that combines GC and MS exquisitely is two-dimensional GC, or GCxGC. Through this method, a chromatogram is run in the first dimension, perhaps through a nonpolar phase, and then the entire eluent is collected and re-injected onto a second column operating orthogonally. What emerge are significantly greater peak capacity, separation capability, and lots of MS data points.

"It works similarly to 2-D HPLC, but it's a lot easier because we're in the gas phase," Hall notes.

"Hydrogen carrier gas has been touted as a smart alternative to helium as a GC carrier gas."

Massimo Santoro, GC marketing manager at Thermo Fisher Scientific, believes that instrument modularity and mass detection are two emerging trends in GC.

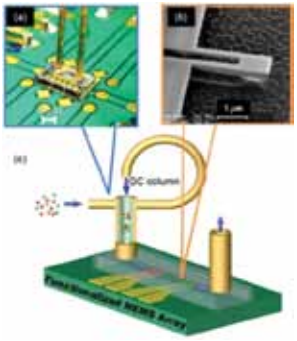
Thermo Fisher Scientific recently introduced the Trace 1300 GC, which allows users to replace injectors and detectors on the fly. "Now users can modify their GC configuration, as they can with HPLC, without a service call."

Injectors become contaminated by matrix components: through poor sample preparation, high concentrations of certain components in samples, or long use. Where a service call might take days or hours in the case of on-site technicians (an increasingly rare situation), users can now swap out components as necessary.

"Modularity is also a way for small laboratories to maximize their investment," Santoro tells *Lab Manager*. "They can purchase the system they need today, and if their business grows, they can add a new injector or detector to accommodate changing workflows." Other benefits include easier troubleshooting.

Terry Sheehan, GC-MS manager at Agilent Technologies (Santa Clara, CA), has noted a shift in some markets away from traditional GC detectors toward mass detection. The trend is most pronounced in environmental and food analysis. In addition, the need to run through samples quickly has been addressed by fast GC, low thermal mass GC, and the use of hydrogen carrier gas to replace helium.

Hydrogen carrier gas has been touted as a smart alternative to helium as a GC carrier gas. Hydrogen's benefits are faster runs and lower cost. The U.S. helium shortage has made the gas particularly difficult to obtain in some geographic areas.



▲ *Gas Chromatography Device / GCAP™ APIX / http://apixtechnology.com*

Replacing helium with hydrogen has been a boon for some analytic areas, Sheehan says, but the process is not as simple as changing tanks. "The two gases differ significantly in nature and chemistry." This is, in fact, the basis of hydrogen's advantages, but exploiting those benefits requires an understanding of the two gases.

Hydrogen is active, helium inert. While fears of a hydrogen explosion in a typical GC setup are irrational, the gas may interact with analytes in ways that helium cannot.

"Yes, you will benefit from switching, but there are things to pay attention to. You can't simply swap hydrogen for helium and be set to go." The method will probably need to be redeveloped and, in some instances, revalidated. "But if you go in recognizing that, in many cases you may be pleasantly surprised. At the worst it will take a bit more work to transfer the method."

SHIFT TOWARD MS DETECTION

Sheehan says that the biggest issue in GC relevant to workflows is sample preparation. "That has been the huge bottleneck in many GC labs." All instrument manufacturers, including Agilent, have worked to speed up analysis so samples do not pile up. The hurdle has therefore shifted to readying the samples for GC.

Sample preparation, including cleanup and derivatization, may be aided by automation tools, as is standards prep. Unfortunately, the wide diversity of GC samples makes a one-size-fits-all preparative cleanup elusive.

This has caused GC users and instrument vendors alike to rethink MS detection—specifically the relative value of a triple-quadrupole detector versus a far less expensive single quad. The latter demands thorough sample prep to remove matrix, while the former does not.

▲ *GC and GC/MSD / 7890B GC and 5977A Series GC/MSD / Agilent / www.agilent.com*

Sheehan mentioned a recent analysis demonstrating, on the basis of workflow compression and cost, the value of triple-quad MS. Even though a tandem triple quad might cost three times as much as a single quad, the return on investment could be less than six months for very high-throughput labs. "And with an average lifetime of ten years, a triple quad provides lots of opportunity to save a lot of money," Sheehan adds.

Mass detectors add significant cost to GC systems. A GC with standard detectors may be purchased for less than $10,000, but most research-grade instruments cost between $20,000 and $30,000. A single-quadrupole mass detector easily adds $35,000 to the cost, while a triple-quad system plus GC will set you back as much as $180,000.

SO WHY UPGRADE TO GC-MS?

MS provides a dimension that flame ionization or thermal conductivity does not. "In addition to elution time, you now get confirmative identification of your compound through mass spectrometry," Santoro says. Analysts who know what they are looking for can employ the selective ion mode, by which the MS looks specifically for ions of interest. "This provides greater sensitivity." MS-MS triple quads provide even greater sensitivity, particularly if analytes are known and even in cases where two or more species have identical mass. The instrument can look for transitions from ions with a mass of, say, 180 to a mass of 130, which may be specific for one analyte but absent in the other. "That provides a lot of signal and a lot of sensitivity."

A Q&A WITH A SELECT ANALYTICAL CHROMATOGRAPHY EXPERT

OUR EXPERT:

Kimberly Moser
Instructional
Laboratory Manager
University of Oklahoma

Q: Describe your institution and how you use analytical chromatography.

A: The University of Oklahoma's Department of Chemistry/Biochemistry is an educational and research facility. We use GC to train students as they move through their educational careers in undergraduate laboratories. Students are first introduced to GC in our organic chemistry laboratories, where they learn how to interpret the spectra of samples they have prepared through experimentation. We use GC heavily in more advanced classes. After learning manual injection, students learn to use a basic autosampler. After understanding basic thermal conductivity detection, students learn on a research-grade GC-MS with FID and trace ion detection.

Q: What detectors and carrier gases do you use?

A: We use both TCD and FID detectors for teaching units, due to the simplicity of maintenance and space issues. We use helium as the carrier gas and dichloromethane as the main solvent. For our FID-equipped GC-MS, we use ultra-high-purity helium.

Q: What are the most significant bottlenecks in your GC workflow, and how do you overcome them?

A: The most significant bottleneck in our workflow is the time required to run each sample. Whether the TCD unit is used with manual inject or the autosampler, each sample takes up to eight and a half minutes. Even the more advanced FID GC-MS only reduces the sample time in half. In the teaching facilities, time is always of the essence. We face a constant battle to get students into the lab, have them perform all their experimentation and instrument runs, and leave on time to accommodate the next class. We alleviate this burden by splitting classes into several sections. Unfortunately, this also increases the time burden on teaching assistants.

Q: What can GC systems vendors do to improve their products and/or streamline your workflow?

A: One issue we have with not allowing students to use the research-grade GC-MS is the delicacy of its construction. We maintain the autosampler on this unit, and it is fashioned so it "sticks out" like a balcony over the counter. Multiple hands using this instrument would be a detriment. There is no physical support for the autosampler, which might be damaged if someone leans on it too heavily.

Time is a part of doing GC, and knowing the retention time of your column is one priority. Technology is advancing and most students are "plugged in" through some fashion these days. To assist them in getting their spectra sooner, it would be nice if messaging software could send their spectra to them as runs complete; this way they could begin their analysis without physically returning to the lab. Then they could incorporate their interpretations of the data into their written reports without delay. As it is now, most students have to wait a week for their spectra.

MASS SPECTROMETERS

WITH MS, IT'S ALL ABOUT ROI

by Rachel Muenz

When to upgrade your mass spectrometer (MS) varies from user to user but there are a few main indicators that are common to many situations, the experts say.

"Overall, the big thing that everyone needs to be concerned about is return on investment (ROI)," says Patrick Jeanville, South American mass spectrometry commercialization leader for PerkinElmer. "Can you improve your overall ROI by replacing your current technology?"

PerkinElmer's AxION® iQT GC/MS/MS , released June 2013, is the first mass spectrometry platform of its kind that performs both superior quantitation and exact mass identification for complex sample analysis.

Other key reasons to buy a new MS include the system needing too much maintenance or the instrument doesn't meet the user's expanding research requirements in terms of detection limits, linearity, speed of analysis, robustness, reporting and regulatory requirements.

Also, if known standards and blanks are incorrect when tested, service and training costs are too high, and replacement parts too difficult to find, it could be time to replace. Growing business is another reason to upgrade.

"If an organization is outsourcing its samples in greater numbers, it may be time to purchase a, or another, MS to meet the growing demand," says Vicky Lander, global director of marketing communications for Bruker Daltonics.

Bruker's new solarix XR FTMS System, recently introduced at ASMS in Minneapolis in June.

However, there are situations where, "If it ain't broke, don't fix it," Jeanville says. "If your current instrumentation meets your productivity, sensitivity, robustness, service requirements and the needs of your customer base, then I really would not recommend replacing it until it suffers from a derogative technical issue or reaches its end of life cycle."

Lander adds that for validated methods or routine analysis, a new mass spec isn't usually necessary. "Also, if they can outsource some work, that may be a preferred, if not temporary, option to buying new."

Yet waiting too long to upgrade can cause future problems.

"You don't want to wait so long that technology is antiquated and … it's going to cost you a lot in terms of what you need to put into it, whether it's training, or whether it's updating the technologies," Jeanville says.

Sticking with a current MS has some short-term benefits, such as saving the cost of buying new, and staff are familiar with it and don't require new training.

"The cons crop up when that system no longer meets their needs and the efforts to keep it running or to work around its shortcomings start to cost more than they save, and certainly if the existing system precludes the organization from meeting new challenges," Lander explains.

Upgrading parts of a current system is also a budget-friendly option, but isn't usually the best choice, especially with older systems.

"Honestly, probably the only benefit is the amount of capital that's going to be needed to perform the upgrade, and this is on a case-to-case basis," Jeanville says.

Both experts agree that in many cases updating parts won't make a future upgrade unnecessary.

"It's just a temporary solution and the user is only delaying the inevitable," Lander says.

With a new system, users may need to invest some time in getting used to new software and hardware, but that software is easier to use and the technology more powerful, speedier, reliable, suits many applications, and often pays for itself in better productivity and higher revenues, the experts conclude.

OPTIONS FOR BUYERS ON A BUDGET:

- Leasing or trade-in programs
- Buying a demo model
- Swapping out older components for new ones, but beware of the third-party market
- Customized purchase agreements

RESOURCES TO CONSULT BEFORE BUYING:

- Current system users and colleagues
- Vendors and sales reps
- Social media sites or forums focused on MS instruments
- System literature
- Trade shows

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Ocean Optics www.oceanoptics.com

PRODUCT SPOTLIGHT

THREE IS BETTER THAN ONE

LC-MS SYSTEM'S UNIQUE ARCHITECTURE BOOSTS ANALYTICAL PERFORMANCE AND METHODS

Back in June, Thermo Fisher Scientific launched the first "Tribrid" LC-MS system at the ASMS Conference on Mass Spectrometry and Allied Topics in Minneapolis.

"Our mission has been to create the highest-performing commercial mass spectrometer ever built," said Dr. Ian Jardine, Thermo Fisher Scientific's chief technology officer of chromatography and mass spectrometry. "Additionally, we wanted to make this power widely accessible to the science community and make it incredibly easy to use."

The Tribrid architecture of the new system, a configuration of three different mass analyzers, offers greater depth of analysis of complex biological samples for the life sciences sector. It also opens up completely new experimental methods.

Dr. Jardine added that, with the Orbitrap Fusion, Thermo has combined and improved its quadrupole, linear ion trap and Orbitrap technologies in a flexible research MS system.

According to one user, the system also helps deal with two main challenges—sensitivity and throughput.

"The Orbitrap Fusion instrument is revolutionary in allowing us to achieve much greater proteome-wide coverage with much greater quantitative accuracy than ever before," said Dr. Steven Gygi, professor of cell biology at Harvard Medical School.

One way the system can address such throughput challenges is through tandem mass tags (TMT), a technique that enables mass spectrometers to determine relative quantification of proteins in multiple samples simultaneously. The instrument also dramatically increases depth and quality of data compared to previous tools to make TMT results better. The Orbitrap Fusion takes advantage of MS^3 selectivity to improve quantitative accuracy, and can collect twice as many MS^3 scans per unit time, at significantly greater sensitivity than was previously possible.

For more information, visit www.thermoscientific.com/asms

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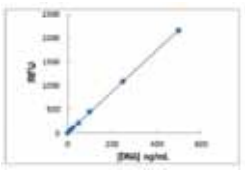
- The SMZ18 is more economic and uses a manual-intelligent zoom
- Both instruments are the first stereomicroscopes to use a fly-eye lens on an epi-fluorescence attachment

Nikon Instruments www.nikoninstruments.com

CHEMICALS, KITS & REAGENTS

Fluorescent DNA Quantitation Kit



- Quantifies double-stranded DNA in the low nanogram up to 5 microgram per ml range using fluorescent bisBenzimide H33258 (Hoechst) dye
- Uses a simple method that may be easily scaled for a single cuvette or for high throughput in multi-well plates
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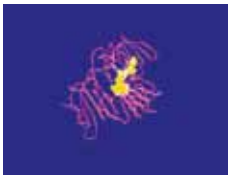

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PRODUCT SPOTLIGHT

IMAGE, READ, INCUBATE

NEW ALL-IN-ONE SYSTEM AIMS TO TACKLE CELL BIOLOGIST'S MAIN HURDLES

BioTek recently released the first hybrid multi-mode microplate reader and imaging system, the Cytation™3. The combination of multi-detection and automated digital microscopy in one instrument allows cell biology researchers to obtain data-rich quantitative and qualitative information from their cells in ways they couldn't before.

The instrument enables both target-based and phenotypic screening and is aimed at price-conscious users.

"We knew that with our expertise, we would be able to develop a system that was affordable," said BioTek instruments product manager Xavier Amouretti, adding that customers can order the system as just a plate reader, as an imager, or both, based on their needs and budget.

One other major hurdle with similar types of instruments is learning and using the software. With the Cytation3's Gen5™ data analysis software, BioTek hopes to address that problem, Amouretti said.

"We thought we could really work on making our software as easy to use as possible for non-experts," he said, adding the software includes many neat features, such as one-click counting. "It's a tool that will automatically identify cell nuclei and give you a count."

Cytation3 also automates repetitive microscopy work and features brightfield imaging and color switching through onboard filter cubes, while the reader measures absorbance, fluorescence and luminescence detection. In addition to reading and imaging, the system offers uniform temperature control to 45°C, variable shaking modes, and CO_2 and O_2 regulation for live-cell assays.

Set to ship this month, early users already seem to like the system.

"It's really great for initial counting," said Dana Nojima, a senior scientist at Amgen. "You can turn it on and it's ready to go."

For more information, visit http://landing.biotek.com/cytation3-pr

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A COMBINED METHOD FOR QUANTITATIVE AND QUALITATIVE CELL-BASED RESEARCH

Biochemical and cell based assays using a microplate reader provide quantitative data on ex vivo cell behavior, while viewing cells with a microscope allows researchers to see cellular and intra-cellular processes via fixed cells or with live cell imaging. Both methods are equally important to life science research and the drug discovery process. Together, these methods provide valuable, content rich data that otherwise requires the expense of multiple instrumentation. The Cytation™3 Cell Imaging Multi-Mode Reader from BioTek Instruments, Inc., combines both methods in one compact, affordable instrument. With this unique combination, BioTek brings microplate detection analysis and automated digital microscopy to researchers without the need for separate, expensive and complex imaging systems. Additionally, cells may be grown directly in Cytation3 to reduce environmental variation due to manual intervention. Now, researchers can culture cells and subsequently glean almost simultaneous quantitative and qualitative data. Cytation3's combination of technologies also helps to streamline cell biology research for improved lab efficiency and increased throughput.

Cytation3 is modular, so labs can select only the modes that they need, and can upgrade at any time as their needs evolve. Microplates from 6 to 384 wells, and microscope slides may be used, for a variety of throughput needs. Optional dual reagent dispensers may be used for inject-and-read assays, and the optional BioStack3™ Microplate Stacker has a plate transfer time of about 8 seconds per microplate, for increased throughput and walk-away automation of up to 50 microplates.

CELL-BASED ASSAYS

Patented Hybrid Technology™, incorporated in Cytation3 or available as an upgradeable option, combines filter- and monochromator-based fluorescence optics in one compact unit for power and flexibility in assay choice. The filter optics use direct, fiber-free light paths to maximize light delivery to the sample and detector, and dedicated filter optics are optimized for live cell assays. Monochromator optics use quadruple diffraction gratings to concentrate and purify the selected wavelength, thus optimizing spectral discrimination. User-selectable monochromator optics also allow for wavelength scanning and kinetic measurements. Multiple parallel detectors decrease measuring time, and both optical systems may be read from the top or bottom of a microplate for increased assay versatility.

CELL MICROSCOPY

Cytation3 automates cell microscopy throughput compared to manual fluorescence microscopy, and also allows simple assay validation before moving to high-content screening. An inverted fluorescence microscope with brightfield capability and autofocus is integrated in Cytation3 or available as an upgradeable option. Fluorescence microscopy and color switching are available through red (Texas red), green (GFP) and blue (DAPI) LED filter cubes, and brightfield images are taken with a simple white light. Additionally, 2.5x and 4x objectives allow researchers to view and read entire microplate wells, while 10x and 20x objectives allow viewing and reading of intracellular details.

CELL PROPAGATION

Cytation3 offers uniform temperature control up to 45°C across the culture chamber, and variable orbital shaking to keep cells in suspension, even during long experiments. An optional gas control module regulates CO2 and O2 concentrations for optimal physiological conditions and pH buffering. Adding these environmental variables directly to the reading and imaging chamber reduces cell culture exposure to unregulated lab atmospheres and fluctuating temperatures that may adversely impact results.

The combination of multi-detection reading and microscopy, along with integrated cell incubation, allows for endpoint, time-lapse and montage information to simplify research and assay development, and increase throughput in cell biology research.

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The PURELAB flex offers many advantages for analytical and lifescience applications. It allows users to focus on routine test work, without having to worry about the water quality affecting any test results. The PURELAB flex 3 and 4 are flexible water purification systems which can be adapted to respond to a laboratory's changing water purity needs today and tomorrow.

The water quality conforms to international water standards e.g. CLSI, CLRW, ISO 3696: Grade 1,2,3, ASTM D1193-06, Pharmacopeia USP, EP and JP. The PURELAB flex can be used for analytical and lifescience applications in all pharmaceutical, university, hospital, food and beverage laboratories.

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HIGH THROUGHPUT SAMPLE PROCESSING AND TARGET DETECTION WITHOUT THE HIGH COST

SAMPLE TO ANSWER IN 15 MINUTES OR LESS

Douglas Scientific has created a new instrument, the Nexar® Optimized for Isothermal DNA Amplification, using chemistry developed by EnviroLogix that allows you to go from sample to answer in 15 minutes or less. The new chemistry, known as DNAble®, is a novel isothermal gene-specific amplification technique that challenges traditional PCR-based chemistries and instruments by providing significantly higher throughput and considerably lower cost. The advantages of the new DNAble/Nexar system include:

- **Tolerance of crude DNA samples, minimizing your lab preparation time to 5 minutes.**
- **Results in 15 minutes, meaning your data is available quickly.**
- **Reduced reaction volumes of 1.6 µL, significantly lowering your reagent costs.**

HOW DNABLE® WORKS

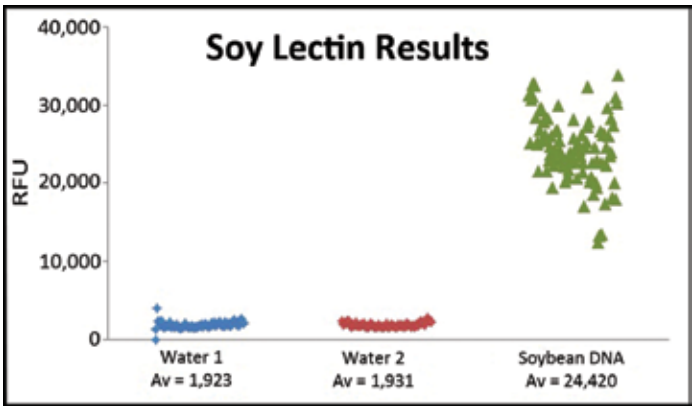
DNAble is a novel isothermal DNA amplification technique that utilizes two primers and a fluorescent molecular beacon to quickly amplify and detect specific DNA sequences. It relies on two enzymes working together at one temperature—a nicking enzyme and DNA polymerase, as shown in Figure 1.

END-POINT ISOTHERMAL NEXAR

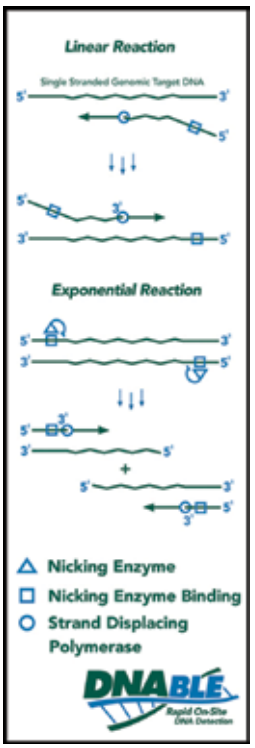
The Nexar Optimized for Isothermal DNA Amplification is a fully automated solution for low-volume, high throughput sample processing that integrates liquid handling, DNA amplification, and fluorescence detection all in one instrument. When combined with DNAble chemistry, it provides a high quality, cost-effective alternative to PCR for many scientific applications.

AMPLIFYING THE LECTIN GENE

A DNAble assay was used to amplify the lectin gene in soybean DNA. Soybeans were ground, combined with a simple buffer, heat treated for five minutes, and centrifuged. The supernatant was used as the soybean DNA sample, and water was used as a negative control. Small reaction volumes (800 nL of sample and 800 nL of 2X master mix) were combined in Array Tape™, sealed, and incubated at 56°C for eight minutes. Fluorescence was measured by the inline scanner. The average molecular beacon fluorescence signal was 12.6 times higher for soybean DNA than for water. These results (see Figure 2) demonstrate that sequence-specific DNA amplification can be quickly accomplished using the DNAble/Nexar system.



▲*Figure 2. DNAble/Nexar Lectin Plot*



▲*Figure 1. DNAble Reactions*

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MORE INFORMATION

To learn more about "Isothermal DNA Amplification for End-Point and Real Time PCR," go to the following URL: www.douglasscientific.com/isothermalandrealtimepcr.pdf

CONCENTRATING HEAT SENSITIVE SAMPLES WITHOUT DEGRADATION

Typically, sample concentration or solvent evaporation requires heat to drive the evaporation process. For heat sensitive samples, adding too much heat can damage or modify the structure of the analyte. The most effective way to safely evaporate solvent from heat sensitive samples is to place the sample in a vacuum atmosphere. At reduced pressure, the evaporation phase change occurs at a lower temperature, allowing the sample to be concentrated without damage from excessive heat. Common laboratory methods for solvent evaporation or sample concentration are lyophilization (also known as freeze drying), vacuum evaporation, nitrogen blow down and rotary evaporation. Several factors determine the optimal method for concentrating heat sensitive samples — sample volume, sample quantity, required temperature range, and solvent(s) being evaporated.

Below is a chart showing the methods of evaporation above.

	Lyophilization	Vacuum Concentrator	Nitrogen Blowdown	Rotary Evaporator
Sample sizes	Microliters to liters	Microliters to 25mls	1ml to 450mls	Up to 25L
Number of samples	Up to 24 large flasks, 1,000s serum vials	Up to 300	Up to 50	One
Temperature range	Freezing to +60°C with shelf dryers	-4°C up to +100°C	Ambient to +100°C	Ambient to +100°C
Limitations	Difficult to lyophilize alcohols	Small sizes up to 25mls	Nitrogen consumption	Single samples only

Video link: http://www.youtube.com/watch?v=IC71tGEbfLo&list=PLE239A977C23C949C&index=5

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AUTOMATING ELISA ASSAY PROCESSING

Problem: ELISA assays are a workhorse assay used in pharmaceutical research and molecular diagnostic labs. This assay can be a high-volume service area for contract labs. However, many IVD labs and CROs have difficulty in cost-effectively scaling their ELISA workflow to meet customer demand. This simple assay becomes deceptively complex: time sensitive steps and subtle workflow changes between different tests can be challenging to process as throughput increases. Reagent costs can cut further into tight operating margins. At some point manual processing becomes too challenging from an IVD compliance and operational perspective. Automating the laboratory's workflow is the answer—but it can seem difficult to implement and expensive.

Solution: One option for dealing with such issues is a new module Hamilton Robotics has launched for the Microlab® STAR workstation that automates an ELISA workflow. The ELISA STARlet module can expand a technician's productivity by processing up to ten plates with minimal hands-on time, enabling walk away automation and time efficiency.

The Microlab STAR liquid handling system provides one of the simplest and most adaptable solutions for medium to high throughput labs to acquire automation. The ELISA module is a dedicated instrument for fully automated processing of ELISAs. This system is priced favorably to other automation solutions in the same class. Process control for the instrument meets CE-IVD 98/79 directives and is designed for long walk-away times.

The deck layout features an intuitive left to right workflow. On deck are all of the integrated devices needed to process an assay: two ten-position incubator towers, multi-flex carriers, sample tube carriers, reagent reservoir carriers, plate carriers, and nested tip carriers that can hold up to 1,920 tips, a microplate reader, shakers and washers. A clean plate entry and plate exit feature enables plates to exit into a holding space, rather than the waste container. This enables the technician to visually inspect the plate, read the plate on a different instrument or follow any specific directions for plate disposal.

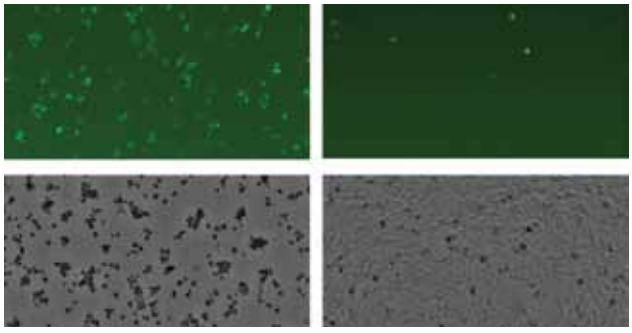
Programming for the VELISA software is driven by GUI–enabled wizards and is easy to program. Application specialists can provide a demo to users' labs as well as assist with automating their protocols. An assay editor wizard enables users to customize individual plate layouts, replica lanes to a user's workflow. The run editor enables users to create a run with a single assay or combine assays into batches—a benefit for labs running multiple assays with varying throughput levels.

Run execution is managed seamlessly at each step by the software. Sample loading is accomplished when the autoloader reads the barcodes from the tubes, plates, containers and records lots, liquid levels and checks for the presence of plates. The software calculates and communicates the need for consumables and disposables to the technician. An easy to understand overview is displayed on the monitor outlining where user interaction is needed. Modules like the Microlab ELISA STARlet are designed to maximize efficiency for the high-volume service needs of laboratories at the forefront of biomedical research and clinical testing.

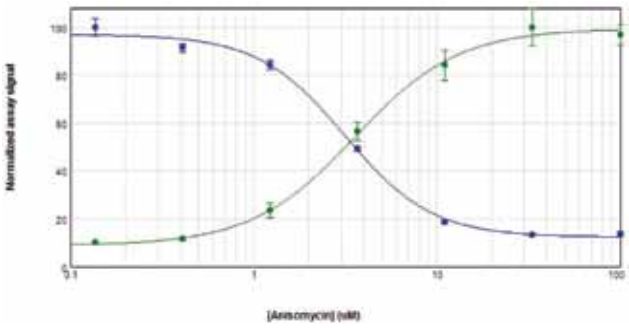
For more information, visit: http://www.hamiltonrobotics.com/hamilton-robotics/standard-solutions/elisa-star/

Microlab ELISA STARlet Workstation.

MONITORING CYTOTOXICITY ON THE SPECTRAMAX I3 MULTI-MODE MICROPLATE PLATFORM WITH SPECTRAMAX MINIMAX IMAGING CYTOMETER



▲*Figure 1. Top: Fluorescent imaging of caspase activity in anisomycin-treated (left) and untreated control (right) cells. Apoptotic cells are green-fluorescent. Bottom: Bright-field imaging of anisomycin-treated (left) and untreated (right) cells. The rounding of anisomycin-treated cells is consistent with apoptosis. All images were obtained with the SpectraMax® MiniMax™ Imaging Cytometer.*



▲*Figure 2. Caspase (green) and ATP assay (blue) results for anisomycin-treated HeLa cells. Caspase activity was detected using the SpectraMax® MiniMax™ Imaging Cytometer, and ATP activity was measured using the luminescence detection mode of the SpectraMax i3 Multi-Mode Detection Platform.*

INTRODUCTION

Apoptosis is an important process in embryonic development as well as in cancer and neurodegenerative diseases. Assays for apoptosis and cell viability can provide information on the mechanisms of cell death. Microplate reader assays often use whole-well luminescent or fluorescent readouts, but even more information can be gathered by combining these assays with imaging cytometry. The SpectraMax® i3 Multi-Mode Detection Platform allows users to measure apoptosis and cell viability on a well-by-well or cell-by-cell basis, as well as control assay quality by monitoring cells' appearance.

EXPERIMENT

HeLa cells were plated at 5000 cells per well in 384-well black-wall, clear-bottom microplates and allowed to grow overnight. The following day, a serial dilution of the apoptosis-inducing compound anisomycin was added to the cells. After 20 hours, apoptosis and cell viability were measured.

Apoptosis was monitored using the CellEvent Caspase 3/7 Green Detection Reagent (Life Technologies cat. no. C10423), which produces a green fluorescent signal in apoptotic cells where caspase-3 or caspase-7 has been activated. Apoptotic cells were detected using the SpectraMax® MiniMax™ Imaging Cytometer with Cell Count analysis. Cell viability was quantitated using the CellTiter-Glo Luminescent Cell Viability assay (Promega cat. no. G7570). This luciferase-based assay produces a luminescent signal proportional to the amount of ATP, and therefore metabolically active cells, in the assay wells. Luminescence was detected using the SpectraMax i3 Platform. All data were collected and analyzed using SoftMax® Pro Software.

Cells were also imaged using the bright field imaging mode of the MiniMax Imaging Cytometer.

RESULTS

After 20 hours of treatment, anisomycin had induced apoptosis in a concentration-dependent manner, with apoptotic cells exhibiting green fluorescence (Figure 1). Bright field images showed rounding of anisomycin-treated cells, consistent with apoptosis. Caspase activity increased with increasing concentrations of anisomycin, while ATP levels declined (Figure 2).

CONCLUSIONS

A more complete assessment of cell health can be performed using a combination of fluorescence imaging and luminescence-based assays. Fluorescent imaging of caspase-3/7 activity, an essential event of apoptosis, was combined with a luminescent ATP assay to monitor cell viability. Bright field images provided information on cell morphology that could be used for quality control. The SpectraMax i3 Platform with MiniMax Imaging Cytometer is an ideal platform combining the benefits of imaging with the versatility of multi-mode plate reader assays. SoftMax Pro Software offers a seamless workflow from data collection to analysis. Learn more about the system: www.MolecularDevices.com/SpectraMax

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PRE-OWNED EQUIPMENT MARKETPLACE

PARTING POINTS

Takeaways from this month's issue:

HERDING CATS

Leaders in research and service laboratories make no secret of their desire for a bigger serving of commitment and cooperation from and among their staff scientists and technicians. However, motivating independently-minded staff to work as a team can be difficult. Doing so involves three key elements:

- Training
- Metrics
- Incentives
- What doesn't work are hierarchical management techniques

10

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MANAGING QUALITY

One of the laboratory manager's top priorities must be to ensure that testing quality is handled impeccably and honestly to safeguard their facility's reputation. Analytical measurements should:

- Be made to satisfy an agreed requirement
- Be made using methods and equipment which have been tested
- Be consistent with those made in other locations
- Be made by qualified and competent staff

20

CHOOSING THE RIGHT ELN

Two chemists, who are both users of electronic lab notebooks (ELNs), discuss their experiences and what they've learned about selecting the right ELN for their facilities. They talk about:

- The reasons behind transitioning from a paper notebook to an ELN
- What factors they considered important in an ELN
- How they went about choosing the right vendor
- How they implemented the ELN to suit their needs

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FOSTERING GOOD BEHAVIOR

Rules of etiquette form the backbone of what is considered "proper behavior" in a given environment. A lab etiquette survey conducted by *Lab Manager* found that maintaining a good attitude ranks highest. Fostering a good attitude can be done by:

- Providing cooperation and teamwork training
- Addressing cultural and religious differences
- Communicating about shared space and equipment
- Enforcing lab etiquette rules

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INSIGHTS ON ANALYTICAL CHROMATOGRAPHY

Chromatography remains the go-to analytical method for many industries. Although the "big two" chromatographic modalities—high-performance liquid chromatography (HPLC) and gas chromatography (GC)— are mature, innovations continue in:

- Hardware
- Software
- Detection
- Stationary phases

experience ergonomics

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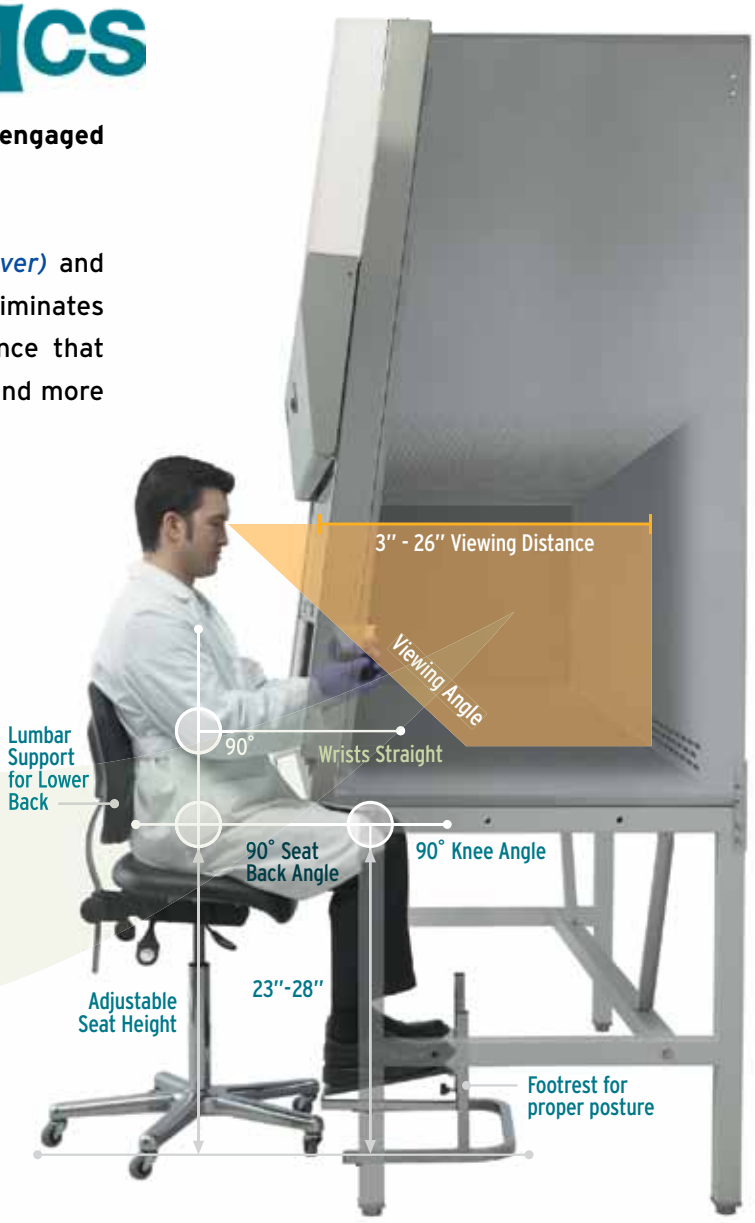

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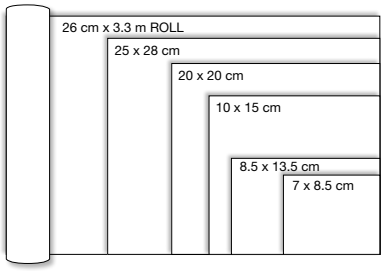

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