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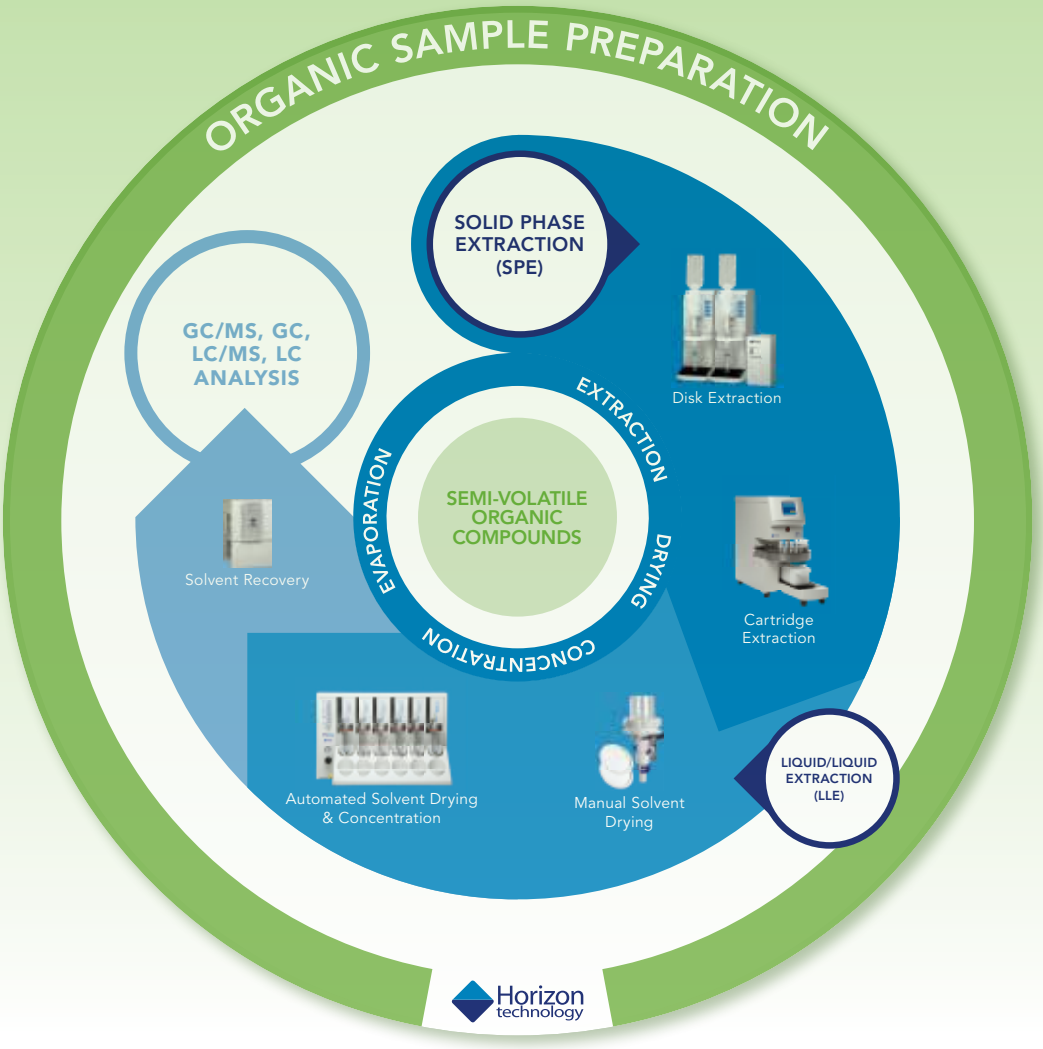

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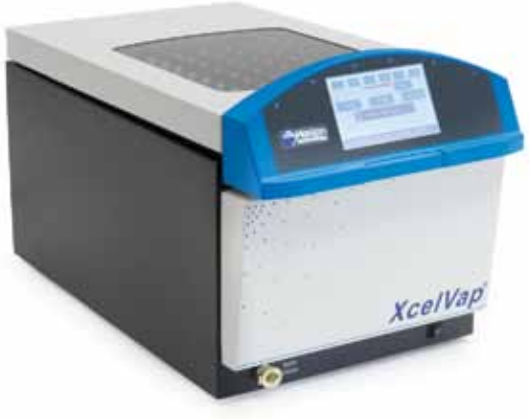

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Another Pittcon Done & Gone

Lab Manager had a great time in Philadelphia at this year's Pittcon conference and exposition along with our fellow LabX Media Group properties, *The Scientist*, LabWrench, LabX.com and our "Science is Awesome" Facebook presence. In addition to meeting hundreds of attendees at our booth, we were also able to attend press conferences and visit vendor's booths to learn about the many new product introductions. We will be bringing you all of that information in our May 2013 issue, so be sure to look for that next month. *Lab Manager* also had a hand in voting for the Pittcon 2013 Editors' Awards for the most innovative new technology at the show. Senova claimed gold for their pHit pH system, silver went to Opto Fluidics for the Nanotweezer, and Apix and Pie Photonics tied for bronze—Apix for its multigas analyzer and Pie Photonics for its Pie-in-a-Box. Thanks to everyone who stopped by our booth to chat and check out our magazine. We look forward to seeing you next year in Chicago!

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Green is Good

It's the week before Easter, but outside my window there are still patches of snow on the ground. To which I say, enough already! Bring on Spring and make it snappy.

If your thoughts, like mine, have turned to things green, you've come to the right place. This month we look at improvements in energy efficient laboratory equipment design and processes. From greener manufacturing to a reduction in the use of certain consumables, you may be pleasantly surprised by recent developments. In addition to sustainability benefits, some of these improvements may also increase the "green" in your wallet.

In "Energy Improvements," a separate article on the same topic, we look at a wide range of solutions for improving a lab's energy usage. While some, such as turning off or turning down equipment, you may already practice, there are others worth reviewing. Turn to page 28 for a quick refresher course.

And if by chance you are involved in a new lab design project or retrofit, the article on page 32 discusses the important role that laboratory exhaust systems play in improving energy efficiency. "Laboratories can reduce energy use significantly by optimizing their exhaust systems, with the use of modern technologies such as VAV controls, airflow and contaminant sensors, and building automation systems that can adjust airflow for actual conditions."

In addition to all this green, this month we address the non-environmental problem of micromanaging. Turn to page 24 to find out what drives the typical micromanager, how to avoid his or her stultifying effect, and whether you yourself may have earned that title. We also cover the critically important matter of evaluating, sourcing and purchasing the best and most useful equipment for your lab. More than simply getting the best price, author Bernard Tulsi explores the myriad of other factors that go into the process. "[Price] is important, but it is not necessarily the largest part of the total cost over the entire life cycle. You have to look at the service and support the vendor offers, the cost of service contracts, and what your uptime and downtime is going to be on the equipment."

If your current purchasing plans include a mass spectrometer, you have again come to the right place. This month's *INSIGHTS* covers every aspect of evaluating and ultimately buying the best mass spectrometer for your research needs. Turn to page 72 to find out the latest trends in the technology, maintenance and sample prep requirements, its role in life science research and as a detector, and finally candid insights from current MS expert users. Once read, you will be in a much better position to make that important purchase.

In March the staff of *Lab Manager*, as well as our sister publications, attended Pittcon 2013—held for the first time in Philadelphia. In addition to the technical and educational offerings, the expo floor featured 1,011 exhibitors showcasing the latest instrumentation and technology used in laboratory science. In next month's issue we will highlight the technologies we learned about at this year's conference.

Happy Spring.

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GOING GREENer

EQUIPMENT VENDORS CONTINUE MAKING STRIDES TO REDUCE ENERGY USE AND CONSUMABLES

by Mike May, Ph.D.

Papers, Ph.D. students, and so on make up the traditional outputs of science laboratories, but these days energy consumption matters more and more. That consumption includes the energy to condition the air and drive the analytical platforms. Disposable plastic, reagents, and other items also contribute to a lab's consumption. Those consumables raise growing concerns as labs around the world strive to be more efficient, more "green." Today's vendors supply more options than ever to build a green operation. Nonetheless, much more work needs to be done to modernize labs.

"Green technology is extremely important in labs," says David Constable, Ph.D., director of the Green Chemistry Institute at the American Chemical Society, "but not as prevalent as other issues. That is one reason that I think we need to raise the visibility."

"Green technology is more important than ever."

Some vendors already see more customers interested in green technology. For example, Cynthia Cai, director of marketing at Agilent (Santa Clara, CA), says, "Everybody is talking about sustainability."

Others agree. For instance, Chip Diefendorf, director of business development at Mott Manufacturing (Brantford, Ontario, Canada), says, "Green technology is more important than ever." He adds, "Many labs are seeking LEED credits." LEED stands for Leadership in Energy and Environmental Design, and this program offers a range of ways to improve the efficiency of any lab.

As this article shows, a broad range of lab tools and techniques factor into today's green thinking.

Assessing the scope

When considering green technology for a lab, two general concepts must be considered: the products being purchased as well as the practices being used by the manufacturer. For example, Mott Manufacturing makes a range of furnishings for labs, from casework—such as drawer and shelf units—to tables, as well as high-efficiency fume hoods. As Diefendorf asks: "What makes the lab furniture green, and what makes the manufacturer of the lab furniture green?" Those are two good questions.

For making the lab furniture green, Mott takes several approaches. For one thing, the company uses sustainable, recycled content whenever possible. "In our wood caseworks," says Diefendorf, "we utilize lots of environmentally friendly materials, like recycled content in our boards and no VOCs (volatile organic compounds) in our finishing systems." This company also makes flexible furniture systems that can be adapted to changes in a lab instead of being replaced.

Mott also uses green manufacturing processes whenever possible. "We are committed to keeping our local air clean," says Diefendorf. "So we use a powder-coated painting system and UV-cured staining systems that don't add VOCs to our local atmosphere."

Key energy consumption

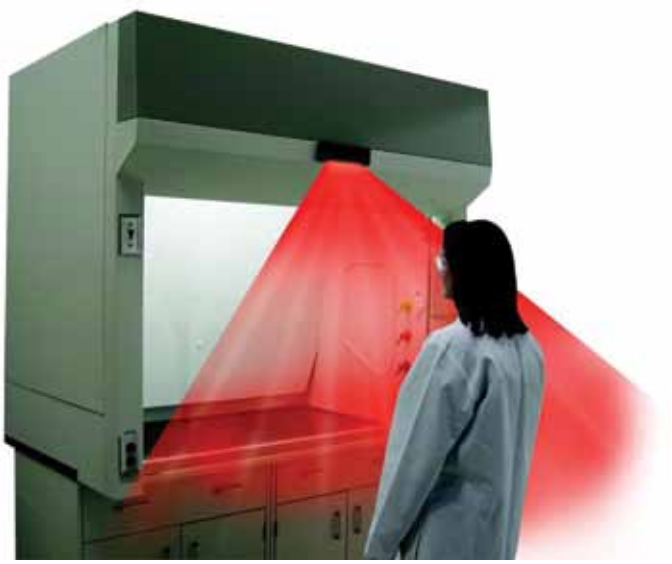
Do you know how your lab uses the most energy? "The biggest energy use comes from HVAC, not equipment," says Constable. "If you have large instrumentation or vacuum pumps, those pieces of equipment will drive the energy equation after HVAC."

Researchers face lots of options in vacuum technology, and many instruments need more than a facelift. "In the vacuum world," says Dan McDougall, senior manager, laboratory products at KNF Neuberger (Trenton, NJ), "some technologies are showing their age because they are not green technologies." The worst of all is the water aspirator that goes on a sink tap. "All that good, potable water gets poured down a drain," McDougall explains. This approach to vacuum technology can also put solvents down the drain. Even with recirculating aspirators that use a water bath to save water, says McDougall, "at some point that water must be disposed of, which causes a groundwater issue."

Early vacuum technology relied on oil rotary vane pumps. Still used in labs, these cause environmental concerns. "Over time, the lubricating oil becomes contaminated and it must be disposed of properly," McDougall says. "So that oil is a consumable."

Oil-free diaphragm pumps, on the other hand, don't use water or oil. "KNF is the pioneer in the chemically resistant, oil-free diaphragm pump," says McDougall. "Ours are designed to work with aggressive solvents and work fine for years and years."

Today's advanced vacuum systems can also raise a lab's green score in another way. For example, KNF's SC920 and SC950 vacuum pumps include a Bluetooth controller that allows the system to be placed in a hood and the sash kept closed during vacuum processes. It's always



▲ *Advanced technology can automatically open and close the sash of a hood as a scientist comes and goes, and keeping the sash closed as much as possible saves energy. (Image courtesy of Mott Manufacturing)*

▲ *Using Bluetooth technology, KNF's SC920 vacuum pump can be used inside a hood with the sash closed. (Image courtesy of KNF Neuberger)*

worth saving hood-related energy use, because Harvard University's Department of Chemistry and Chemical Biology website states: "A typical fume hood in the United States that runs 24 hours a day, 365 days a year, uses 3.5 times more energy than the average house!" In addition, sensors on the new vacuum systems operate pump motors at slower speeds and only when needed, conserving energy.

Slow the flow

The key to efficiency in a fume hood depends on the total volume of air that gets exhausted from a lab space. "Green technologies correlate with a low volumetric rate of flow," says Luke Savage, product manager for fume hoods at Labconco (Kansas, MO). This can be limited with ductless technology where applicable.

"There are limitations on ductless technology," says Brian Garrett, product manager for biological safety cabinets at Labconco. "It can't be a direct replacement for a fume hood, but ductless technology can replace lots of fume hoods." That leads to savings in money and energy.

Even ducted hoods—such as Labconco's Protector XStream—can perform more efficiently. "This chemical fume hood ensures a user's safety to the highest possible level," says Savage. "The second issue is energy consumption." He points out that a hood that is six feet long and running at 100 feet per minute costs $8750 a year, whereas the Protector XStream provides the same safety running at 60 feet per minute, costing only $4830 with the sash fully open. Closing the Protector's sash to just 18 inches drives the annual cost down to $3010, Savage says.

To keep the sash closed as much as possible, Mott developed an automatic system. "It uses a proximity sensor that closes the sash when you walk away and opens it when you return," Diefendorf explains. Labconco offers a similar system.

The lifetime savings can grow to a staggering level. "If you couple a high-performance hood like the XStream

◀ *Agilent's 7890B gas chromatograph reduces gas use by more than 90 percent. (Image courtesy of Agilent)*

with a variable air volume mechanical system, the hood will consume a meager $1800–$1900 a year, which is more than $100,000 in saved energy expenses over the hood's 15-year lifetime."

Other containment technologies can also get more efficient, and biological safety cabinets are a great example. Making such an instrument efficient depends on the blower motor, and the greenest one is a DC electrically commutated motor (ECM). "In the past," says Garrett, "everyone used AC motors, which are very inefficient." Then, Labconco put an ECM in its Purifier Logic biosafety cabinets, and it also used that kind of blower motor in its new Purifier Logic+. In addition, advanced biosafety cabinets can include a night-running mode that is 90 percent more efficient than its day-running mode and maintain the interior cleanliness of the biosafety cabinet.

Other vendors also pursue more efficient biosafety cabinets. Dave Phillips, product application specialist for biosafety cabinets at Thermo Fisher Scientific (Waltham, MA), says, "In 2002, we started putting DC motors in our biosafety cabinets for better performance, but we later found that it improved their efficiency by 25 percent." To make biosafety cabinets even more efficient, Phillips and his colleagues match the unit to the user. "Our primary cabinet is great for a very demanding user," Phillips says. "It provides incredible safety and containment, plus it has a reduced flow mode where you can close the window and the fans slow down for much

The Thermo Scientific Sorvall LYNX Centrifuge and the Thermo Scientific Fiberlite carbon fiber rotor in combination provide a range of green benefits, from energy savings to reduced waste. (Image courtesy of Thermo Fisher Scientific)

lower energy consumption."

Phillips points out that the biggest increase in energy consumption comes from adding external exhaust. "The decision of whether to exhaust or not is not scrutinized very much," he says. "People might just add exhaust to be safe, but then be catapulted into the annual cost forever." He adds, "If you need it, you need it, but if you don't, it's a waste."

"The biggest energy use comes from HVAC, not equipment."

Controlling the consumables use

Some technologies use large amounts of solvents, which can be environmentally hazardous. As an example, Constable mentions high-performance liquid chromatography (HPLC). "This deals with large volumes of solvent, so you should try to minimize that or use alternative chromatographic approaches that use less solvents or ones that are more aqueous-based." He adds, "You could move to supercritical fluid chromatography to get away from standard HPLC columns."

Some consumables must be used more efficiently because of dwindling supplies. The best example might be helium. To help researchers conserve helium, Agilent (Santa Clara, CA) added gas-saving technology to its new 7890B gas chromatograph and its 5977A gas chromatograph/ mass spectrometer. This technology reduces gas use by more than 90 percent, says Cai. Both of these platforms also use less energy. These savings stretch across a wide range of users, because Cai says that the customers who use these platforms include academics, pharmaceutical scientists, and researchers in environmental testing, as well as scientists in food safety, forensics, and the petroleum industry.

Sometimes, the source of a "consumable" can be surprising. For example, Thermo Scientific Fiberlite

Carbon Fiber Rotors for centrifuges outlast metal rotors. "You replace them less often, so there's less waste over the lifetime," says Phil Hutcherson, product manager for centrifugation at Thermo Fisher Scientific. To make its centrifuges even greener, the Sorvall LYNX 6000 Centrifuge removes part of the air from the chamber. "This reduces friction," says Hutcherson. "Friction creates heat that requires refrigeration." He adds, "The centrifuge also gives users different sleep modes."

"In the vacuum world, some technologies are showing their age because they are not green technologies."

Automating for efficiency

In many cases, researchers can also improve a lab's efficiency by adding automation. For example, Constable points out that "multicolumn chromatography enables faster and larger separation in pilot-scale operations." In addition, using robots allows some lab operations to run around the clock. "That can introduce some economies and reductions in energy use."

Some of the least efficient laboratories exist at colleges and universities. "Academic labs are for the most part comparatively far behind industry," says Constable. "Some academic institutions have great instrumentation, but many of the smaller college teaching labs don't have the means to upgrade as often." He adds, "Major institutions that are R&D focused do a slightly better job." By comparison, Constable sees much more greening going on in industry. "There's lots more effort in the name of efficiency and energy reduction in industry, whether you're going into an analytical lab or a contract research organization."

Much of today's inefficiency in labs arises from a lack of information. "Real-time analysis will help researchers understand what is really happening," says Constable. In chemistry, for example, a researcher might leave a hot plate stirring for an hour when the reaction is over in two minutes. "If we probe the kinetics," Constable says, "we will have a much better understanding of when the desired endpoint is reached."

By combining all these tools and technologies, greener endpoints will emerge in labs around the world.

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

SHOPPING AROUND

BEST PRACTICES FOR SOURCING, EVALUATING AND PURCHASING LABORATORY EQUIPMENT

by Bernard Tulsi

The acquisition of equipment is a strategic business and operational decision that balances technology, durability, reliability, active running time, purchase price, maintenance, service, and running costs with the value the acquisition could potentially deliver for a laboratory enterprise.

Adding or upgrading equipment is challenging, says Jason Todd, liquid and gas chromatography laboratory manager at Polymer Solutions (PSI) in Blacksburg, VA. Todd says, "Acquisition of new equipment is based on perceived demand and is customer driven. We don't want to spend money on equipment for which we will rarely or never get requests for tests."

"If a capability we don't have comes up frequently, that could help us to make the decision to acquire new equipment." Still, it is difficult to quantify, he says. "If we do not already have the equipment, it is challenging to estimate how much work we will bring in, and whether the investment will pay off."

Benny McKee, executive VP, business development at Analytical Food Laboratories (Grand Prairie, TX), describes a formalized process to acquire analytical instrumentation for their laboratory, which offers a full range of specialized food, pharmaceuticals, dietary supplements, cosmetics, beverages, and water analyses.

He says that the executive team gets together on an annual basis to examine capital equipment needs for the upcoming year. "Some of the items we discuss are the ages of existing equipment and their remaining shelf life. Then we decide whether we need to purchase a backup or something new to take its place. We also make decisions on what equipment is needed to increase our capacity and productivity, and what will allow us to offer additional services to customers."

"We evaluate our equipment and look at current usage and try to project what we might need for the future," says William L. Fornoff, laboratory manager, Clean Harbors Environmental Services (Baltimore, MD), who also has some responsibility for monitoring all inventory for the 30 Clean Harbor labs in North America. In Baltimore, he manages an analytical laboratory that serves the needs of their wastewater treatment facility. The lab's capabilities parallel those of environmental contract laboratories and use the same Environmental Protection Agency methods for industrial waste.

"I know what instrumentation is located at all the laboratories, and so when I am looking for something here, one of our other labs may have it and can often make it available to us, or vice versa," says Fornoff. In acquiring equipment, he says, the first priority is to see if needs can be met in-house, with an eye on savings. This approach has sometimes resulted in extending the life of current equipment by as much as a year or two, he says.

> "Maintaining long-term relationships with vendors has solid cost benefits."

Fornoff says when equipment cannot be found in-house, or when there are regulatory changes that require lower detection limits or different tests, then it becomes necessary to purchase from outside sources. "For metals analysis, the primary vendor for Clean Harbors is PerkinElmer (PE). It has always been that way, and when we look for metals analysis instrumentation, we always start with them. Most of our facilities have PE's metals analysis instrumentation, and because of this, we get preferred pricing. We also get favorable service agreements from them."

He says that maintaining long-term relationships with vendors has solid cost benefits; although that does not necessarily mean that they will never consider sourcing equipment from other vendors. "I am always open to new ideas and product offerings. I use recommendations from other laboratories to take a look at other vendors, I field sales calls and talk with other vendors, and I review current trade magazines and periodicals to keep abreast of new methods and the vendors developing them," says Fornoff.

"We are always interested in tools and technology that will make our jobs easier by increasing productivity and sensitivity at a good cost," he adds.

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Decisions on the purchase of new equipment vary depending on the situation, he says. "For instance, this year we are getting close to the end of the life for a group of ICPs at Clean Harbors. So maybe five to 10 ICPs will have to be bought within the next few years. For decisions on this, we will get a group together to decide how to go forward. For individual plants and for equipment that do not require that level of expense, the purchasing decisions are usually made in-house," says Fornoff.

He says that decisions are based on a variety of key factors. "One of the keys is, of course, price. But at Clean Harbors, we have learned that price is not everything—it has to be the quality of the products. They have to be rugged, and capable of handling the tests we run in the waste, because we are analyzing difficult and dirty materials that are challenging to test."

"The ability to have the equipment serviced is very important to us. We also ensure that the equipment supplier has a strong reputation and a wide geographic area of service, because our operations span from Western Canada to Puerto Rico—with the size of our company now, we need suppliers that can operate in all of North America," says Fornoff.

"Companies that pay attention to us on a more personal basis are more likely to get our business."

Todd lists trade shows and similar venues as key information sources. "We do a lot of homework, researching offerings from different vendors, and we assess the technologies incorporated into different instruments, their reliability, performance and durability, the backup and support services offered by vendors, and our experience with that vendor in the past."

They also review trade magazines, peruse emails from equipment vendors, and participate in vendor-sponsored webinars. Todd notes that the most important information source is personal contacts with sales representatives who visit periodically and provide updates about new equipment and processes. "The companies that pay attention to us on a more personal basis are more likely to get our business than those we never hear from."

"For analytical instrumentation, we always purchase directly from the manufacturer. We also buy some consumables, especially parts, directly from manufacturers. We are a GMP-regulated, FDA-registered laboratory, and our quality systems require that our equipment be maintained in a validated, qualified state. All parts have to be suitable for the equipment, and that is best ensured by purchasing from the OEM," he says. For most other consumables, they use the Fisher Scientific one-stop convenience.

McKee says that last year, for example, when his company decided to acquire a new GC-MS, "We looked at offerings from three different vendors and invited their representatives to come in and discuss key characteristics such as capacity, throughput, accuracy, and price point."

He notes further, "Price is always important. Sometimes we get sticker shock when we get the first proposal. My experience, however, is that the first proposal is always the highest, and that there is always room to negotiate discounts.

"So while price is important, there are others elements that are just as important. These include backup service, responsiveness to technical issues, the availability of technical staff in the area in the event the equipment goes down, and the vendor's ability to ship in a piece of backup equipment to keep our operations running," he adds.

In selecting among different vendors, Todd says, "The decision is based more on the relationships with their sales representative, how much time they spend with us, our impression of how well they will support and service the equipment, the resources they devote to service, how far away the nearest field service engineer is, how long will it take to get service when we need it, their position in the marketplace, their experience, and what other end users think about the company's equipment."

For highly complex instruments, PSI always selects the manufacturer with the best technology. "If the item is not the first HPLC or GC-MS, and if we are not really unhappy with the instruments and vendors we acquired them from, there is a strong chance we will order any new equipment from the same suppliers. Using the same vendor makes training, service, and keeping parts on hand much easier."

While price certainly factors into the decision, it is always a case of price versus perceived value, according to Todd. "If we have researched the offerings of two vendors thoroughly from a technology standpoint, conclude that both instruments will do what we require, and if they both have the same reputation based on our past experience with them or their references, and all other factors are equal, and one has a lower price than the other, we will go with the lower price—but price will certainly not be the primary factor," he says.

Todd says that his lab has acquired and used pre-owned equipment. The most recent, an electron microscope, was

acquired last year. "The manufacturer helped with the installation and some preventive maintenance. That was a pretty big investment and the price differential versus new made sense in this case."

In making the decision to buy used equipment, he says, "It depends on the complexity of the equipment, how familiar we are with the technology, how much we think we will be self-sufficient with the piece of equipment versus requiring extensive help from the OEM, and what resources will be available to support the equipment."

"A good example will be buying a used auto-sampler for an HPLC versus buying an LC-MS. Many people are familiar with auto-samplers and lots of parts are available. I will be more comfortable with that than with complex equipment like an LC-MS or GC-MS, especially if they are older. These instruments have a finite life cycle of roughly 10 years. If you buy equipment that is already a few years old, then there will be questions about how long the necessary support and parts will be available and how long you will be able to keep it running."

Todd notes that with used equipment there is a difference if you are buying from a private seller versus a reseller who purchases in bulk, warehouses, and resells. "You will pay a premium if you buy from a reseller."

McKee says that his facility has purchased and used pre-owned equipment in the past. "We like that the initial price point is usually a lot lower than for new equipment. It is important to understand that there is an inherent risk involved, so we ensure that we find out the history of the used equipment, including the circumstances of its last operational setting and any performance metrics."

Todd says that it will serve lab managers well not to focus exclusively on the initial purchase price. "That is important, but it is not necessarily the largest part of the total cost over the entire life cycle. You have to look at the service and support the vendor offers, the cost of service contracts, and what your uptime and downtime is going to be on the equipment. It is important to make sure that your equipment suppliers are willing to partner with you and support you well."

McKee concurs, "First and foremost there is a need to ensure that the equipment being purchased is a good fit for the intended job. It does no good to purchase something that does not work with your analytical matrix."

He offers additional advice to lab managers facing the challenges of equipment acquisition. "If you are going with an OEM, it helps to ask for demo equipment, which tends to cost a lot less than brand-new equipment. Also, ask for second-generation equipment that the manufacturer is about to phase out. These cost less also and may quite adequately satisfy the needs at hand. One advantage of going through manufacturers is that they typically have their own financing departments, eliminating the need to source funds from external organizations."

He adds, "It is important to examine service contracts in detail and look at the warranties manufacturers offer, examine all quality documents, and try to negotiate those in addition to the price of the equipment."

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BEING GREAT ISN'T GOOD ENOUGH ANYMORE

By Enette Pauzé

When new general managers are brought in to fix professional sports teams, the first two things they do are wipe out the underperforming, unmotivated, unwilling-to-adapt-to-change staff, and bring in THEIR people. Why? Because having the right people, in the right roles, at the right time is the difference between success and almost success. When you have a partnership that works, don't mess with it! And when your legacy and millions of dollars are at stake, you don't want to be left holding the dirty diaper.

Every day you engage in partnerships (teams) that influence your reputation and your results. Your relationships can be collaborative or competitive, transactional or transformational. Business partnerships are about learning to leverage the best of what others can bring to the table for mutual benefit and growth.

Are you still trying to be the all-star?

When was the last time you saw a professional sports team carried for an entire season by just one player? Sure, a superstar can lead, inspire, and significantly influence the mindset and performance of other team members. But a superstar never wins the season alone. What's an all-star without his fans, his "kryptonite," or his opposing villain? He's just a guy running around in tights, dogging imaginary people, scoring on himself, and doing a victory dance while no one is watching ... looking like an idiot.

> "When you have a partnership that works, don't mess with it!"

In any lab, we can't win the season alone. We need to partner with our coworkers, our collaborators, *and* our competitors in order to thrive. (Did you just say, "*What?!*")

The difference between a competitor and a collaborator is a common enemy. The bigger the "enemy," the bigger the opportunity there is for partnership. Cancer, hunger, poverty, space travel, illiteracy, and winning the Tour de France are challenges that require people to work together in new ways to find solutions to old problems.

If you want to run your lab like a business, learn to leverage three characteristics of successful partnerships. First, focus your team's efforts on a common purpose. The bigger the problem you solve for the world, the more valuable you are and the more people want to help you. Second, work with people who love what they do (and I mean LOVE what they do). These partners require less energy to manage and are more creative because they are inspired and lead from within. And finally, have fun. Profane laughter and profound results go hand in hand.

The world is changing, and being great is no longer enough. You have to be great and work with other great people. What results are you working toward? And who's helping you get there?

***Enette Pauzé**, Ph.D., is an organizational partnership broker who specializes in helping professionals develop and sustain successful partnerships. She can be contacted at enette@enettepauze.com.*

LABCAST Be sure to attend Enette Pauzé's Lab Manager Academy webinar "Partnership Synergy: It's Not Enough to Be Great" on Wednesday, May 1 (or afterward at www.labmanager.com/synergy, to watch the archived video).

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MANAGING THE NEW INDEPENDENT WORKFORCE

By Mark Lanfear

In the age of the "human capital" economy, we are experiencing incredible shifts in the way people work. Contingent labor, virtual workplaces, free agency, and the cloud are just some of the fundamental shifts currently taking place. As a result, management is faced with all sorts of new challenges: how to be more efficient, how to be sure that the work is actually getting done, how to watch compliance issues? If you aren't already a micromanager, these challenges may drive you to become one in these pressure-filled times.

Micromanagement is most often defined as an extremely involved leadership team or highly developed and defined process. And we all need these things at times for purpose and focus. Yet despite best intentions, micromanagement in the form of frequent check-ins, discussions, reports, and conversations can interrupt our work and drive the efficiency quotient down in our labs and on our production lines.

The days of the insular workplace may be approaching their end, especially in the science industry. As the need to address the global marketplace has arrived, most companies have found they must free themselves from the constraints of bricks and mortar—as well as old-fashioned micromanagement.

Enter the professional flexible workforce—that large community of highly skilled "free agents" across the globe who can, and want, to work outside the boundaries of traditional employment engagements and locations. Various reports predict that half the U.S. workforce, or about 70 million people, will be independent workers by 2020 and that the demand for seasoned skilled workers will grow as companies start to see the value of engaging people outside traditional workplace constraints and traditional workforce models. In fact, it is not uncommon for many Fortune 500 companies today to draw 20 percent or more of their professional workforce from a flexible talent pool.

> "Various reports predict that half the U.S. workforce, or about 70 million people, will be independent workers by 2020."

Trying to tightly manage a group of loosely woven but highly functional professionals like this would be an exercise in futility for even the greatest of micromanagers. Therefore, the time of micromanagement may have passed, not only because of the rise in expert consultants throughout our industry but also because of the need for all of us to prepare for the next generation of talent that highly directs its own type of engagement.

New strategies for management must be accepted. Generation Y workers, for example, when managed properly as free agents, can elevate the quality of a company's product because of the high level of education and skills that they bring to the table.

But strong-handed management from a decade ago must realize that some of the foundations of that management style will only reinforce a generational divide and cause a degree of lower production that that very micromanagement was meant to address! Uniformity is a formula for failure with millennials in the workforce.

Managers and the organizations they work for and oversee have a host of new challenges with this workforce. The tactics that will ultimately prove successful will be based on understanding differences much more than understanding similarities. A new management technique, especially in the form of moving away from the over-scrutinizing manager, will no longer be optional in order to engage with the hardwired and fundamentally different and younger generations that will come to define and influence the world of work. Members of Gen Y expect and need dialogue and input. They will expect interaction regardless of rank or role. And straight-lined organizational structures just won't work for them.

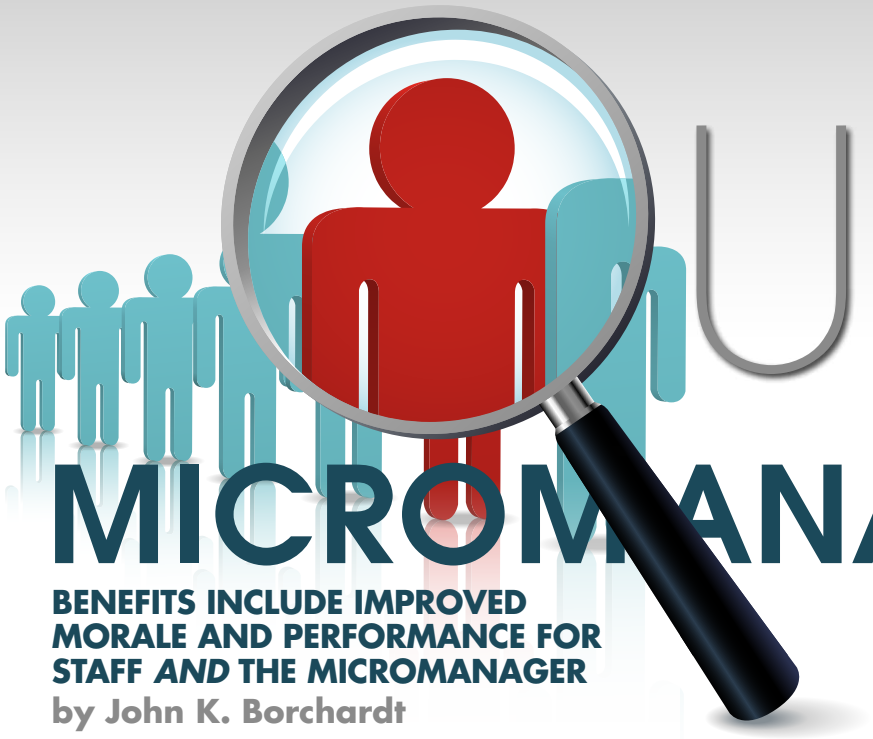
The world of work has changed, and the social hierarchical system (once called management) has changed too. Whether it be the highly educated returning consultant or the next generation of slick social media-driven college grads, any leader who wants to harness the full potential of the workforce is putting down the weekly reports, cutting out the need for daily updates, letting go of the minutia, and having meaningful dialogues with expert talent to accomplish business goals.

As the prayer goes, "Grant me the serenity to accept the things I cannot change, the courage to change the things I can, and the wisdom to know the difference."

"The world of work has changed, and the social hierarchical system (once called management) has changed too."

Managers, pencils down! Time to leave micromanaging behind and enter the new workplace where meaningful goals, directions, and dialogues are the spreadsheets of the day.

Mark Lanfear *is a global practice leader for the life science vertical at Kelly Services, a leader in providing workforce solutions. He has operated clinical trials around the world for almost two decades. In addition, Mark is a featured speaker at many life science industry conferences and a writer for life science periodicals. He can be reached at MARL773@kellyservices.com or 248-244-4361.*



QUIT MICROMANAGING!

BENEFITS INCLUDE IMPROVED MORALE AND PERFORMANCE FOR STAFF *AND* THE MICROMANAGER

by John K. Borchardt

The slogan of the micromanager may well be "If you want something done right, do it yourself." However, "Micromanagement stifles initiative and kills motivation," according to a very successful manager, World War II General George S. Patton. Despite this, many of us have worked for micromanagers and some of us (this author included) have even been micromanagers. Why do people micromanage? How can micromanagers change their ways?

Rationale for micromanagement

The emphasis of the last decade has been on short-range industrial R&D and technical service. This has resulted in short-term project deadlines and provides fertile ground for micromanagement. Micromanagement can help lab managers meet these short-term deadlines but at the cost of long-range research and strategic planning.

People micromanage for four main reasons. First, people recently promoted to the management ranks may be uncertain of their ability to be a manager and leader but confident of their abilities as hands-on problem solvers. More comfortable when in the problem-solving mode, they often move in on their subordinates' responsibilities to solve their problems for them. Second, in achieving their first management position, researchers are usually chosen on the basis of their accomplishments. They're rewarded for doing things and taking control. The third reason is that micromanagers may feel uncomfortable delegating authority because they worry they'll lose control and power. Fourth, micromanagers often are ambitious and want to achieve superior results. So they want to be sure their staff members don't make any mistakes that could make the manager look bad. This lack of trust leads micromanagers to closely monitor and control their staff members' activities.

Managers may not only tend to micromanage staff members, they may also micromanage team leaders, project managers and lower-level managers who report to them. In doing so, micromanagers can deny these people opportunities to develop and practice their own management skills.

Micromanagers often feel that they are helping their staff members who should then be grateful. However, as Sally Love, president of Paragon Management Consulting (Greenville, South Carolina), observes, "Your employees are probably not very thankful toward you for helping them get through their problems. In fact, they may be downright resentful." By taking away the planning and organizing aspects of employees' jobs, micromanagers indicate a lack of respect. Micromanagers sometimes interrupt workplace conversations among subordinates, discuss employees' perceived mistakes in front of others, and even overrule decisions. All these behaviors also indicate a lack of respect for employees.

People being micromanaged often stop making suggestions for fear of being criticized. As a result, many good ideas go unvoiced.

Some micromanagers can be quite successful up to a point. For example, former President Jimmy Carter was well known for his micromanagement style. Among other

things, he was known to personally review staff members' requests to use White House tennis courts.

The best managers help employees learn to work independently by giving them meaningful responsibilities, according to organizational coach Diane Foster of Diane Foster & Associates.

Working for a micromanager can increase staff turnover. Foster comments that not many people want to work for a company where they are not allowed to think. Of course, increased staff turnover can reduce productivity and have an adverse effect on morale.

Staff empowerment

Micromanagement is the opposite of staff empowerment. Why? Because in helping your subordinates solve their problems by working on them yourself, you rob them of independence and make them feel powerless. Employees become dependent on you to solve their problems for them and fear criticism if they proceed on their own. As a result, they are less productive and work slows down.

Micromanagement is a drive for perfection, according to Dr. Paul Baard, organizational psychologist and management professor at Fordham University. Baard says he's seen it lead to procrastination, resulting in missed deadlines due to repeated project revisions and staff members not speaking up in meetings for fear of being wrong.

Working for a micromanager can even adversely affect employees' health, according to Baard. If staff members feel powerless, their productivity declines and illness often increases. When workers have independence and the power to make their own decisions, they are motivated, energized and physically healthier.

Being a micromanager can place a lot of stress on micromanagers and their relationships with others, according to psychologist Dr. Alan Cavaiola of Ocean County College (New Jersey). Cavaiola suggests that exercise, deep breathing, yoga or meditation can create a sense of calm, making it easier for managers to break the micromanagement habit.

"Short-term project deadlines provide fertile ground for micromanagement."

Don't necessarily attend all project team meetings. If your project manager or team leader is doing a good job, your presence may not be necessary. When you do attend a team meeting, do not make yourself the center of the meeting, particularly if it is being well run and team members are making good progress on their assignments.

Allowing staff members to develop their own strategies to achieve their job goals does not mean lowering your own standards or abandoning your management responsibilities. Work with staff members to ensure that their strategies are consistent with corporate limitations

such as research budgets for new equipment. Capitalize on staff members' knowledge and capabilities.

Coaching employees is different from micromanaging them. Coaching helps staff members gain the skills they need to carry out their job responsibilities. Encourage them to be problem solvers who come to you when they do need help but only do so after making reasonable efforts to solve problems on their own. When they do need your help, coach, don't instruct. An example of this is an interesting scene in the movie *The Hunt for Red October*. Hero Jack Ryan is flown out to an aircraft carrier in preparation for capturing the submarine *Red October* and explains his mission to Admiral Painter. With the admiral's first questions, it becomes obvious that Ryan doesn't have any clear ideas about how to accomplish his mission. Rather than issuing orders, the admiral shifts to a coaching mode that forces Ryan to think through his mission and develop his own plan.

I've seen this scene played as a coaching example twice in management short courses. Because he developed the plan himself with the admiral's coaching rather than having the admiral plan his work for him, Ryan was more committed to its success and willing to do more to achieve that success.

"Micromanagers may feel uncomfortable delegating authority because they worry they'll lose control and power."

As manager, focus on work group goals and allow your staff members a major role in determining how to meet these goals. Your primary roles as lab manager are goal setting and allocation of resources, including staff members' time, to achieve these goals. Another responsibility is setting performance standards. Diane Tracy, author of *10 Steps to Empowerment: A Common-sense Guide to Managing People* (William Morrow and Company, New York, New York), observed, "When asked to stretch beyond their self-imposed limits, people discover powers they never knew they had. A manager has more power to achieve his own objectives when the people who work for him work to their full capacity." People won't do this for a micromanager.

Responding to a micromanager

Working for a micromanager in my first industry job was a shock for me. I had never expected to be supervised more closely in industry than I had been in graduate school or while working on my senior research project in undergraduate school. I soon learned that there are four ways to respond constructively to a micromanager. The first is to accept the situation and keep your sense of humor. This is easiest when the micromanager is an excellent chemist who makes good decisions. This is what I did on my first job.

Another response is to accept the situation while venting your frustrations to coworkers. While those who share the same manager may agree with you, the net result of sharing complaints is often lower morale and reduced productivity, thus making the problem worse. Venting your frustrations to coworkers often makes those coworkers lose respect for both you and the manager.

A third response is to ask for training to enable you to solve problems on your own. This approach is most effective when staff members work together and all make similar requests.

The final response is to exit the situation and find a manager whose work style is more compatible with your own. This exit may be to another department within your company or to another firm. In either case, the change should be made only after careful consideration. When leaving your current assignment, don't burn any bridges behind you, particularly if you remain with the same company. The manager you leave behind may be your supervisor again someday.

The secrets of delegation

Staff members need to understand that, while being given independence and authority, they are now responsible for achieving their goals and meeting mutually agreed-upon deadlines in doing so. Establishing mutually agreed-upon deadlines, organizing work to be performed by teams, and setting project milestones are all ways managers can maintain control while still empowering employees.

When empowering their staff members by delegating independence and authority, managers must follow up to determine how well the staffers are performing and whether goals are being met. They must effectively communicate this information to staff members. People need to understand how to improve their performance to meet the manager's performance standards. When providing feedback, follow the dictum "Praise in public, criticize in private."

Other tips for micromanagers

There are several things micromanagers can do to break the micromanagement habit:

- Clearly articulate your expectations at the beginning of projects or when you assign work to a staff member.
- Focus on hiring and placing staff members in positions that are a good match for their skills and interests.
- Delegate. Allow staff members to have an appropriate amount of decision-making power. This will increase as staff members gain experience in their job assignments. Frontline staff members often are best suited to identify problems and suggest creative solutions.
- When designing projects or reviewing progress, encourage staff members to ask questions and offer suggestions.
- Offer constructive feedback to staff members making reports.
- Don't take over at the first sign of trouble. Instead, work with staff members to develop solutions to the problem and let them go ahead and implement them. The more experience they have, the more they should develop solutions on their own.

Wrap-up

Ask yourself the question, "While I'm micromanaging, who is doing my job?" Amazingly enough, managers often neglect their own job duties to take on the often more comfortable responsibilities of solving their staff members' problems for them. This often means they are limiting their own career advancement.

Avoiding micromanagement can improve your own morale, reduce your stress level, and increase your own contributions to your organization.

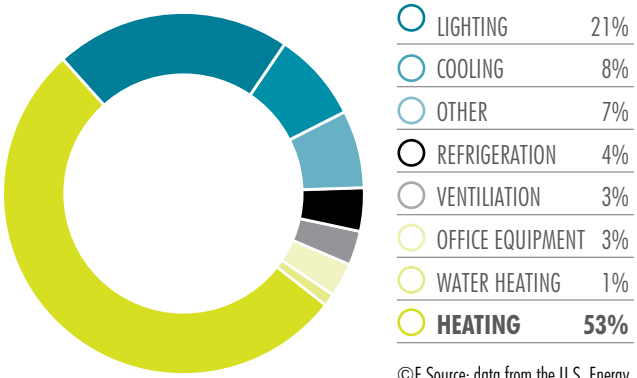
Dr. John K. Borchardt *was a consultant and technical writer. He was the author of* Career Management for Scientists and Engineers *and often wrote on career-related subjects.*

ENERGY IMPROVEMENTS

FROM TASK LIGHTING TO ZONE SYSTEMS, SOLUTIONS ABOUND FOR IMPROVING YOUR LAB'S ENERGY USAGE

Laboratories in the U.S. are energy-intensive facilities that use anywhere from 30 to 100 kilowatt-hours (kWh) of electricity and 75,000 to 800,000 Btu of natural gas per square foot annually. Actual use varies with such factors as the age of the facility, the type of research done there, and the climate zone in which the lab is located. In a typical laboratory, lighting and space heating account for approximately 74 percent of total energy use (Figure 1), making these systems the best targets for energy savings. Because laboratories consume so much energy, the potential for energy and dollar savings through energy-efficiency improvements and energy conservation is impressive—some studies estimate that implementing such measures can result in savings as high as 50 percent for laboratories and cleanroom facilities.

In laboratories, HVAC systems account for about 64 percent of total site energy usage. Heating is mainly natural gas–based, but all other end uses are electrical. The data represent average values from measurements at 43 laboratory facilities around the United States.



©E Source; data from the U.S. Energy Information Administration (2003)

▲ *Figure 1.*

Although detailed benchmarking data on energy usage in laboratory facilities have historically been hard to come by, researchers working with the Laboratories for the 21st Century (Labs21) program, which is sponsored by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy, are currently collecting data measured by others on lab facilities in a variety of climate zones. You can use these data to benchmark your facility against others like it—always an effective first step toward reducing energy use.

Benchmarking is particularly important because of the wide variation in laboratory energy use. It shows you how your facility is using energy, can help you indentify the most cost-effective areas for improvement, and provides a baseline against which improvements can be measured.

"Benchmarking is particularly important because of the wide variation in laboratory energy use."

Programs like Labs21 help laboratory owners and managers to benchmark, monitor, and report annually on building energy performance. More comprehensive tools are available from rating programs like the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) for Labs program or the Labs21 Environmental Performance Criteria. These programs can assist you in benchmarking your facility, identifying areas for improvement, and ultimately getting recognition for your efforts.

Many laboratories can benefit from simple low- or no-cost energy-expenditure reductions, such as turning things off and turning things down.

Turning things off

Turning things off seems simple, but remember that for every 1,000 kWh that you save by turning things off, you save $100 on your utility bill (assuming an average electricity cost of 10 cents per kWh).

Lighting. Turn lights off when they are not in use. When properly installed, occupancy sensors and timers can help to achieve this. A no-cost option is to simply train staff to turn off lights as part of their closing procedures (you can also help by identifying the location of light switches on a posted notice).

Computers and monitors. You can gain significant energy savings by verifying that power management settings are enabled on individual computers and monitors, forcing them to enter sleep mode after a specified period of

inactivity. Most desktop computers built since 2008 are shipped with these settings enabled. Power management settings can cut a computer's electricity use roughly in half, saving from $25 to $75 annually per computer. If you need help activating power management features on individual computers, the EPA offers detailed instructions by operating system on its ENERGY STAR® website (just search on "computer power management" plus your operating system). Some users may be concerned that automatic software updates will be inhibited if power management settings are enabled, but that is not the case. Updates will automatically begin to download when the computer awakens from sleep mode.

Other plug loads. Plug loads in laboratories are typically higher than in other buildings. Though office-building plug loads fall into the 0.5 to 1.0 watt per square foot (W/ft^2) range, laboratory plug loads can range from 2.0 to 20.0 W/ft^2. With so much equipment in place, turning it off when it's not in use can represent a big savings opportunity. To automate this process, consider buying and installing smart power strips that can turn off equipment when an area is vacant or when the equipment has been idle for a set period of time. Additionally, when it's time to replace equipment, look into purchasing ENERGY STAR®–rated or other energy-efficient products.

Turning things down

Some equipment cannot be turned off entirely, but turning it down to minimum levels where possible can save energy.

Reduce light levels. Ensuring that light levels are sufficient for the tasks at hand—not unnecessarily bright—can help reduce energy costs. In spaces where natural lighting is available, lights can be dimmed, or selected lights can be switched off in response to the availability of sunlight.

Implement HVAC setbacks. Adjusting overall temperature settings by just a few degrees can yield significant energy savings without affecting occupant comfort levels. When possible, make sure that HVAC settings in stockrooms, offices, and other peripheral rooms are at minimum settings.

Although the actions covered in this section require more-extensive implementation efforts and have higher costs, they can dramatically increase the energy efficiency of your laboratory while maintaining or improving productivity. Ask your local utility representative for more information about funding or guidance that might be available for such projects.

Lighting

Because lighting accounts for roughly 21 percent of overall energy use, it's a great area in which to implement energy-efficiency measures.

Upgrade fluorescent lamps. If your facility uses T12 fluorescent lamps, relamping with modern T8 lamps and electronic ballasts can reduce your lighting energy consumption by 35 percent or more. Adding specular reflectors and new lenses can increase these savings and yield short simple payback periods.

Use CFLs and CCFLs. If you are still using incandescent lamps, replace them with compact fluorescent lamps (CFLs). CFLs use one-quarter of the energy incandescents do, and they last up to 10 times as long. In areas where lamps are dimmed or frequently cycled on and off, consider cold-cathode fluorescent lamps (CCFLs), which, though more expen-

sive, last even longer than CFLs, are easier to dim, and their life is not shortened by frequent cycling.

Install occupancy sensors. Areas that are not consistently occupied—such as storage rooms, restrooms, and back offices—are ideal places for occupancy sensors. They can save 30 to 75 percent in lighting-energy consumption, and they typically yield simple payback periods of one to three years.

Use task lighting. Task lights can improve lighting quality and yield energy savings because lighting an entire workplace at full brightness is inherently less efficient than lighting just the area you need. If you decide to pursue this strategy, make sure that room lights can easily be dimmed or selectively switched using either manual or automated controls. In some cases, task lighting can accompany a delamping project, but make sure that delamping doesn't create an undesirable light distribution.

Employ daylighting. Using daylight for lighting can reduce both lighting and cooling loads. Although daylighting is an approach that's generally best implemented in new construction, some daylighting technologies (including light scoops and tubular skylights) can be retrofitted in existing buildings to bring in more daylight without increasing cooling loads or glare. To save energy with daylighting, turn down existing electric lights in response to daylight levels. In addition, studies show that daylighting improves productivity among a building's occupants—and even small productivity gains can dwarf dollar savings from energy efficiency and conservation alone.

HVAC

To maintain health and safety and to meet building codes, laboratories require a large volume of ventilation air. Rather than recirculating indoor air, most laboratories use 100 percent outside air to prevent cross-contamination and accommodate the exhaust requirements of the fume hoods that are commonly used. However, relying entirely on outdoor air also presents a significant challenge: all that air must be conditioned, at considerable expense. As a result, heating, cooling, and moving ventilation air in a lab typically accounts for 60 to 70 percent of total building energy use.

Zone systems and spaces. Zoning a laboratory building's energy systems can prevent energy waste. It is critical to distinguish between lab spaces and non-lab spaces because they have significantly different operational characteristics, energy-using equipment, and energy-use patterns. Laboratory spaces can be energy-intensive, but offices, common areas, and other spaces have far less onerous energy requirements. Designing mechanical systems to accommodate these varied uses saves money and energy.

Design for part-load and variable conditions. Configure fans, pumps, chillers, boilers, and other equipment for high-efficiency operation even at very low loads. One way to do this is to use a modular design, using a number of smaller modules rather than one or two large ones and installing controls to ensure that only the components needed to meet the current load run at any given time. Another is to install variable-air-volume air-moving equipment and variable-frequency drives (VFDs) on fans and pumps.

Right-size equipment. Laboratory facilities have highly variable HVAC demands, and engineers often oversize mechanical heating and cooling equipment in an effort to anticipate the convergence of worst-case equipment and climate loads. Their mistaken belief is that this practice provides flexibility and reliability, improves comfort, and reduces the likelihood of litigation; in reality, oversizing is far more likely to waste energy, hurt life-cycle economics, and diminish comfort. By utilizing sophisticated building simulation software and incorporating measured usage data from the Labs21 program, designers can better plan the lab's HVAC system to maximize system performance and minimize energy consumption.

Improve fume-hood efficiency. Although vital for the safety of employees, fume hoods, which limit exposure to hazardous or noxious fumes by venting them outside, are typically among the largest single sources of energy consumption in labs. Lowering the maximum height of the sash—an adjustable screen that protects the user from chemicals—can result in less fan power needed to maintain proper airflow. As a result, using fume hoods with two-position variable-sash airflow equipment can be an effective way to save energy. Where applicable, consider adding occupancy sensors and VFDs as well. All of these measures can yield large energy savings with attractive returns on investment.

Seal ductwork. Because so much of a lab's energy use goes toward HVAC, any leaks in the ductwork can result in significant energy waste (not to mention the potential for cross-contamination of air and the dangers involved in fume-hood exhaust reentering the building). One particularly effective approach is to use an aerosol duct-sealing process created by Lawrence Berkeley National Laboratory (LBNL), which is now sold under the trade name Aeroseal. The basic idea of this process is to blow sticky particles into ducts, where they attach themselves to the edges of leaks and effectively seal them. Aerosol duct sealing is currently the only way to seal leaks in ducts made inaccessible by walls and insulation.

Cleanrooms

Many laboratory facilities have cleanrooms, which have much higher energy intensities than the rest of the lab. In California, for example, cleanrooms account for only 12 percent of the floor space of labs, but consume 54 percent of the total electricity used in these facilities. Because these areas have unique requirements and involve complex systems, the best way for laboratory owners and managers to learn more about potential efficiency improvements is to look through resources like LBNL's cleanrooms Web page (part of its High-Performance Buildings for High-Tech Industries web site). In particular, LBNL offers a number of best-practice guidelines for HVAC air and water systems, power systems, and process systems, as well as cross-cutting issues like motor efficiency, steam, lighting, commissioning, heat recovery, and right-sizing, all of which may be helpful in identifying areas for improvement.

Whole-building efficiency

Because laboratories have many interdependent systems, a comprehensive approach to energy efficiency can result in large net savings and better overall performance.

Design. In new laboratory facilities, a whole-building approach to design can yield significant energy savings while reducing up-front construction costs through right-sized equipment. This approach necessitates a design and construction team that is able and willing to integrate a range of performance criteria at each stage of the process, including first costs, life-cycle costs, quality-of-life issues, flexibility, productivity, energy efficiency, aesthetics, and environmental impacts. A good way to introduce stakeholders to these concepts is to invite them to a design charette at the beginning of the process. This focused, collaborative, interactive brainstorming meeting allows all the participants to address the project's challenges and opportunities from a cross-disciplinary perspective.

Commissioning. Commissioning is a process in which engineers check and tune up building systems to ensure that they are operating appropriately and efficiently, and it extends beyond the "testing and balancing" that is typically implemented in labs. A 2009 LBNL study indicates that commissioning existing buildings is among the most cost-effective ways to reduce energy use, particularly in high-tech facilities like laboratories. In many labs, whole-building energy savings as high as 30 percent are possible with simple payback periods of less than three years.

In addition to providing energy savings, commissioning often increases system performance and occupant comfort and decreases annual maintenance needs, yielding additional (and significant) non-energy benefits. If your building was previously commissioned, consider investing in recommissioning every three to five years, or in ongoing (also referred to as monitoring-based) commissioning. The latter option involves the installation of a system of sensors designed to continually monitor energy use and system efficiency to ensure maximum persistence of savings, and it may be worthwhile despite potentially high initial costs.

OPTIMIZING LABORATORY EXHAUST SYSTEMS

HOW NEW TECHNOLOGIES, SUCH AS VARIABLE AIR VOLUME CONTROLS, CAN PROVIDE SIGNIFICANT ENERGY SAVINGS

by Victor Neuman

The creation of sustainable, high-performance and efficient buildings is growing in importance for companies and governments around the world for both economic and environmental reasons. In particular, laboratories are the focus of many of these reduction efforts as they are some of the largest consumers of energy due to the specialized equipment and ventilation systems required for safety and compliance.

Consider this: buildings are currently the largest consumers of energy on the planet, accounting for a staggering 42 percent of energy usage worldwide and generating approximately 40 percent of global greenhouse gas emissions. Compared to a typical commercial office building, the average laboratory facility uses 10 times more energy per square foot, with some laboratories accounting for as much as 100 times more energy use.[1] While much of this is due to specialized equipment, a significant amount of energy consumption—up to 80 percent—is due to ventilation systems.[2,3]

While much attention is focused on air supply and conditioning, exhaust systems have traditionally received the least amount of attention in terms of energy optimization because they only make up one part of the ventilation system. However, exhaust energy comprises up to 40 percent of a ventilation system's energy use, and as much as 30 percent of a laboratory's energy consumption, presenting a significant opportunity for laboratories to realize operational energy savings as well as more sustainable operations.

The importance of optimizing laboratories: Financial and beyond

Taking into consideration the amount of energy a laboratory ventilation system uses, reducing any possible waste through energy reduction can provide laboratories with a tangible return on investment in operational costs alone. But beyond the obvious financial benefits, it is also important to consider the emphasis by today's consumers and the federal government to operate in a sustainable manner. For this reason, corporate responsibility and environmental protection are also large considerations for any company operating in today's economy.

In addition, the potential for reducing impact on the climate in laboratories alone is enormous. The U.S. Environmental Protection Agency (EPA) estimates that if half of the laboratories in the U.S. reduced energy use by 30 percent—a goal that it considers possible—it would be comparable to reducing national energy consumption by 84 trillion BTUs. That's enough energy to power 840,000 households and is equivalent to removing 1.3 million cars from U.S. highways or preventing 56 million trees from being harvested.[2]

Laboratory exhausts and energy consumption

Reducing the energy use of laboratory exhaust systems can be achieved by addressing two primary issues: design of exhaust stacks and power maintenance of the systems.

Historically, the exhaust stacks have been kept short for aesthetic reasons. However, because plume rise is directly related to stack height, shorter stacks increase the exhaust load, resulting in wasted energy. If a stack is taller, less power is required to reach the desired plume height, whereas with shorter stacks, more energy is required.[4] This is critical because laboratories must maintain a minimum exhaust velocity to ensure safety and effectiveness. The American National Standards Institute (ANSI)[5] recommends a minimum exit velocity of 3,000 feet per minute (fpm), and the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) puts the figure at between 2,000 and 3,000 fpm.[6]

A second reason for the high energy consumption of exhaust systems is that they are typically maintained at full power on a constant basis—in many laboratories, 24 hours per day, 7 days a week. Furthermore, these settings are usually based on worst-case scenarios for wind conditions and contaminants. In the case of wind, the worst conditions only occur a small percentage of the time. For contaminants, the EPA states: "An overly conservative judgment about the potential toxicity of an exhaust stream may result in a high-energy-use exhaust system as volume flow or exit velocity is increased unnecessarily." The agency recommends that the exhaust flow be based on scientific measurements of actual contaminants, adjusting it accordingly to achieve "an exhaust system that yields acceptable air quality while consuming a minimum amount of energy."[7]

Considering the above factors, it is very likely that in most laboratories, exhaust flow is set higher than needed a high percentage of the time, resulting in a significant amount of energy waste.

Adding up the savings

While mathematical modeling and wind tunnel tests can provide valuable predictive data on exhaust safety and engineering savings, the real test is in actual use. Field data suggests that the energy savings from optimized exhaust systems can be substantial.

Based on the experience of operating research laboratories that have used air quality monitors in their exhaust flow, it has been found that worst-case airflow rates are needed only about 12 hours per year—which means that lower set points could be used if proper monitoring is in place—as much as 99 percent of the time. For example, one laboratory was able to reduce the exhaust-related energy use to just 10 percent of previous levels through the use of a staged variable air volume (VAV) system with anemometer control. This resulted in annual savings of $81,000 plus an additional bonus of $90,000 from the company's utility company for conservation incentives.

While the potential for realized savings is dependent on each laboratory, its system and air quality requirements, there is a clear opportunity to reduce costs and environmental impact by optimizing exhaust systems.

Strategies for reducing energy use

By using an automated monitoring and control system, it is often possible to safely reduce energy use in laboratory exhaust systems by as much as 50 percent or more, which would reduce a laboratory's total energy use by 15 percent. There are several proven concepts within the market, and one such example is based on the paper "Labs for the 21st Century," authored by Brad Cochran, Ron Petersen and John Carter of Cermak Peterka Petersen (CPP). The paper offers three effective strategies for accomplishing a safe reduction of energy use, based on replacing CV systems with variable volume exhaust systems,[8] including passive variable volume exhaust, active VAV with anemometer and active VAV with chemical monitor.

"Labs for the 21st Century" is just one example of several successful concepts for reducing energy in laboratory exhaust systems. However, before being able to execute such a strategic plan for reducing energy within a laboratory facility, today's laboratory managers are often met with the challenge of justifying the cost of installing new equipment to reduce energy while improving ROI. The following steps will assist laboratory managers and facilities professionals in executing similar projects within their buildings:

1) Engage with a building professional that has knowledge of laboratory environments and understands your company and building's unique needs and challenges.

2) Perform an audit of your existing exhaust systems to identify areas for improvement.

3) Based on the findings of the audit, create a plan that shows the current amount of energy being used by laboratory exhaust fans, and show the ROI and environmental savings that can be achieved by optimizing the fan system.

4) Once the upgraded equipment is in place, properly train staff on the system to ensure that the equipment is being used correctly for the maximum amount of energy savings.

5) Continuously monitor and look for areas of improvement based on actual aboratory operations.

Conclusion

For compliance and safety reasons, air quality is essential in any laboratory, and exhaust systems play an important role in meeting this requirement. At the same time, exhaust systems are a major contributor to laboratory energy use.

Laboratories can reduce energy use significantly by optimizing their exhaust systems, with the use of modern technologies such as VAV controls, airflow and contaminant sensors, and building automation systems that can adjust airflow for actual conditions. Combined with dispersion analysis studies—using either mathematical models or physical wind tunnels—design engineers can specify exhaust airflows that will reduce energy usage to gain significant operational and environmental savings, while ensuring safe and compliant operations.

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ASK THE EXPERT

INNOVATIONS IN CELL CULTURE: CELLS, REAGENTS, AND ASSAYS

by Tanuja Koppal, Ph.D.

Scott Martin, Ph.D., team leader for RNA interference (RNAi) screening at the National Institutes of Health, Center for Advancing Translational Sciences, talks to contributing editor Tanuja Koppal, Ph.D., about recent trends in the use of different types of cells and reagents for screening drug targets and cellular pathways. While his group does not continually look to evaluate and replace cells and reagents being used in the lab, he mentions that there are certain deficient areas such as cell transfection and cell imaging that could benefit from new and improved reagents entering the market.

Q: What types of assays do you currently run in your lab?

A: We are a high-throughput screening lab serving the National Institutes of Health (NIH) intramural research program, and so we screen various approved projects that come through our door. We work on a dozen different projects each year, and each project has a few different screens embedded in it, which are mostly performed using cell lines. Many of those screens are cytotoxicity screens, where we are looking for cell vulnerability between different types of cancers using traditional luciferase-based cell viability readouts. We also work with our collaborators to look at cellular pathways of interest in areas such as cancer or immunology, using reporter assay systems in engineered cells. These assays are either luciferase-based readouts or fluorescence-based high-content imaging, the latter of which tends to yield much more information. We also perform numerous high-content cellular assays using host cells infected with virus-expressing green fluorescent protein (GFP) to identify host factors important to viral spread. In that context, we do screen a number of different viruses in our lab. There are other broader high-content phenotypic assays using fluorescently modified proteins that we use to monitor changes in expression or cellular localization.

"When you use primary cells or cells in suspension, growth and transfection both become a problem."

Q: Have you worked with assays using stem cells?

A: We have worked with stem cells in the context of reprogramming and will soon be moving into projects related to cell differentiation. The challenge working with induced pluripotent stem (iPS) cells is that the experiments are much longer, on the order of several weeks, so they require more liquid handling and sometimes multiple rounds of transfection.

Q: What challenges do you run into with using primary cells?

A: We perform our assays mostly in cell lines, because they are easy to grow and harvest and because they are highly transfectable. When you use primary cells or cells in suspension, growth and transfection both become a problem. We recently performed a small-scale pilot screen using mouse primary neuronal cells in a model that is relevant to retinal injury and glaucoma. For this project we had to use NeuroMag, a neuron-specific transfection reagent that uses magnetic nanobeads for transfecting the primary cells. We added the primary retinal ganglion cells to these nanobeads complexed with small interfering RNA (siRNA) for screening and set the plate on a magnet for the duration of the experiment. The transfections worked beautifully and reproducibly in these cells, and some of this early work has already been published. So we do try to work with some of these difficult-to-use cells, but it's certainly a challenge.

Q: Can this magnetic technology be used in cell lines as well?

A: With cell lines it's usually easy to use lipid-based transfection reagents, so there's no need to experiment with magnets and other less-used technologies. Also, on a cost basis, the lipid reagents are generally cheaper than alternate technologies. We have also used nucleofection reagents in 384-well format, primarily for T cells, and have found it

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Dr. Scott Martin is the team leader for RNAi screening at the NIH Center for Advancing Translational Sciences. His facility performs numerous genome-wide RNAi screens in collaboration with NIH intramural investigators. These studies span a wide variety of biology, ranging from cancer to infectious and rare diseases. Dr. Martin is interested not only in discoveries made through RNAi screening but also in advancing its successful application. Prior to establishing the RNAi screening facility at NIH, Dr. Martin attained his Ph.D. in chemistry at Pennsylvania State University in 2004. While there, his studies focused on engineering small molecules for the targeted delivery of bioactive cargo to the surface of cancer cells. After obtaining his Ph.D., Dr. Martin pursued a postdoctoral fellowship at the National Cancer Institute (NCI) in Bethesda to further his understanding of cancer biology. At NCI, Dr. Martin's work focused on understanding RNA interference in mammalian cells and using RNAi as a tool to uncover genes associated with cancer and the activity of therapeutically relative agents in cancer.

difficult to optimize, given the number of protocols and buffers that are available. It also requires too many cells and is hard to optimize to a point where you get good transfection without much toxicity. It works well with cDNAs, but for RNAi screens it requires much more siRNA than is needed with other protocols.

Q: Are you continually looking for new ways and reagents to do your assays?

A: We pretty much stick with what's working, unless it's for a new type of assay. Especially with the basic cellular reagents, they all seem to work pretty well. However, we would surely evaluate reagents where things are less worked out. For example, reagents that can enhance fluorescent signals in imaging assays are worth looking at because that's an inherent limitation. We are also more apt to try new things in areas that are deficient such as in primary antibody staining or where we are experiencing difficulties, like with transfections. Certain transfection reagents claim to be more amenable to certain systems than others, and we will certainly test those.

Q: Do you experiment and test different types of cell growth media, buffers, and matrices?

A: Most of the projects that come to us come with recommended protocols, and hence we don't play much with growth media and cell culture reagents. However, in terms of protocols, going forward we plan to stop culturing our cells in antibiotics. This will alleviate any concerns regarding low-level contamination that goes undetected. We are also becoming more rigorous about scheduled mycoplasma testing and putting cells in quarantine once they enter our lab.

Cell identification is another big issue, where people are reporting data using cells when the cells are not what they claim to be. So every time we get new cells we will now test them for mycoplasma and then send them out for identity testing or short tandem repeat (STR) profiling. The cell testing services are becoming cheaper and more accessible, and it's definitely something that everyone should start doing. Cell misidentification is a huge problem, and scientific journals are also going to be requiring this testing soon.

Q: What are you looking to invest your time and money in this year?

A: There are a few different things we would like to look at this year. Long noncoding RNAs (LncRNA) seem to be an area of upcoming interest, and vendors are starting to provide reagents and tools to probe LncRNA and the "dark matter" in the genome. We have also done some microRNA (miRNA) screens, and what's really frustrating there is that the libraries are constantly being updated and it's hard to keep up with the additions. However, the major crux of what we do is still siRNA screening, and we will be looking more carefully at the on- and off-target effects in these screens. Finally, something that is outside our current workflow but that we would like to do is pooled short hairpin RNA (shRNA) screens. The infrastructure needed to do arrayed shRNA screens is complicated and is not something we are set up to do. However, many of our projects are amenable to shRNA screens, and so we would like to assess some of the shRNA reagents. From a reagent perspective such screens are now becoming more practical and affordable, and vendors are also offering these screens as a full service.

Q: Are you interested in the 3-D cell cultures?

A: I would like to start exploring 3-D cell culture-based screening, although it is not very practical for a high-throughput lab like ours. However, we could certainly do some follow-up experiments in 3-D cultures, which would be more relevant. The traditional 2-D, large-scale cellular screens are fine, but in terms of predicting how the results translate in in *vivo*, they are certainly thought to be inadequate. It is routinely thought that 3-D cultures are more physiologically relevant, and we want to take a closer look at that. We have some groups here at the NIH that are screening small molecule libraries in 3-D cultures and looking at differences in responses in 2-D versus 3-D screens. It would be interesting to find out how different the data really is and if the differences in 3-D are in fact more clinically relevant.

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SLIPPERY BUSINESS

CREATING THE BEST SLIP, TRIP, AND FALL PREVENTION PROGRAM FOR YOUR LAB

by Vince McLeod

Again and again we hear about the dangers of slips, trips, and falls and the heavy cost associated with the resulting injuries. A few recent statistics hammer home the reality of the concern:

1. **Slips and falls account for 12 percent of all work related deaths.**
2. **Fatal injuries in slips and falls rank second behind motor vehicle deaths in the workplace.**
3. **Slips and falls cause more than 300,000 disabling injuries and deaths annually.**
4. **Costs in compensation (wages and medical) as a result of slipping accidents average $6,717 per occurrence (more than 41 percent above the average of all other accidents).**
5. **Work-related accidents in the United States cost $34.8 billion annually.[1]**

And you may not think so, but laboratory facilities are prime candidates for slips and falls. The constantly wet surfaces, frequent spills and splashes, constant washing of glassware, etc., all combine to make laboratories some of the places most vulnerable to slips, trips, and falls. So in this issue, the Safety Guys offer a few tips on preventing these types of accidents

Look at the big picture

There are many reasons for slips and falls, but they have one thing in common—they usually could and should have been prevented. Accidents do happen; however, by using a commonsense approach and following some simple key steps we can avoid the major causes of slips and falls. As in other safety programs, employee participation and vigilance are key to success. This is especially important with trips, slips, and falls, as the hazards are dynamic (i.e., constantly changing), so it is imperative that employees observe and take preventive action during their day-to-day activities.

The first thing to do is to take the time to survey your facility and try to identify potential problem areas. Once these trouble zones are spotted, you then can evaluate fixes or different control measures. Finally, implement the corrections and controls. After addressing the trouble areas, it is a simple matter to perform a facility inspection at regular intervals, maintaining, repairing, and replacing controls as needed.

> "Laboratory facilities are prime candidates for slips and falls."

We know from experience that rough, dry concrete sidewalks have good traction and that icy, wet, or smooth surfaces often do not. The technical term for this is coefficient of friction (COF). The higher the COF, the more traction that surface offers. Field measurement of COF is difficult and often inaccurate. The COFs mentioned are from lab data on dry surfaces. For most walking and working surfaces, we should aim for a COF of 0.40 or greater for the best traction. As a reference, a dry, rough concrete sidewalk may have a COF of 1.0 or more, while a wet, smooth surface such as ceramic tile or ice can have a COF of as low as 0.10. Let us keep that in mind as we begin our survey.

Take a walk on the outside

Start by taking a tour outside, walking around the perimeter of your research facility. Make a list of the usual suspects when it comes to areas where trips and falls

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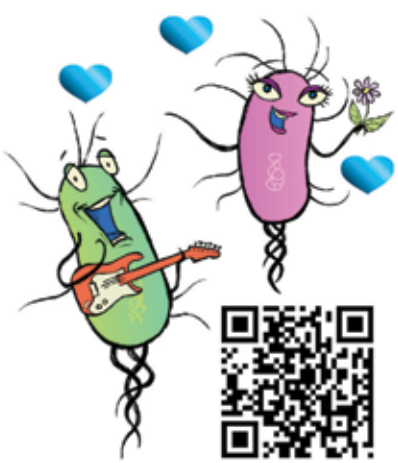

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SAFETY TIP

DEVELOP A SAFETY ORIENTATION PROGRAM

By James. A. Kaufman

All new employees, students, faculty, and staff should receive a specially designed introduction to your safety program.

This orientation should cover the philosophy, policies, and procedures. It should explain how to deal with emergencies and how to handle emergency equipment. The new person should receive a set of rules or operating manual for the academic institution or company and be expected to sign a statement (rules agreement) indicating that they have read, understand, agree to follow, and realize the failure to do so can result in termination.

Some schools require new students to have a three day orientation program and then score 100 on a test before they can begin attending classes. One college in Minnesota turned the first five labs in general chemistry into a 15 hour, one-credit, lab safety course. Students have three chances to pass the final. If they don't pass, they are done with science labs for that semester.

If you are involved in hiring new employees, consider asking the candidates the following question: "What is there in your background that suggests that you are both concerned and knowledgeable about issues of laboratory safety?"

You'll never have the special opportunity again that you have on day one to make a lasting impression about how much you care about health and safety.

Want to start your "new employee safety orientation" sooner? Add the two words, "Safety Conscious" to your display ad looking for new lab employees. Why not tell the whole world that your organization wants "safety conscious" not "safety unconscious" employees.

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

occur most frequently. These include entrances, sidewalks, steps, and ramps. Take note of the different surfaces and whether they have good traction. We suggest trying the "scuff test" of sliding or kicking your foot along the surface in both dry and wet conditions. If the surface seems slippery, then it is a good candidate for nonskid epoxy coatings or nonslip treads. Areas that are very frequently used in locales with wet weather should also be considered for permanent coverings to reduce slipping.

Are the usual suspects likely to get wet at times other than in inclement weather? For example, does the irrigation system or do sprinklers hit these potential trouble spots? If so, have them corrected immediately. Does their proximity to water, such as from roof drains or storm water systems, lead to regular wetting? Then nonskid coatings with a very high COF are a must.

Do not overlook shipping and receiving areas or loading docks. These high-traffic areas are often exposed and must have excellent traction due to the added hazards of moving loads in and out. Also, make sure all steps, ramps, and elevated docks have appropriate guardrails.

Another hazard to look for is uneven surfaces. Very small changes in elevation can lead to a trip from a "stubbed" toe, resulting in a fall. In fact, the Americans with Disabilities Act (ADA) requires differences in elevation to be a quarter-inch or less.[2] The best fix is to fill in or grind down the adjacent areas to smooth them out. If that is not practical, consider yellow safety markings to draw attention to the change in levels.

Since most research facilities do not adhere to a strict 8-to-5 workday and activities can take place before and after daylight hours, make sure you visit your trouble spots in the dark in order to evaluate the lighting. It is very helpful and recommended that a good-quality light meter be used for this survey, and that the results be compared to the national consensus standards.

Inside track

Continuing our inspection indoors, we encounter a variety of uses, each with different requirements. Typically we have offices; break rooms, canteens, and perhaps cafeterias; receiving and storage areas; workshops; and, of course, laboratories. The floor surfaces and the hazards vary with the intended use of each space.

Housekeeping issues are the number one reason for trips and falls indoors. Therefore, avoiding clutter and keeping floors and walkways clear are important for all areas. Check for stray or inappropriate cords, such as

extension cords and computer or phone cables, and reroute them properly if they are present. Ensure that mats lie flat, and secure them if they tend to move. Repair any bulges in the carpets, and take extra care where floor surfaces change—for example, where carpet meets tile or other flooring—to keep them smooth and trip-free.

Receiving and storage areas and workshops present special challenges and need a nonslip floor with a high COF. It is a good idea to designate paths and walkways with on-floor markings to aid in keeping these areas clear.

Any specific washing areas or tank rooms need special attention. It is highly recommended that walking and working surfaces in these areas have nonskid coatings, due to their frequently wet conditions. Use anti-fatigue mats wherever employees must stand for long periods. Make sure employees know to clean up any spills immediately. In addition, expanding your lighting survey to indoor areas is another recommended prevention task.

Summary

Taking a few hours to inspect your research facility will go a long way in preventing slips, trips, and falls. Most fixes and corrections are low-cost and easily installed and maintained. Given the costs associated with the alternatives, it is hard to argue against a good slip, trip, and fall prevention program.

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EVAPORATORS

ENHANCED SIMPLICITY LEADS TO EXPANDING APPLICATIONS

by Mike May, Ph.D.

Evaporators are a common sight in virtually any laboratory. "Everyone is evaporating off solvents," says Jeff Reid, product specialist for evaporation at BUCHI (New Castle, DE). That includes everything from academic and environmental labs to the chemical and pharmaceutical industries. So anyone who wants to dry something down to a powder, recrystalize a sample, or recycle a solvent needs an evaporator.

"More people are finding uses for evaporators," says Jim Jacso, director of sales and engineering at Glas-Col (Terre Haute, IN). "For instance, some biologists use evaporators to dry down well plates." He adds, "The pharmaceutical industry uses evaporators for many things, such as drying down compounds." Jacso also notes growth in evaporator use in the food and beverage industry. "There's an increased demand for them to make sure that there are no residues, such as pesticides, in the foods that we're consuming."

Evolving evaporators

"The technology is very mature," says John Pollard, director of sales at BUCHI, "so the real trends are in the usage of the products." He adds, "[As with] many other products in the marketplace, customers want automation, automation, automation." As Pollard says, "A user wants to start the evaporator, walk away, and come back and have the process completed."

Jacso adds, "There is always talk about helping the end user do the research in the minimum amount of time." He adds, "We develop our evaporators so the researcher spends less time standing around [waiting] for the process to finish."

Researchers save the most time by taking advantage of rotary evaporators that have individualized, preprogrammed parameter settings, says Nicole Kvasnicka, product marketing manager at Heidolph North America (Elk Grove Village, IL). She adds, "Lots of customers request digital displays on the units to control all parameters such as bath temperature and rotation speed." She also points out the requests for reduced process time and says, "Heidolph is releasing a new unit called the Distimatic, which provides automated evaporation 24/7. What's unique about the product is its automatic residue drainage that allows you to distill large volumes in a continuous and unattended way." She adds, "This is a product that is not currently out on the market, and we find that [there] is a need in labs so that researchers can optimize their daily workflow."

The automation in evaporators can also extend to safety. "You can automate our units to lift the flask out of the bath if needed," says Pollard. "That way you can walk away and not worry about the unit being damaged." Such features used to exist only on high-end evaporators. "Some of these features are making their way down in terms of price," Pollard says. "Plus, if you don't need or can't afford these features today, you can add them on later."

Greener goals

Some of today's evaporators also give users options to be much more environmentally friendly. For example, Jacso mentions that Glas-Col has developed evaporators that reduce the consumption of nitrogen. "We also have a new one that allows customers to recapture solvents," he says. "We're hearing a lot that companies are getting more strict about what they're sending up their stacks."

Evaporators can also be more green by being more efficient. Evaporators could save energy, for instance, if the technology "knew" how long it needed to run. For example, Jacso says, "We're coming out with new end-point [detectors]. So the concentration goes only to some level, which you establish by monitoring the level in the tubes."

Rotated, not stirred

Sometimes the concept of a laboratory goes beyond science, and that really happens with

rotary evaporators, which now show up in kitchens and bars. In so-called molecular cooking, chefs often use a rotary evaporator to make sauces and other delectable concoctions.

For example, Kvasnicka says that their rotary evaporators are "used from creating dishes in five-star restaurants to [mixing] unique cocktails." She adds, "University culinary courses are now using rotary evaporators."

So the next time you order a cocktail, maybe you should add "Rotated, not stirred."

Keeping economical

An evaporator should last a long time in almost any lab. "We're in hard economic times," says Pollard, "and people are trying to get as much value as they can afford." He adds, "They might not have funding for a new evaporator, so they are looking at the serviceability of the system, the quality of the system. Is it going to last ten to fifteen years?"

Beyond making evaporators last a long time, vendors also make them cost less. When asked about trends in evaporators, Jacso says, "Price. There's lots of competition out there as far as different models and price ranges."

In addition to saving money, researchers also want to save space. "The bench space that an evaporator takes is the most important thing that we hear," Jacso says. "Some researchers are using more personal types of hoods where they want to use an evaporator." He mentions that some scientists use hoods that are only 24 inches wide and about 15 inches deep, and they want to simultaneously run three to four samples in evaporators. That takes small evaporators.

At the Woods Hole Oceanographic Institution in Massachusetts, assistant scientist Jessica Tierney, Ph.D., uses "evaporators to remove solvent from lipid extracts." She writes by email, "When buying an evaporator I look for flexibility (e.g., being able to adjust each nozzle on its own), the ability to blow down multiple samples at once, efficiency in terms of using [nitrogen gas, and the] ability to adjust to different vial sizes."

Whatever uses a scientist plans for an evaporator, some of the same concerns apply in every case. "A buyer should look for quality and craftsmanship as well as the kind of support team that can help you if anything happens," says Kvasnicka.

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MICROPLATE HANDLERS

CRITICAL COMPONENTS OF LAB AUTOMATION

by Angelo DePalma, Ph.D.

Microplate handlers developed around the need to further automate liquid handling beyond its original function of dispensing fluids. "Integrating plate movement was a secondary feature," says Eric Matthews, Midwest sales manager for BMG LABTECH (Chicago, IL). Today, robotics is central to integrating one or more devices with liquid handling.

Manufacturers have to some degree always taken a turnkey approach to designing automation systems, but today it is possible to design nearly any combination of components (handler, washer, reader) task-specifically or with built-in versatility.

This was due in no small part to the advent of inexpensive computing. "There was no true automation until PCs were capable of doing it," Matthews says, comparing lab automation of 30 years ago to a drill press. "You'd put a plate into something, and it would do something to that place. There were no thermosensors, no scheduling, and everything required a lot of human intervention. If a plate was in the wrong spot or a pipettor wasn't calibrated properly, users had to work it out themselves."

Another innovation that changed plate handling was the availability of relatively inexpensive robots capable of fluid, three-axis movement and incorporating error detection and correction. "That ability, to move plates wherever you want, is a big deal," Matthews says. "Like many other technologies, plate handling has followed Moore's law."

> "The combination of articulated arm robotics and turntables can make a huge difference in terms of throughput."

Spanning size, capabilities

Andreas Niewoehner, product manager for automated systems at PerkinElmer (Waltham, MA), breaks down the microplate automation market thus: small, benchtop systems; larger robotic systems; and full-scale, industrial robotic systems. For smaller systems, labs increasingly look for safe operation without the need for protection enclosures. "These are also easier to fit into tight lab space and integrate with other devices," Niewoehner says.

Capabilities increase with size: Smaller systems may perform only one task, while larger automated workstations connect ten or more operations. "Users also expect a higher level of speed and robustness from these systems," Niewoehner explains. "They were designed for production-like processes, such as pharmaceutical high-throughput screening, but are becoming popular in other industries."

One problem with single-plate capacity plate handlers is that they create bottlenecks when one assay component is completed but the next one is not yet ready to accept the plate. An example might be a rapid agitation step followed by a ten-minute read. Employing two full-featured handlers or robots gets expensive. An alternative is "turntable" technologies that accept plates from the shaker. Turntables serve as workflow buffers, holding plates until the reader is ready. "The combination of articulated arm robotics and turntables can make a huge difference in terms of throughput," Niewoehner notes.

Human factors

The decision to automate is often based on throughput—number of plates processed per hour or per shift. But other factors enter the picture as well, such as plate read times and the

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anticipated level of human involvement in the process. A two-minute read of, say, 30 plates would require the operator to hover over the process for at least an hour, whereas a thirty-minute read affords meaningful time to attend to other duties between reads.

The value of automation also depends on the assay, says Kasia Proctor, product manager at Molecular Devices (Sunnyvale, CA). "The assay's stability is critical. How stable is it [with] fluctuations in temperature or evaporation? Does it need to be in an incubator? Do you need to maintain a stable environment, or is the assay more flexible? Are your controls stable over the time frame of your process? You want to be sure that variations between plates are due to assay results and not to plate handling."

> "Full automation makes sense when labs anticipate running the same process(es) for long stretches."

Proctor differentiates between three automation options. A straightforward system based on a plate stacker adds and removes plates to one instrument, for example, a reader. At the next level of sophistication a small robotic arm may be employed to integrate three or four instruments (e.g., reader, washer, incubator). At the high end a full automation system involves several robots and multiple instruments or workflows.

"There are costs associated with fully automated systems, and the investment has to pay off at some point," Proctor explains. Full automation therefore makes sense when labs anticipate running the same process(es) for long stretches. "You don't want to build a whole room of automation for a month's use or if you're doing a little of this and a little of that," she adds.

Consistency, operator time

Jason Meredith, product manager at Tecan (Männedorf, Switzerland), agrees that throughput issues most frequently trigger the automation of microplate processes but notes that consistency and freeing operator time may be just as valuable.

Automation suppliers can succeed today only if they account for human factors. "Robotics is not quite a commodity, but it's close," Meredith observes. "Robotics exists in many different workflows and is used by scientists and technicians who are not automation specialists."

Prominent among usability factors are software and interface. "How many people know that their electronic gadgets have user manuals?" Meredith asks. "They do exist, but people find their way around the devices' hundreds of functions without instructions. The same philosophy should apply to laboratory automation."

Software plays a critical role in system versatility, allowing someone lacking extensive training to alter a protocol. "A user's ability to set up new protocols reduces the need to call the manufacturer to adjust the robotics," Meredith says. Some Tecan customers reconfigure on a daily basis, which is possible through the company's open format automation systems. "Flexibility and usability increase the value of the automation component, improving its return on investment."

Like many top vendors, Tecan configures systems to specific workflows. Flexibility is nevertheless highly desirable when projects end and instrumentation is reconfigured or when the same system serves more than one workflow. The company's customers range from labs that perform highly repetitive assays to academic and drug discovery labs conducting a wide range of assays.

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TOC ANALYZERS

AUTOMATED CAPABILITIES MAKE PLATFORMS MORE EFFICIENT

by Mike May, Ph.D.

Many industries, including pharmaceuticals and water quality, often measure a sample's total organic carbon (TOC). These instruments come in various forms, including some that use combustion, others that rely on ultraviolet persulfate oxidation, and so on. Some TOC analyzers also combine approaches to oxidation. According to Tammy Rellar, TOC product manager at Teledyne Tekmar (Mason, OH), "Operational efficiency is paramount in today's TOC market."

"When looking for a TOC analyzer," says Bob Clifford, Ph.D., TOC product manager at Shimadzu Scientific Instruments (Columbia, MD), "ask whether you want to bring the sample to the unit or the instrument to the sample. That determines whether you need a lab or an online platform."

The type of sample also determines the best form of oxidation. Some research shows that both combustion and wet-chemical methods, such as heated persulfate or UV-persulfate, work equally well on particulate samples. In general, though, some trade-off arises in the performance of different techniques. For example, combustion-based methods tend to have trouble in approaches that require low-level measurements, such as less than two parts per million of carbon. On the other hand, a heated sodium persulfate approach can oxidize virtually all the organic compounds that are dissolved in water. The best technique really depends on the sample and the required measurement sensitivity.

Advancing the analyzers

Beyond measuring carbon, some users want even more. "People are asking for additional parameters," says Clifford, "like TOC and total nitrogen or total phosphorous."

No matter what an analyzer is measuring, it can read only the samples that it receives. To enhance the sampling, Shimadzu developed a Sample Thief. "This pulls the sample into the system and rinses after every sample," Clifford explains. This provides an example of the ongoing increase in automation.

Rellar also points out that the impact of automation has changed TOC analysis. For example, the calibration and intelligent dilution of highly concentrated samples back into the calibration range—previously labor-intensive tasks—are now automated in some analyzers. "Manufacturers must meet and exceed the needs of their users," Rellar says, "while not compromising reliability for complexity."

In addition, modern TOC analyzers must be extremely efficient. "We sometimes forget that TOC is rather simple in terms of analysis. Technology will continue to advance TOC analysis, but it is irrelevant without reliability," Rellar says.

Safer drinking water

When disinfecting drinking water, more utilities include TOC analysis. "We're seeing a transition to using online TOC analyzers for this," says Gary Engelhart, laboratory products and marketing manager at OI Analytical (College Station, TX). His colleague William Lipps, wet chemistry products manager, adds, "Previously people grabbed a sample as the water was coming in and a sample as it was going out and then analyzed the two." He adds, "If you did that once a day, you got one difference number, but with continuous monitoring you can analyze water all day." That technique can be used to continuously monitor how much disinfectant should be added.

Indeed, today's TOC analyzers in general enhance simplicity but provide more data.

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MICROWAVE DIGESTION

FRONT END TO METALS ANALYSIS

by Angelo DePalma, Ph.D.

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

"It's a method for samples when you need to know the metal content but can't get the species into water or other solvents," says Jason Keith, product manager at CEM (Matthews, NC). "Unlike hot plates, microwaves heat only the sample, not the sample container."

CEM sells two systems, the newest being the MARS6, which incorporates the firm's One Touch™ Technology, combining advanced software, sensors, touch screen operation, and multiple sample capability.

In context

With microwave digestion products under PerkinElmer's (Waltham, MA) "aftermarket" business unit, product manager Mike DiVito views the technique in context rather than as an isolated prep method. "We view microwave as a way to provide customers looking for inorganic sample prep with a more complete solution" that includes collecting and preparing samples, introducing them into instruments, and data management.

PerkinElmer is in the midst of a microwave product transition due in early spring 2013. The new instrument(s) design is in response to customers demanding greater ease of use.

> "As instruments become faster and more sensitive, sample prep must follow suit."

"They increasingly see sample prep as a bottleneck," DiVito explains. As instruments become faster and more sensitive, sample prep must follow suit. "Producing a great sample is challenging: garbage in, garbage out." General instrumentation trends carry over into sample prep. Users want easy setup and operation and color touch screen controllers as simple to use as consumer electronics. At the same time operators want instruments and associated labware that last, with low consumables costs and sample versatility.

Let's take a look

Anton Paar's (Ashland, VA) Multiwave ECO is a budget-friendly microwave system that features pressure-activated venting on the digestion vessels, which eliminates external temperature and pressure sensors. By processing samples of up to 2g, Multiwave ECO should interest pharmaceutical companies working with USP chapters 232/233 for metal impurities. "With many products, QC labs can use the entire tablet for analysis, which simplifies sample preparation," notes Reynhardt Klopper, product specialist at Anton Paar. Multiwave ECO processes up to 16 samples simultaneously, with a cycle time of 30 minutes (including heating and cooling).

Multiwave PRO, Anton Paar's flagship microwave system, offers what Klopper calls "the highest temperature and pressure capabilities in the

industry." Multiwave PRO is capable of digestion, leaching, oxygen combustion, solvent extraction, drying, evaporation, and UV digestion on a single platform. Other features include wireless data transfer from sensors and simultaneous pressure monitoring of all samples.

Pharmaceutical firms will be interested in the PRO's microwave-induced oxygen combustion (MIC) application, Klopper says. "MIC offers efficiency for analysis of complex pharmaceuticals incorporating enteric polymer coatings that inherently resist conventional acid dissolution techniques." MIC combines both sample combustion and acid digestion in a single, closed-vessel system to effectively liberate elements of interest (metals and nonmetals) from nearly all types of combustible materials (polymers, chemicals, pharmaceuticals, etc.).

"Efficient destruction of the sample matrix using MIC ensures complete analyte recoveries and works for a wide variety of sample matrices." The MIC accessory is a low-cost upgrade for the Multiwave PRO.

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SAMPLE PREPARATION FOR CHROMATOGRAPHY

ESSENTIAL PRE-ANALYSIS CLEANUP

by Angelo DePalma, Ph.D.

It's official: Sample and standards preparation are significant bottlenecks in high-throughput laboratories, particularly those partly or fully automated. Improved instrument sensitivity—and the need for speed and accuracy—have made sample prep a top priority.

Yet discussing sample prep as a monolithic operation is impossible because prep steps, analyses, and matrices are highly variable among industries. Measuring protein levels in energy drinks is not the same as for granola; food safety analyzes for pesticide residues and microbial contamination; still other tests quantify trace nutrients. Matrix removal is a great idea, but even the "matrix" differs for all the tests mentioned.

Sensitivity allows analysts to probe for low-abundance or dilute compounds. This is usually a good thing, but sensitivity also uncovers more contaminants and interferences. As with analytical instruments, users are looking for simpler, faster, solvent-sparing prep methods. "New sorbent chemistries are allowing analysis of a wider range of analytes more rapidly than ever," says Sueki Leung, technical specialist for sample preparation at Phenomenex (Torrance, CA). Selecting the right prep method can save thousands of dollars per week in solvent and solvent disposal costs and can be "greener" than traditional methods.

The major challenge, according to Leung, is striking a balance between sample cleanup (removing the matrix and contaminants) and target analyte recovery.

> "Users are looking for simpler, faster, solvent-sparing prep methods."

Where traditional methods relied on extraction, today's methods aim more at matrix removal that spares target compounds. Rapid cleanup methods may not produce samples that are quite as clean as those produced by more time-consuming protocols. "Laboratories need to look hard at their overall goal," Leung adds. "Can you compromise cleanliness for the speed of newer techniques, or will that approach generate samples that do not meet your objectives? Labs may need to rethink their sample preparation methods and adopt ones that take more time."

Diverse samples, diverse methods

Pesticide testing in foods has been simplified by the QuEChERS (pronounced "ketchers," a portmanteau for "quick, easy, cheap, effective, rugged, and safe) method. QuEChERS is a dispersive solid-phase extraction method that isolates basic, acidic, and neutral pesticides. Developed at the USDA in 2003 and adopted by AOAC in 2007, QuEChERS greatly improves pesticide analysis by removing interfering species. "Traditionally, pesticides were analyzed individually by concentrating analytes. QuEChERS removes species that interfere with chromatography or suppress ionization in mass spectrometry," Leung explains.

Several companies sell proprietary QuEChERS extraction kits, many of which contain a capital "Q" in their trademark name. Phenomenex's roQ QuEChERS kit debuted in October 2012.

Sample prep for biological samples is a topic in and of itself. Think about the diversity of biological analytes: organisms, organs, tissues, molecule types, etc. Proteins, for example, exist over a concentration dynamic range of approximately 1014. For analysis of very low-

concentration proteins, removing the matrix must be done with extreme care so as not to deplete the analyte as well.

Assuming that efficient cleanup is possible, low-abundance proteins face other issues between the source and the HPLC system. Proteins are known to stick to a variety of surfaces, including most glass and plastics. Protein adhered to surfaces is forever removed from the usable sample.

"The inherent danger of standard polypropylene tubes is that proteins and nucleic acids stick to surfaces through hydrophobic interactions," comments Matt Lieber, product manager for centrifugation and sample prep at Eppendorf North America (Hauppauge, NY). Conventionally, analysts swamped dilute protein solutions with bovine serum albumin (BSA) to stabilize the molecule of interest. Another approach is to apply a thin coating of silicone oil during the manufacture of sample tubes.

The first approach is impractical because BSA tends to swamp out signals from the analyte, particularly if it resembles the stabilizing protein. Moreover, silicone is known to separate from surfaces and contaminate samples. Constructed from a proprietary polypropylene, Eppendorf's LoBind tubes practically eliminate protein binding to tube surfaces. The company claims maximum protein recovery of 97 percent, which is comparable to the performance of siliconized tubes, without the possibility of silicone oil leaching into the sample.

Why automate?

According to Tony Mamone, senior market manager at Tecan Group (Männedorf, Switzerland), throughput needs are the most common, obvious triggers for automating sample preparation. Then an entirely new world opens up. Customers may not realize it initially, but arguably the greatest benefits to automating are consistency; error reduction; more efficient utilization of solvents and reagents; an audit-worthy paper trail; and the practical elimination of tedious, repetitive work. "Automation greatly reduces the potential for someone who is tired mixing up samples at the end of [a] shift."

For example, most assays require the use of standards and generation of standard curves. When the end point is a mass spectrum, the standards need to be "right and tight," Mamone explains. "Questionable results can be questioned in court. If the curves aren't straight you may have to explain it." To avoid those uncomfortable situations, technicians will discard standards and start fresh, wasting both time and reagents. "The goal is making processes more reproducible and secure, even if you don't have a million samples."

"The goal is making processes more reproducible and secure, even if you don't have a million samples."

Traceability becomes a huge factor when a lab manager must face a disappointed pharmaceutical customer or an inquisitive attorney. At the basic level, all data generated through sample prep robotics enters a log file. "What you do with that data is up to you," Mamone tells *Lab Manager*. "You can ignore it or use built-in reporting capability to generate a report. Or you can pull the data into a LIMS, compile it, and generate a report consisting only of the information you care about. It's even possible to use tracking functions as a time-reporting tool for human resources."

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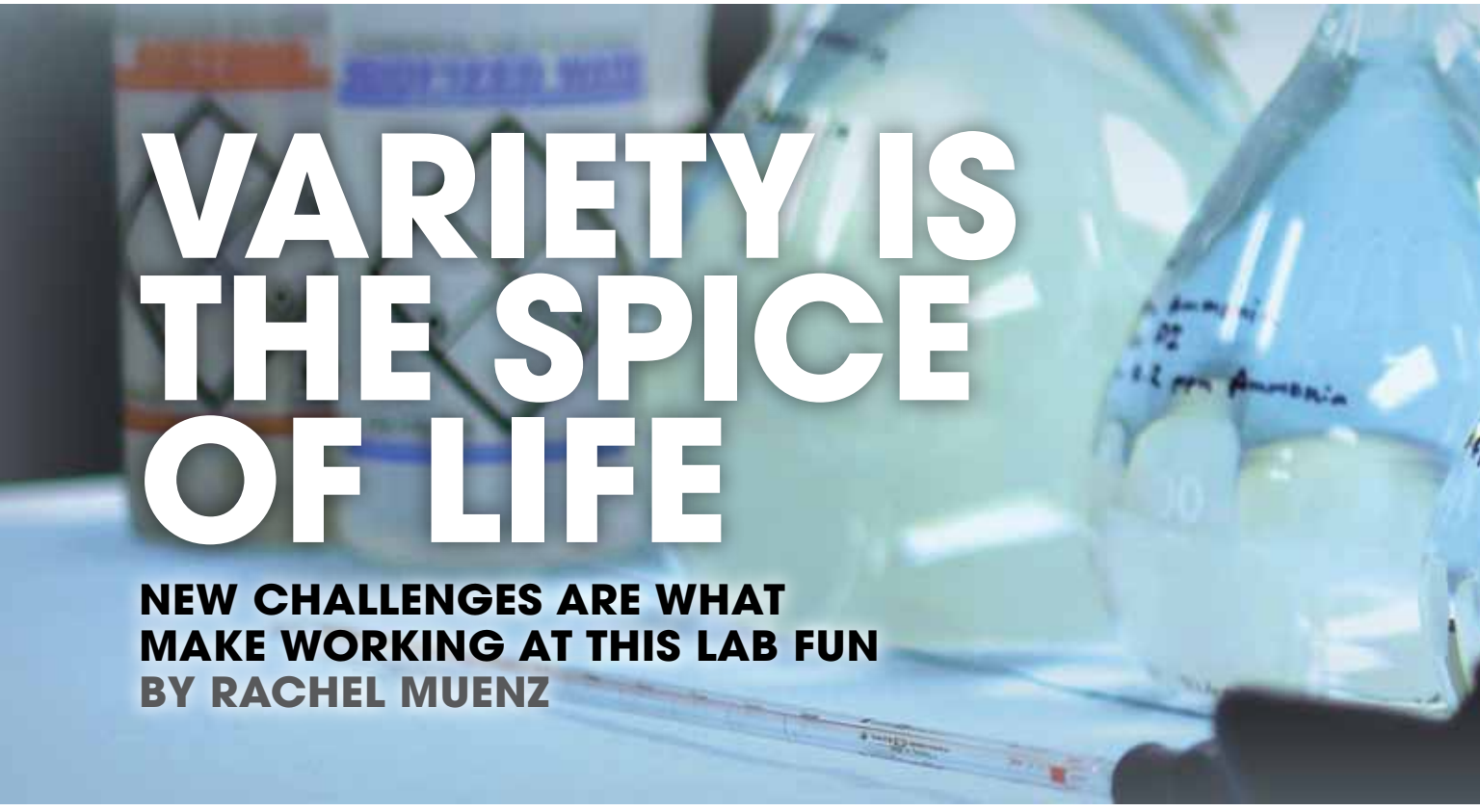


VARIETY IS THE SPICE OF LIFE

NEW CHALLENGES ARE WHAT MAKE WORKING AT THIS LAB FUN

BY RACHEL MUENZ

Airtech Environmental Services' Denver, Colorado environmental lab may be small at just 600 square feet, but it deals with hundreds of samples from stationary sources—such as power plants, oil and gas facilities, and cement plants—all over the United States each month. On average, the lab deals with about 200 to 300 samples each month.

"The company will go out and do sampling, and we'll either do the analysis on-site, or we'll bring wet samples back to the lab and we'll do the analysis [there] in Denver," says the lab's manager and environmental chemist Michael Ogletree of the lab's role in Airtech as a whole.

The Denver office is 6,000 square feet in total, with 35 employees overall, and the company also has an office in Chicago.

"We're not really like a traditional lab per se where people are sending us samples," says Airtech president Patrick Clark about the Denver lab. "A lot of the samples we analyze we collect ourselves, and a lot of the analysis we do in the field in mobile trailers."

He adds that the company has recently been expanding its lab capabilities and expanding on outside analysis for other stack testing companies.

> "A lot of the samples we analyze we collect ourselves, and a lot of the analysis we do in the field in mobile trailers."

There also isn't one type of sample the lab does any more than another, with a wide variety being sampled all the time.

"Unlike a traditional lab, like say, a research and development lab that'll do the same thing over and over or where there are three different tests that they'll run over and over, from week to week our work varies significantly," Ogletree said of the types of tests Airtech does and the samples the lab analyzes.

Clark adds the lab also often gets new compounds to test, meaning work in the lab is always fresh.

"It varies from week to week, month to month, and a lot of things are somewhat routine, but then a lot of them are compounds we've never done before, and we have to develop methodology for them," he says. "That's what makes it interesting."

Ogletree, who has been working at

Preparation of analytical standards for EPA-CTM 027 (Ammonia).

Airtech for three years, is the lab's primary analyst, and the company also has about ten field analysts who work on-site. Those field workers all have undergraduate degrees, and most of them are engineers, while Ogletree was working on his master's at the time of writing this article. Working at Airtech also involves both hands-on training and written tests.

"For the first couple jobs there's always someone who's well versed in the method who goes along, so they [field workers] won't go out on the job without having done it a couple times with someone who's experienced," Ogletree says of the training necessary for the field analysts at Airtech.

He adds a recent change has also meant new training.

"The whole stack testing industry has recently been mandated to comply with the ASTM D7036-04 standard practice for competence of air emissions testing bodies," he says. "We've been going through that this past year, and we have achieved third-party interim accreditation through the Stack Test Accreditation Council. That involves training on specific methods for all the field guys."

Management role

Ogletree's role as lab manager also isn't like that in a traditional lab, since he is the main analyst who works in-house and doesn't really oversee the field workers.

Sample preparation for analysis by EPA Method 323 at Airtech's Denver lab.

"I don't manage, per se, the field guys. What I do in the lab is take all the samples that get brought back [from the field]," Ogletree explains. "In the field, there are some limitations on what we can do, and some methods require samples to be collected in aqueous solutions, so a lot of the wet testing that's done in the field will come back, and I'll do the analysis in-house."

Time restraints also mean samples need to be brought in to the Denver lab instead of being analyzed on-site.

"Some analyses are more involved, so we need to do some kind of method development, and that'll require samples to be brought back," he says.

> "The jobs I go on are generally pretty complex and require a lot of planning in advance, and when you're out there, there's always something interesting going on."

Keeping track of all the samples that get brought back from the field is another of Ogletree's duties as lab manager, and while he doesn't directly manage the field workers, he does do lab technique training with them and is currently involved in setting up a new lab at the Denver location to do water analysis for the oil and gas industry. He also prepares samples that Airtech cannot analyze in-house and sends them to outside labs.

"Occasionally we'll get a large allotment of samples at once, and some of the field guys will have to spend a week or two with me, helping out," he says.

During a typical day in the lab, Ogletree starts off by looking at the sample list to see what is in-house and figuring out which are the priorities.

"Typically, when we have lots of samples in-house, I'll be running one

5890 Gas Chromatograph with FID used for EPA Method 18

instrument while I'm working on another instrument," he says. "A lot of times, it's two or three tests going on at the same time just based upon run times. Some samples you'll inject on the GC and it'll take 25 minutes, and then with another instrument it's ten minutes, and then I'll be doing some kind of sample prep for another instrument. There are just always a lot of things going on." All those samples are kept organized using chains of custody, the ASTM quality assurance program, and through a sample receiving area.

"We keep things organized by projects, and we keep a running list also, a computer spreadsheet, letting everyone know what samples are coming," Ogletree explains. "We also have a job list that keeps track of when samples are going to be coming in the future."

Things are also busy on-site, Ogletree adds.

"In the field, there's always lots going on as well," he says. "You'll be running a rack of analyzers and then doing sample recovery and sample analysis all at the same time."

Challenges, fun stuff, and technology

Ogletree says the variety of the work at the Airtech lab and out in the field is what makes his job enjoyable.

"I enjoy just getting new stuff in and the challenge of doing some kind of method development and figuring out how to do things," he says. "And on occasion I get to travel for work. That's fun because the jobs I go on are generally pretty complex and require a lot of planning in advance, and when you're out there, there's always something interesting going on."

The work environment at Airtech is another plus of the job. Ogletree says Clark has done a great job of hiring people who all work well together as a team and who are friends beyond the workplace.

"We spend a lot of time together outside of work, and you kind of have

to, because when you travel, you're with these people for a week straight," Ogletree says. "For instance, tomorrow [Feb. 2] we're all getting together to go ice fishing. It's not company-sponsored, but everyone just gets together and we do it as a company, and it's a lot of fun. Pat usually hosts a St. Patrick's Day party. Outside of work, we're just a tight-knit group. We keep each other motivated for that reason. If someone gets down, we pick each other up just because we're good friends."

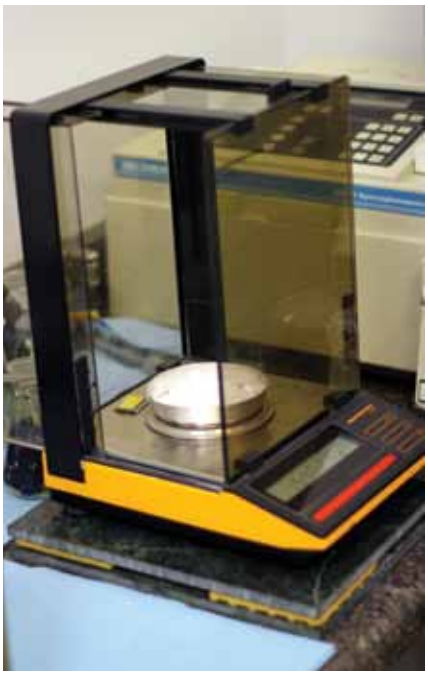
He adds that while the complexity and variety of samples the lab deals with can be challenging, they are also positive aspects of the work.

"I think the challenges are the fun part. As Pat likes to say, 'Everything's routine but not routine,'" Ogletree says. "The analyses are somewhat similar, but there's always something new—it keeps things interesting. I used to do R&D, and it was boring doing the same thing over and over, but here from day to day it's something different. Especially with this expansion into water analysis; it's definitely something I'm looking forward to getting involved with."

That variety means the lab uses many different technologies, including GC-FID, TCD, FPD, FT-IR, UV-Vis spectrophotometry, ion chromatography (IC), gas chromatography, atomic absorption spectrometry, and continuous emissions monitors (CEMs).

Ogletree says the GC is one of his favorite instruments to use.

"I'm pretty fond of our GC—it's just a really robust instrument," he explains. "We travel a good amount, so it gets bumped around, but it has always worked."



Analytical balance used for gravimetric analysis in the Airtech lab.

He adds the lab hasn't seen a huge change in technology since he started, though they have added two GCs, an FT-IR, and several analyzers and are currently in the process of purchasing a GC-MS for the new water analysis lab.

"With the EPA [Environmental Protection Agency], it takes a while to make drastic changes, so there's some technology that's really old, but it's required by the EPA," Ogletree says of why there haven't been too many changes in technology at the lab. "We could get all kinds of crazy new stuff, but we're kind of limited for that reason."

Industry changes and lab outlook

The two new main industry standards, apart from the stack accreditation, that affect Airtech are 40 cfr part 60—the new stationary source performance standard—and 40 cfr part 63, which is an all-encompassing standard for

MAIN INSTRUMENTS:

- MKS FT-IR
- Beckman DU-64 UV-Vis Spectrophotometer
- Dionex ICS-90 Ion Chromatography
- Ohio Lumex Atomic Absorption Spectrometer
- GC-FID
- TCD
- FPD
- CEMs

hazardous air pollutants, Clark says.

"Detection limits have needed to get lower and lower because the limits are tighter and tighter," he adds of the biggest change in the industry over the past few years.

Adding the new water analysis lab is the major change for the lab going into the future and will involve bringing on about five new employees, moving to a larger space, and adding new equipment in around a year and a half, Clark says.

> "Detection limits have needed to get lower and lower because the limits are tighter and tighter."

"I think this expansion into water analysis is really an exciting thing to be a part of right now," Ogletree says about the project. "It's an up-and-coming field with oil and gas drilling and that kind of stuff. It's a major part of what we've been doing recently. It's somewhat of a slow time for us, so we've had a little bit of time to focus on expanding stuff and enhancing capabilities and doing things like that."

Rachel Muenz, assistant editor for Lab Manager Magazine*, can be reached at rachelm@labmanager.com or by phone at 888-781-0328 x233.*

ARE YOU IN THE MARKET FOR A... FUME HOOD?

One of the primary safety devices in laboratories where chemicals are used is the laboratory fume hood. It allows a researcher to work with—but not be exposed to— materials that create toxic fumes or particles when it is properly installed and maintained.

Top 6 Questions You Should Ask When Buying a Fume Hood

1. Can your lab go ductless? Ductless hoods are a viable solution for most routine laboratory applications.
2. What is the hood constructed from and how is it constructed? Will the chemicals you use attack, degrade or physically alter the material of the hood?
3. What types of safety controls are included in the base cost of the unit?
4. Has the manufacturer/distributor gone through a thorough application review process? Does the suggested filtration make sense?
5. How hard is installation? Will there be a future/potential need to move the hood after initial installation? Should the hood be portable?
6. What are the capital, installation and operational costs? From the lab manager's perspective, capital costs are but a fraction of the overall budget.

Top ten features/factors survey respondents look for when buying a fume hood

Durability of product	97%
Performance of product	94%
Ease of use; ergonomic operation	93%
Safety and health features	92%
Low operating costs	91%
Low maintenance / easy to clean	91%
Value for price paid	89%
Total cost of ownership	86%
Service and support	86%
Warranties	84%

Fume hood type(s) currently being used in readers' labs

Conventional ducted fume hood	76%
Laminar flow hood	36%
Benchtop ductless fume hood	19%
Canopy ducted fume hood	18%
Variable air volume ducted fume hood	12%
Down flow workstation	7%
Portable ductless fume hood	6%

Survey respondents are also using the following fume hood-related components:

Airflow monitor	54%
Base storage cabinet	48%
Work surface	38%
Blowers	28%
Digital monitor	19%
Fume extractor arms	10%
Transport support cart	8%
Other	2%

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Value for price paid	89%
Total cost of ownership	86%
Service and support	86%
Warranties	84%

Percentage of respondents who agree with the following fume hood safety statements:

All lab fume hoods have been tested within the past year	90%
Workers using biohazards, toxins and regulated carcinogens have received the proper training	87%
Test labels are properly affixed to all fume hoods tested	87%
Storage in fume hoods is kept to a minimum and doesn't impede proper airflow	87%
Fume hoods containing regulated carcinogens, biohazards and radioactive materials are properly labelled	83%
Samples/specimens/cultures are protected from environment particulars	77%

The frequency of fume hood inspections in respondents' labs

Monthly	11%
Quarterly	15%
Every six months	15%
Annually	49%
Every two years or more	4%
Not applicable	2%
Don't know	6%

Completed Surveys: 236

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

ARE YOU IN THE MARKET FOR... HPLC COLUMNS?

The wide spectrum of columns available makes selecting this most important component of an LC system extremely difficult. Column choices span normal phase, reverse phase, size exclusion, ion exchange, hydrophobic interaction, & affinity chromatography. One is hard-pressed to find a more innovative, self-reflective instrument market.

Top 7 Questions You Should Ask When Buying HPLC Columns:

1. Based on your analyte(s), matrix, separation goals, and instrumentation, what column does the vendor recommend?
2. What benefits does this column offer over your current column? Performance, lifetime, reproducibility, etc.
3. How should you clean/prepare your sample prior to injection on the column?
4. How do you care for the column? Conditioning, cleaning, storage, etc.
5. What type of chromatographic media (fully porous, monolithic, core-shell) is going to provide the most benefit for your separation?
6. Do you need a unique selectivity (HILIC, polar-end capped, etc.) to separate any very polar and/ or non-polar components in your mixture?
7. What column dimension is going to be most suitable for your loading requirement?

Top ten features/factors survey respondents look for when buying HPLC columns

Technical performance of HPLC columns (e.g. peak shape)	**97%**
Ruggedness / durability of HPLC columns	**93%**
Lot-to-lot reproducibility of HPLC columns	**88%**
Initial purchase price of column	**80%**
Reputation of column manufacturer	**71%**
Specials and promotions	**66%**
Applications support	**64%**
Method validation / compliance support	**64%**
Column discount program	**63%**
Breadth of HPLC column offering (Selectivity)	**62%**

The HPLC separation modes being used by survey respondents

Reverse phase	**81%**
Normal phase	**47%**
Ion exchange	**37%**
Hydrophilic interaction (HILIC)	**32%**
Ion chromatography	**21%**
Affinity	**20%**
Chiral	**18%**
Gel filtration (GFC)	**17%**
Gel permeation (GPC)	**16%**
Ion exclusion	**14%**
Other	**2%**

The columns currently used in readers' labs

Analytical HPLC Column	**89%**
Prep HPLC Column	**26%**
UHPLC Capillary Column	**20%**
Fused-Core Column	**19%**
Micro or Nano LC Column	**14%**
Other	**5%**

The types of columns used in readers' liquid chromatography work

Analytical scale (~4.6 mm dia)	**95%**
Narrow-bore (1 to 2 mm dia)	**37%**
Large ID (> 10 mm dia)	**23%**
Capillary columns (< 0.3 mm dia)	**14%**
Other	**3%**

The column phase(s) respondents are using

C18	**75%**
C8	**46%**
C18 (polar endcapped)	**45%**
Silica	**41%**
Phenyl	**38%**
Anion exchange	**36%**
Cation exchange	**31%**
Cyano	**29%**
Amino	**23%**
C4	**16%**
Biphenyl	**14%**
PFP	**13%**
Other	**9%**

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

ARE YOU IN THE MARKET FOR A... CENTRIFUGE?

When it comes to common technology in a laboratory, centrifuges rise toward the top of the list. Centrifuges separate particles and structures suspended in liquid by applying thousands of gravitational force equivalents to the sample through spinning and play a role in a wide range of workflows and applications.

Top 5 Questions You Should Ask When Buying a Centrifuge

1. What is the maximum g-force the centrifuge can generate?
2. How does the company's centrifuge differ from other ones that can do the same speed & capacity?
3. What kind of warranty comes with the centrifuge & what does it cover?
4. If the company discontinues the product, for how many years do they provide accessories and parts for the centrifuge?
5. Ask about cost of the purchase— not just the price of the product being installed but the total cost of ownership including price, service expectations, warranty, etc.

The type of centrifuge(s) currently in use in respondents' labs

Benchtop Centrifuge	67%
Microcentrifuge	58%
Benchtop Refrigerated Centrifuge	54%
Benchtop Clinical Centrifuge	33%
Floor Refrigerated Centrifuge	32%
Floor UltraCentrifuge	25%
Benchtop UltraCentrifuge	23%
Floor Centrifuge	14%
Other	2%

The speed range (RPM) of the centrifuge(s) used by readers

0 - 7,500 RPM	74%
7,500 - 10,000 RPM	43%
10,000 - 15,000 RPM	47%
15,000 - 20,000 RPM	33%
20,000+ RPM	26%

Top ten features/factors survey respondents consider when buying a centrifuge

Reliability	97%
Ease of use	96%
Low maintenance / operating costs	94%
Price	90%
Safety features	88%
Warranty	78%
Service and support	74%
Accuracy	70%
Type of centrifuge rotor	68%
Ease of installation	64%

The typical way labs train staff in centrifuge operation

On-the-job training by fellow worker	89%
Vendors	4%
Have to learn it on our own	4%
Videos, books, etc.	2%
Off-site training courses	1%

The following hazards exist relating to the centrifuge(s) in readers' labs

Physical hazards: Mechanical stress, metal fatigue, and corrosion of the rotor over time	40%
Exposure hazards: Aerosolization of biological, chemical, or radioactive materials	38%
Don't know	30%
Other	6%

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

Completed Surveys: 243

NEW!

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Multiple users. A variety of processing requirements. A range of user experience. To overcome these everyday challenges of a shared laboratory setting choose the **NEW! Thermo Scientific Sorvall LYNX superspeed centrifuge**. With 100,000 x g performance and maximized capacity up to 6 liters. Plus breakthrough rotor innovations including Auto-Lock rotor exchange, Auto-ID instant rotor identification and lightweight and durable Fiberlite rotors that shorten run set-up time and increase rotor security. The result? Productivity, safety and reliability simplified.

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Sorvall LYNX Superspeed Centrifuges
Powerful technologies with breakthrough simplicity

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Push-button security and application flexibility

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Immediate rotor detection and programming

Fiberlite® Carbon Fiber Rotors
Improved ergonomics and performance

TECHNOLOGYNEWS

ANALYTICAL

GC and GC/MSD

7890B GC and 5977A Series GC/MSD

- 7890B GC offers improved performance specifications with advances in numerous detector modules
- GC also features lower operating costs and eco-friendly operation with power/gas management and sleep/wake modes
- 5977A Series GC/MSD enjoys all the benefits of the 7890B GC and features a redesigned inert MS ion source that enhances performance with highly efficient ion collection

Agilent www.agilent.com

PRODUCT SPOTLIGHT

RESEARCH-GRADE CAPABILITIES FOR EVERYONE

PORTABLE RAMAN SPECTROMETER WELL SUITED TO FIELD ANALYSIS

B&W Tek recently launched an enhanced version of its i-Raman® portable Raman spectrometer, the i-Raman Plus. The new portable instrument is powered by the company's smart spectrometer technology.

"The i-Raman Plus is a great step forward," says Dr. Katherine Bakeev, director of applications service for B&W Tek. "It puts research grade Raman spectroscopy into a platform that is accessible to more users. It's ideal for field analysis such as in *vivo* studies of ancient art and archaeology, environmental studies, and even identifying low-dose adulterations in counterfeit products."

The new Raman spectrometer uses a high efficiency back-thinned CCD detector with deep TE cooling and high dynamic range to deliver an improved signal to noise ratio for up to 30 minutes of integration time, making it possible to measure weak Raman signals. It also features a combination of wide spectral coverage and high resolution with configurations measuring out to 4000cm^{-1}, enabling the measurement of CH stretching bands around 3100cm^{-1}. The system's small footprint, lightweight design, and low power consumption mean users get research grade Raman capabilities almost anywhere.

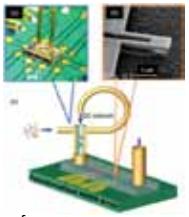
As with all of B&W Tek's products that have smart spectrometer technology, the i-Raman Plus includes on-board processing including averaging, smoothing and dark compensation.

The instrument comes standard with a fiber optic probe, probe holder with XYZ positioning stage, cuvette adaptor for measuring liquid samples, and the company's proprietary BWIQ™ multivariate analysis software.

For more information, visit: http://bwtek.com/products/i-raman-plus/

Gas Chromatography Device

GCAP™



- Flexible, versatile architecture, based on high-density silicon columns and sensors, means GCAP can be configured to perform in a number of different modes, including conventional, multi-dimensional or concurrent analysis
- Features the ability to work with a number of different carrier gases
- Separates and precisely quantifies individual molecules among hundreds of interfering substances, depending on architectural configurations

APIX http://apixtechnology.com

ICP-MS

aurora Elite

- Complements the updated workhorse aurora M90 ICP-MS for routine laboratory analysis
- Sets new standards for sensitivity and matrix robustness
- Exceeds the performance of expensive magnetic sector field ICP-MS systems in many aspects
- Features 1.5 gigahertz per parts per million (1.5 GHz / ppm) sensitivity for precise and accurate quantification at single digit ppt levels and below

Bruker www.bruker.com

Microscope Enhancement

FLS980 and FLS920

- Edinburgh Photonics' FLS980 and FLS920 ranges of photoluminecence spectrometers now include a combined microscope and imaging camera
- Allows measurement of specific points within a sample and for imaging with monochromatic excitation/illumination
- Either upright or inverted microscopes from leading microscope manufacturers can be coupled to the spectrometers via optical fibers

Edinburgh Instruments www.edinst.com

TOC Analyzer

BioTector B3500c

- Designed and engineered to meet the requirements of clean water applications
- Offers process insights, process incident alerts, environmental monitoring, energy optimization, product and water loss prevention, and boiler and plant protection
- Only requires reagent replacement every 6 months
- Able to monitor two streams at the same time, eliminating the potential double-cost of needing two separate analyzers

Hach www.hach.com

NEW STANDARDS IN DECONTAMINATION METHODS WITHIN CELL CULTURE INCUBATORS

Impact of H2O2 Decontamination Technology Over High Heat Sterilization: Increased Efficiency and Efficacy with Significantly Reduced Downtime

By Deepak M. Mistry, Senior Manager, Strategic Development & Marketing and Nehal Kothari, Strategic Marketing & Application Specialist

Panasonic

www.panasonic.com/biomedical

Contamination of cell cultures is easily the most common problem encountered in cell culture laboratories and can lead to very serious consequences. Of all the likely sources, the cell culture incubator has often been considered one of the most probable sources of biological contamination. Many incubator manufacturers have addressed this issue using different types of sterilization technologies. A study was undertaken to determine the effectiveness and efficiency of three industry-leading incubators that utilize different sterilization techniques: Panasonic's MCO- 19AIC UVH with H2O2 decontamination technology that requires 2 hours for its cycle with around 15 minutes of prep time, Brand A with a dry heat sterilization method that takes 10-12 hours for the complete process, and Brand B with a moist heat sterilization method that requires up to 25 hours from start to finish. Five different microorganisms, generally considered the most common contaminants in a cell culture environment, were tested in this study: Candida albicans, Acholeplasma laidlawii, Mycoplasma orale, Bacillus subtilis, and Staphylococcus aureus. At a specific CFU, each organism was placed on both upper and lower shelves of the incubators, which were then allowed to go through their individual sterilization cycle. A time control coupon was also run simultaneously for the same amount of time as the sterilization cycle. Each of the three cell culture incubators showed complete bioburden reduction for each organism. However, Panasonic's MCO-19AIC UVH offered complete organism elimination in 2 hours, as compared to 10-12 hours and 25 hours for Brand A and Brand B, respectively. In addition, a significant reduction in viability was observed for Candida albicans, Acholeplasma laidlawii and Mycoplasma orale when each time control was compared. The Panasonic MCO-19AIC UVH effectively showed a greater bioburden reduction than Brand A and Brand B when the 2 hour time control was compared to the 10-12 hour and 25 hour time controls. This validates the effectiveness with which Panasonic's MCO-19 AIC UVH incubator decontaminates the chamber. For Staphylococcus aureus and Bacillus subtilis, an increase in viability was observed over time when compared to time controls. However, Panasonic's MCO-19 AIC UVH incubator efficiently eliminated all of the bioburden in a considerably shorter span of time without significantly increasing the original concentration of the organisms. The 2 hour uptime advantage offered by the Panasonic MCO-19AIC UVH incubator with 100 % kill rate and at least a 6 log reduction for all the organisms tested, lead to increased productivity in a research or GMP environment.

▲ **MCO-19AIC** UVH

Go to www.SterisonicH2O2.com to download a full version of the Whitepaper.

High Throughput Spectrometers

Ventana

- Combine an optical bench configuration with very high collection efficiency and a high-efficiency volume phase holographic (VPH) grating
- Provide high throughput and sensitivity for low light level applications
- Three preconfigured Ventana spectrometers are available: 532 nm and 785 nm excitation wavelength Raman models, and a visible to near-IR model for general purpose fluorescence applications

Ocean Optics www.elitespectrometers.com

HPLC Sample Evaporators

MiniVap and UltraVap

- Use warm air or nitrogen to speed up the evaporation of common HPLC solvents such as dichloromethane, methanol and acetonitrile from sample vials
- A new 48-well needle head with a dedicated HPLC vial holder that accepts 48 standard 1.5ml vials transforms any MiniVap or UltraVap system into a high throughput HPLC sample evaporator

Porvair Sciences www.porvair-sciences.com

Gas Chromatograph

Tracera

- Provides high-sensitivity analysis of organic compounds, permanent gases and light hydrocarbons with the BID-2010 Plus, a novel universal detector that incorporates plasma technology
- Enables trace impurity analysis with detection sensitivity more than 100 times higher than thermal conductivity detector (TCD) analysis
- Permits ppm-level trace-component analysis not possible by TCD

Shimadzu www.ssi.shimadzu.com

LIBS Desktop Analyzer

ChemReveal

- Uses laser-induced breakdown spectroscopy (LIBS) to provide rapid and reliable identification of materials and chemical composition of solids
- Features real-time chemical analysis
- Equally effective for light and heavy elements analysis
- Provides surface and depth profiling for coatings and is easy to use
- No or minimal sample preparation required

TSI Incorporated www.tsi.com

Charged Surface Hybrid Particle Columns

ACQUITY and XSelect™ CSH130

- Offer unique selectivities for UPLC and HPLC peptide mapping and proteomics applications
- Set a new standard in the analysis and purification of peptides for the quality of information generated by UPLC and UPLC/MS assays
- Available in a variety of particle sizes and column dimensions
- Can be used with a weaker acid modifier such as formic acid

Waters www.waters.com

BASIC LAB

Bulk Handling Enclosures

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- The drum can be raised and sealed to the access port, effectively extending the enclosure's containment area into the drum
- Included access port cover can be used to seal the base, allowing for use as a standard balance enclosure
- Move air in a horizontal pattern to maximize containment while minimizing sample loss and balance instability

AirClean Systems www.aircleansystems.com

Safety Enclosure

Lab-Bubble™

- Can be used to provide many different types of safety or controlled environments simply by using additional components to change the function of the enclosure
- Environment can be controlled for humidity (20-55% RH) using a Nitrogen glove box and temperature (15-30°C)
- Air extraction provided via a small box section fan filtration system

Asynt www.asynt.com

Mass Flow Controller

GF 80

- Now features an increased flow rate up to 50 slpm
- Also now includes a Teflon valve seat, allowing it to be used on all gases, including corrosive and reactive gases
- Has expanded RS485 communication protocols
- Provides excellent long-term zero stability at less than 0.5% per year
- Available with Brooks' patented MultiFlo™ technology

Brooks Instrument www.BrooksInstrument.com

Switching Mode Power Supply

HVPS Series

- Provides precise 1 to 100 kV adjustable output at power levels up to 200 kW
- Featuring < 0.1% ripple and regulation with << 10 joules stored energy, depending upon configuration, this compact unit eliminates the need for connecting multiple smaller units
- Packaged in a 19" W rack that uses tap water for cooling

Diversified www.divtecs.com

Uninterruptible Power Systems

SG® Series

- Now includes 12-year rated valve-regulated lead acid (VRLA) batteries
- Features a dual-conversion, on-line topology that is designed to provide automated systems, instruments, computers and other sensitive electronics superior power protection during a power outage
- Wide-temperature batteries are designed to operate at -20°C to 50°C
- Offers users the latest communications options

Falcon Electric www.FalconUPS.com

Acid-Resistant Evaporators

HT-4X, HT-12 and EZ-2

- For laboratories that wish to use stronger mineral acids and acid chlorides, special models of Genevac systems exist which are specifically designed to be resistant to these highly corrosive acids
- Acid-Resistant EZ-2 Plus Evaporator uses inert and corrosion proof materials to enable it to withstand up to 6N Hydrochloric acid, 70% Nitric acid and most acid chlorides including thionyl chloride

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Overhead Stirrers

Eurostar

- Feature a detachable impeller, digital display interface and the option of monitoring the flow properties and other parameters using labworldsoft® software
- Can process quantities ranging from milliliters up to 200 liters
- Include a removable digital display interface, also called Wireless Controller (Wico), which can operate the unit via Bluetooth wireless technology

IKA www.ika.com

Laboratory Freeze Dryers

Revo® and Magnum® Series

- Feature an all new Clean In Place (CIP) option
- Gives users the option to perform a basic rinse to remove residue material or a full, multi-stage cleaning cycle using detergent, rinses and even hot air drying phases
- CIP systems are capable of 95 to 98% coverage of all internal surfaces

Millrock www.millrocktech.com

Thermal Imaging Camera Kit

OSXL-SC

- Economically priced, compact, rugged and lightweight
- Features plug-and-play compatibility, fast data transfer, wide temperature range and a high sensitivity of <50mK
- Includes everything needed for a quick "out of box" deployment and the kit is designed specifically for thermal benchtop testing applications

Omega www.omega.com

Filter Dispenser

Sentino™

- Simplifies membrane handling and maximizes workflow in high throughput microbiology testing laboratories
- Aseptically dispenses individual membrane filters with a single press on a soft-touch keypad
- Easy-load design ensures highly reliable dispensing in a compact and portable design
- Complements the Sentino Pump and features a 200-membrane capacity

Pall www.pall.com

Turbopumps

HiPace™ 300 Plus

- Available with pumping speeds up to 260 liters per second (300 Plus) or 685 liters per second (700 Plus) for N_2
- Feature reduced and improved vibration spectrum and reduced magnetic stray field
- Suited for analytical applications such as electron microscopy and high-end mass spectrometry
- Improved rotor design gives both high pumping speeds and very good compression for light gases

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HiPace™ 300 Plus

- Available in 23 different models and can achieve temperatures as high as 200°C with temperature stabilities as exacting as ±0.005°C
- Come in reservoir sizes ranging from 7 to 28 liters and are available with six different temperature controllers, including two programmable models
- Incorporate many ergonomic features that make life in the lab more productive and efficient

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Laboratory Homogenizing System

Multi-Prep

- Homogenizes up to 6 samples at a time quickly and with ease
- All samples are homogenized simultaneously in seconds, ensuring accurate homogenizing speed and results
- Precision crafted 316 Stainless Steel Multi-Prep Sample Probes deliver accurate and quick homogenizing results
- Can result in 300 homogenized samples per hour
- Stores up to 10 different homogenizing programs in memory

PRO Scientific www.proscientific.com

Thermal Profiling System

Hyb-Ice

- An affordable and flexible alternative to a standard thermal cycler for performing everyday temperature profiles
- Consists of a programmable heating/cooling base and removable block that heat and cool samples from 4 to 99°C
- Accommodates a variety of quick-change blocks to fit nearly any tube or plate
- Performs PCR in either standard or large volume tubes

SciGene www.scigene.com

CELL CULTURE

Cell and Tissue Acquisition System

Kuiqpick™

- Less expensive and easier for researchers to use in the lab than existing laser-assisted microdissection systems
- Costs less than $30,000 per device, or about one-fourth the cost of existing systems
- Collects cells from tissues and cultures without affecting their viability, meaning the collected cells can then be cultured in the lab

NeuroInDx www.NeuroInDx.com

Untreated Polystyrene Culture Microplates

- Available in 12-, 24-, 48- and 96 well formats
- For growing embryoid bodies and other cells where cell attachment needs to be reduced or avoided
- Natural, unmodified polystyrene surfaces are hydrophobic and only bind cells and biomolecules through passive hydrophobic interactions
- Supplied with lids in individual sterile packs

Porvair Sciences www.porvair-sciences.com

Pre-coated Cell Culture Products

GrowCoat™

- Peptide-coated cell culture products better mimic the *in vivo* environment for enhanced cell attachment and growth
- An assortment of vented flasks, well plates, and dishes are available in three pre-coated options: PureCol® type I bovine collagen, gelatin, and poly-D-lysine
- Packaged and sold in small packs to minimize product waste

Sarstedt www.sarstedt.com

Cell Culture Chambers

x-well

- x-well system consists of slide-based vessels in a range of materials and chamber formats with excellent microscopic properties and chemical resistance
- Slides are available in PCA plastic, glass, and 170μm coverglass fitted with a polystyrene flask or 1-, 2-, 4-, and 8-well chambers
- All slide surfaces are treated for the cultivation of adherent cells

Sarstedt www.sarstedt.com

Plate Heater

- Designed specifically for cell biologists that require accurate and precise temperature control for plates in laminar flow hoods
- Has a defined temperature range suitable for cell biology use (ambient + 5°C to 50°C)
- Maintains a consistent temperature across its surface ensuring all cells, no matter where their location on the plate, are incubated at the same temperature

TAP Biosystems www.tapbiosystems.com

24 Well Cell Culture Kit

RAFT™

- Can produce realistic, reproducible single or multiple 3D cell cultures in physiologically relevant collagen scaffolds
- Could improve the results of a range of cell based assay models including those suitable for *in-vitro* toxicology models
- Packaged individually to give ultimate flexibility
- Allows for the generation of 3D cell cultures using a simple protocol, in less than an hour

Sarstedt www.sarstedt.com

CHEMICALS, KITS & REAGENTS

5-Clone Collagen Antibody-Induced Arthritis (CAIA) Kit

- Designed to induce consistent arthritis more effectively in various mouse strains including CAIA low responder C57BL/6 mice, and a variety of unpredictable knockout and transgenic mice with C57BL/6 (H-2b) or 129/Sv (H-2b) backgrounds
- Produces faster results: Typically severe arthritis is induced within 24-48 hours instead of the four weeks required to induce CIA after immunization with type II collagen

AMSBIO www.amsbio.com

^{13}C-Labeled Internal Standards Certified Spiking Solutions®

- For use in preparation of calibrators and controls of T4-$^{13}C_6$, T3-$^{13}C_6$, and reverse T3-$^{13}C_6$ for monitoring free and total thyroid hormone levels in serum or plasma by LC-MS/MS
- Offer clinical and endocrinology labs the full range of stable-labeled internal standards necessary for accurate quantitation of T4, T3, and reverse T3 using LC-MS/MS methods

Cerilliant www.cerilliant.com

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- Enables the chemist to scale up from small to medium-large quantities while using a benchtop evaporator
- The automatic module Distimatic automatically refills the evaporation flask and discharges condensate
- Exceptional option if the process volume exceeds the volume of the evaporation flask by three times

Heidolph www.HeidolphNA.com

Electric Decapper

Univo DC480

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- Compatible with all Micronic tubes (up to 1.40ml) and also with tubes and caps of other brands
- Enables user to select any rack to decap, without using different adapters for different tube sizes / brands

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PRODUCT SPOTLIGHT

EFFICIENT, COST EFFECTIVE SAMPLE PROCESSING

NEW SYSTEM ELIMINATES THE NEED FOR MULTIPLE INSTRUMENTS

Launched at the 12th Annual Protein Science Week (PepTalk) in January, PerkinElmer's JANUS® BioTx Pro™ automated workstation for improved process development of protein therapeutics is the only workstation that accommodates multiple chromatography modes (column, tip and batch).

That accommodation eliminates the need for multiple instruments, resulting in more efficient and cost effective sample processing, the company says.

"Sample preparation for protein characterization can be a time consuming and tedious process," said Kevin Hrusovsky, president of life sciences and technology at PerkinElmer. "Automating this function frees up valuable research time and enables scientists to obtain critical information earlier in the protein development pipeline. This is particularly important to support quality by design experimentation in both upstream and downstream processes to improve product quality and reduce development time."

The JANUS BioTx Pro enables small scale purification of μg to mg proteins on one system instead of three individual dedicated systems, supporting the use of commercially available plate and column based screening tools such as GE PreDictor™ plates, PhyNexus PhyTip® columns and Atoll columns. Applications for the workstation include resin binding studies and conditions screening, PerkinElmer says.

Users can also expand capacity as requirements for sample throughput increase and the workstation can be combined with PerkinElmer's GX II LabChip to accelerate research and eliminate the need to handle time-consuming SDS Page gels.

For more information, visit: http://www.perkinelmer.com/biotherapeutics

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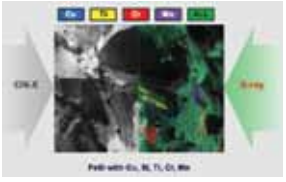

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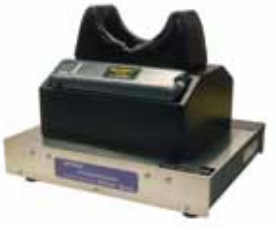

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INSIGHTS ON MASS SPECTROMETERS

A LAB MANAGER MAGAZINE TECHNOLOGY BUYER'S REPORT

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VOLUME 2
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INSIGHTS ON MASS SPECTROMETERS

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

INSIGHTS
LAB TECHNOLOGY BUYER'S REPORT

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MEASUREMENT FOR THE MASSES

One trend evident in science generally, and for laboratories in particular, is the desire to do things faster, more reliably and economically, at a higher level of hardware and method robustness, and all with a less-specialized workforce.

"Years ago, MS operators had post-graduate degrees in spectrometry and significant experience," comments Andrew Tyler, field technical sales leader for mass spectrometry at PerkinElmer (Waltham, MA). "Users had to be jacks of many trades, with knowledge of chemistry, electronics, and mechanical repairs."

Tom Szarzynski, director for North American service at AB Sciex (Framingham, MA), recalls tuning parameters set by hand-turned knobs, with settings marked in pencil. Walk-up operation was strictly forbidden. "Operators didn't let you near the instrument," Szarzynski recalls. Those days and their legacy are mostly gone, the only exceptions being university research and some very high-end instruments.

As MS instrumentation became more modular, reliable, smaller, and less expensive, as applications became more complex, and as the user base evolved from experts to generalist scientists, the role of service and support changed. Users now are more likely to be technicians than Ph.D.s, a sign of the times for the analytical instrument industry.

"As MS gains in popularity, users discover and develop more applications and methods."

▲*LC/MS/MS System / TripleTOF™ 4600 / AB SCIEX / www.absciex.com*

Tyler views instrumental analysis as consisting of three components: the sample's metadata, the analysis, and post-experimental data. Integrating and balancing these three components is critical for success.

Metadata incorporates data on sample origin, who generated it, and the operations it has undergone. Software and user interface, which facilitate data capture, must be straightforward and accessible. One could envision mass spectrometers becoming black boxes—the sample goes in, the MS does its thing, and data emerges appropriately tagged. The final component involves getting the data back to the person who requested the experiment in a form suitable for report generation, archiving, sharing, and annotation.

As MS gains in popularity, users discover and develop more applications and methods. Tyler calls this "good news for vendors" because it expands their instruments' application base. "It's also a challenge to support applications that people need within the context of maintaining the balance between metadata, analysis, and data handling. What the instrument does with the data, how it's distributed, and how it's retained is as much a challenge as the analytical part. If you can't meet the client's expectations in that third phase, nobody is going to buy your instrument."

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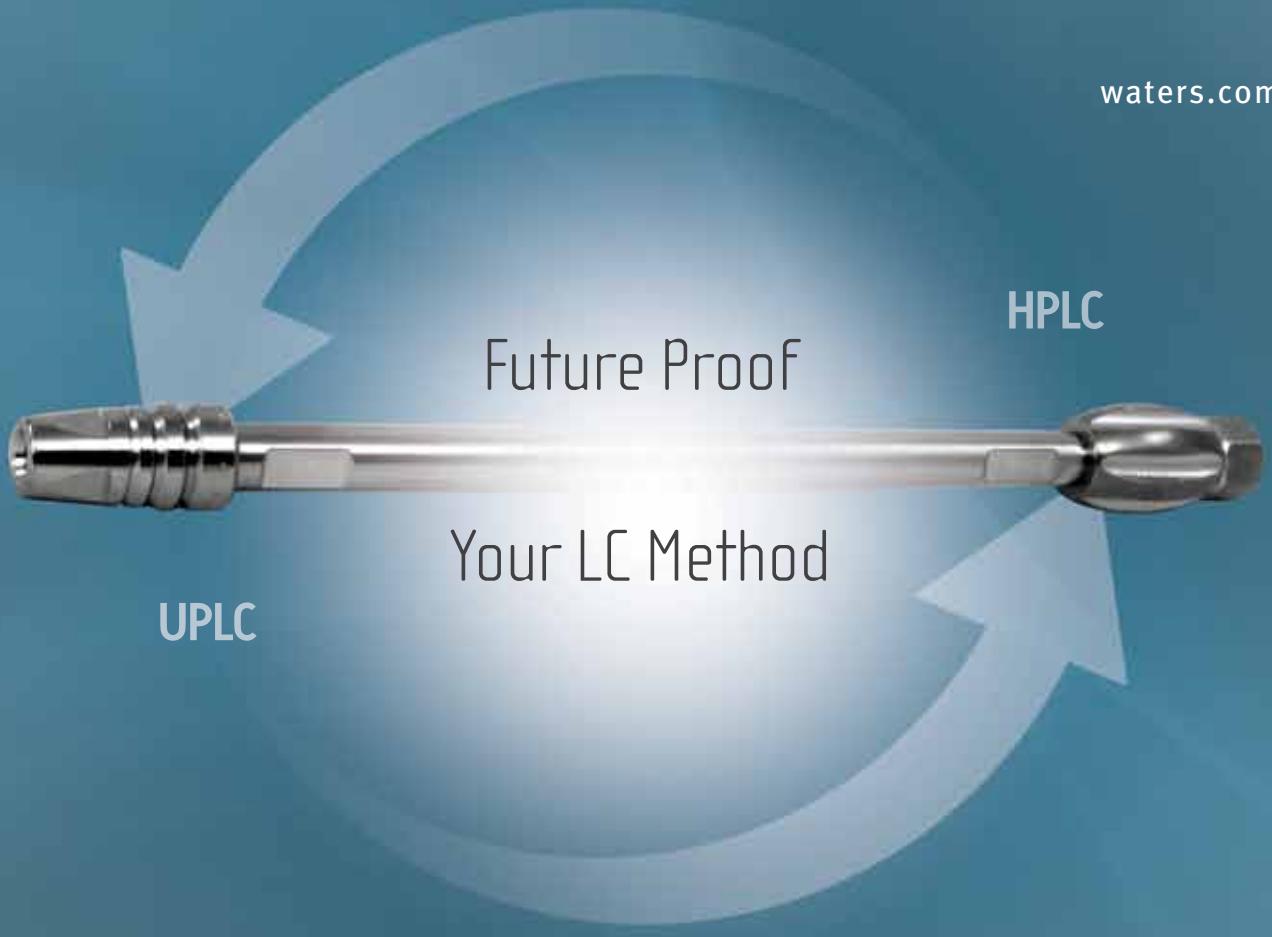

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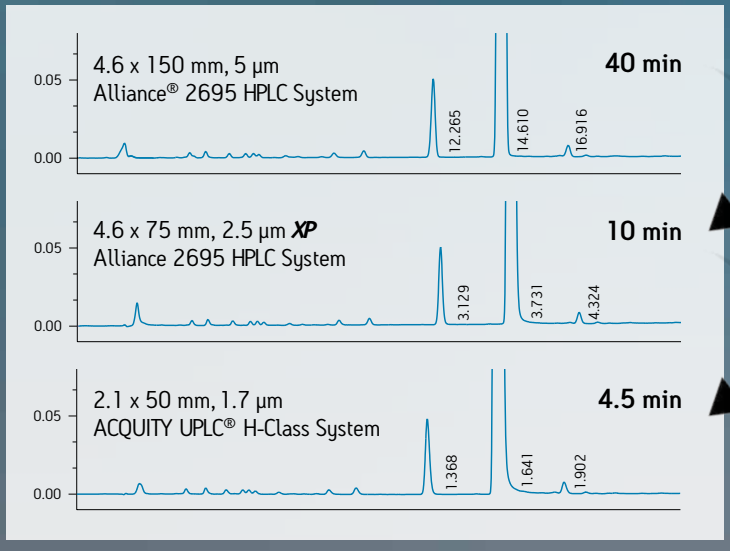

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"The democratization of MS … would not be possible without computerization and the instrumentation's shrinking footprint."

Employing MS as a chromatography detector has been the most significant factor in the acceptance of MS in industries and applications where MS had not traditionally played. The second driver has been the simplification of MS, chromatography instrumentation, and systems combining both techniques. Instrumentation has become easier to use, and user interfaces more accessible, which has further popularized MS in both stand-alone and detector modes. "Walk-up" or open-access operation, while not yet universal, is gradually becoming the norm for many applications. Whether the disappearance of specialist-experts has fueled these trends or the other way around is difficult to say.

The democratization of MS, and its adoption as a detector for GC-LC, would not be possible without computerization and the instrumentation's shrinking footprint. Thirty years ago, computers were uncommon and less powerful than today's calculators are, and mass spectrometers sprawled across an entire room. Since instruments were rare, it took days to get data back.

One aspect of simplification has been the design of MS systems around markets, applications, and workflows rather than generic mass analysis. Workflow-dedicated instrumentation relieves analysts of most of the burdens of method development and many validation tasks as well, while eliminating lab-to-lab variability. Instead of requiring users to extract results from complex instrumentation, the burden is now on instrument designers to introduce spectrometers that resemble appliances in their operation more than instruments.

▲ *GC-MS / GCMS-TQ8030 / Shimadzu / www.ssi.shimadzu.com*

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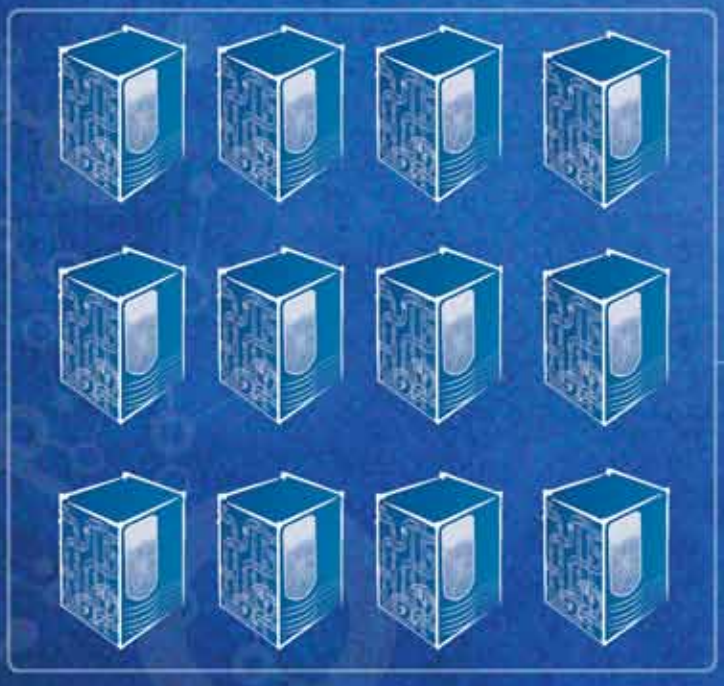

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INSIGHTS ON MASS SPECTROMETERS

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WHAT TO EXPECT

Because modern mass spectrometers are based on solid-state electronics, they do not suffer from the mechanical and electronic problems of yesterday's instruments. Solid-state electronics, the "shrinking instrument," and robust dial-up methods have eliminated yesteryear's high level of specialization and the obligatory doctorate in spectrometry. MS has reached the point where walk-up operation is common, and the instruments are frequently viewed as "just another detector" for GC and HPLC.

The role of an MS lab manager has similarly changed. When MS skills were concentrated within large core laboratories, MS managers possessed many skills, but their responsibilities were geographically limited. Managing

> "Today, MS may occur in three different buildings, across ten labs, for biology and chemistry."

and controlling activities was straightforward. (This goes for other instruments that have been "democratized," such as nuclear magnetic resonance spectrometry, elemental analysis, and to an extent even HPLC.)

"Today, MS may occur in three different buildings, across ten labs, for biology and chemistry," Andrew Tyler explains. Management of MS instrumentation has become decentralized, if one specialist/manager exists at all. The burden of caring for instrumentation and guiding end users falls onto group leaders, who by necessity must rely on the vendor's customer support.

Tyler also sees a generational change based on what he calls the "instant message generation." We've heard this before with regard to complex instrumentation. "But most software from mass spectrometer vendors has not begun to incorporate the sort of thinking that allows users to scan bar codes from samples in one room onto a handheld device, and upload the list to an instrument in another room." Sample data is most often still typed into a spreadsheet or database.

➤*ICP-MS Cone Protectors / ConeGuard™ / Glass Expansion / www.geicp.com*

According to Tom Szarzynski, the top service-related issue today is an unintended consequence of instrument sensitivity and stability. "It doesn't take much to dirty up the source, which is where ionization occurs. The majority of those service calls require only a thorough cleaning and recalibration." Szarzynski recommends at least two preventive maintenance visits per year, and ongoing routine care for high-throughput laboratories whose spectrometers are working constantly.

WHAT CAN GO WRONG?

Introducing too much sample is one source of contamination. Everyday usage and complex matrices that have not been properly prepped are two other potential causes. But for LC-MS, the HPLC eluent itself, containing acids, bases, and salts, poses contamination risk.

While service groups are ready to perform necessary and even routine maintenance, labs would do well to train users and mid-level personnel in first-line or "triage" maintenance, which minimizes downtime for many routine problems. Users can be trained to remove the source assembly, clean it, and reinstall it. "Regardless, some customers are so busy they call us in even for routine problems," Szarzynski says.

> "Labs would do well to train users and mid-level personnel in first-line or "triage" maintenance."

Aside from electrical power, MS does not have a very large environmental or consumables footprint. This trend will continue as spectrometers' physical size shrinks. "Every vendor is looking to reduce the space taken up by mass spectrometers," Szarzynski admits. "Except for the design of research-grade instruments, every manufacturer is trying to achieve benchtop size. However, vendors will compete as always on performance characteristics such as mass range, speed, and the switch from ion trap to quadrupole detection. Those are the big difference makers."

Cost of ownership, which includes work lost through downtime, is always a consideration when investing in MS. Spetrometers have historically been prone to breakdowns and extensive maintenance requirements. Even today, sensitivity improvements often occur at the expense of robustness.

But current breakthroughs have made instrumentation more reliable, according to Erik Hansen, VP of commercial operations at IONICS Mass Spectrometry Group (Ontario, Canada). Nevertheless, the "black box" nature of MS will always demand comprehensive service and maintenance, although not everyone is happy about that.

"The cost of service contracts is often questioned," Hansen says, "but service contracts have several advantages. They carry guarantees on downtime and service response times, plus response prioritization when necessary."

One option to consider when uptime is important is the cost-benefit of on-site maintenance personnel. This can lower the cost of ownership by limiting outside service calls and reducing overall downtime.

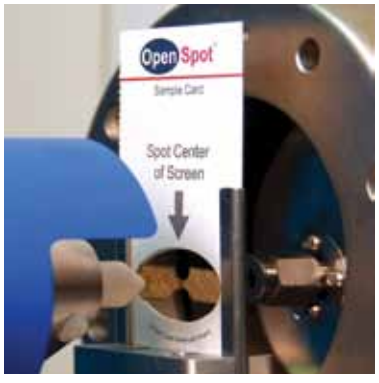
"Cost of ownership goes well beyond the initial capital outlay," Hansen advises. "Evaluation of new instrumentation should include understanding the vendor's commitment to service, customer support, training, retraining, and methods development."

▲ *GC-MS Connector / SilTite™ µ-union / SGE Analytical Science / www.sge.com*

INSIGHTS ON MASS SPECTROMETERS

CRITICAL ANALYTICAL WORKFLOW COMPONENT

"APCI has been known since the early 1980s but is emerging as a popular approach to MS."



▲ *Mass Spectrometry Source / DART®-OS / IonSense / www.ionsense.com*

▲ *MS Syringes / Diamond / SGE Analytical Science / www.sge.com*

Sample preparation reduces sample complexity and renders samples into a format amenable to downstream analysis. Sample prep is most necessary for complex, multicomponent samples containing substances that interfere either with the MS (e.g., through ion suppression) or, in GC/LC-MS, the chromatography. Interferences are common in biological samples due to the large molecular diversity and wide concentration dynamic range. Prep is also required for foods (due to their complexity) and environmental samples (low concentration target analytes).

We often hear of chromatography being the "prep" step for LC/GC-MS, but that is only partly true. As Vivek Joshi, Ph.D., senior research scientist at EMD Millipore (Danvers, MA) notes, prep is often required even with chromatography as the first step. "In fact, really complex samples might require multiple sample preparation techniques for enriching particular components. On the other hand, with simple particle-free solutions, 'dilute and shoot' methods might work as well."

Some MS techniques require less rigorous sample prep than others.

Atmospheric-pressure chemical ionization (APCI) has been known since the early 1980s but is emerging as a popular approach to MS. In APCI, samples are ionized directly from HPLC effluent, without splitting off a large fraction to waste. In this technique, the mobile phase is heated above 400° C, and swept by a nitrogen flow into an ionizing corona discharge at atmospheric pressure vs. the high vacuum required by other ionization methods. Unlike more common electrospray, ionization occurs in the gas phase. APCI allows the use of nonpolar HPLC solvents. On the downside, this technique involves hard ionization, resulting in more fragment ions.

According to PerkinElmer's Andrew Tyler, modified APCI-like techniques also allow the direct analysis of organic molecules from dry or solid samples. "You can basically wave a sample on a dipstick in front of the machine and generate data from it. APCI is great for seeing if your compound is there or not, without running chromatography."

Numerous papers have been published on APCI for direct MS measurement of a wide range of analytes with little or no sample preparation. Quantifying drugs of abuse on currency, cholesterol variants from dry blood spots, plasticizers in toys, plasma drug levels, and chemical warfare agents are just a few of the possibilities. Matthias Jecklin at Switzerland's ETH Zurich wrote in *Rapid Communications in Mass Spectrometry* that a variant of APCI was "a powerful high throughput tool for the investigation of very low amounts of pesticides in fruit juices and on fruit peel/vegetable skin."

Because it is a rapid technique, APCI is an excellent screen for the presence or absence of target analytes. Samples that come back positive could then be subjected to corroborative GC-MS or HPLC-MS afterward.

In MS or GC/LC-MS, the sample preparation method must match the workflow as well as the analysis objectives. For example, prep can easily become a bottleneck when conducting rapid MS methods. "If your sample prep isn't rapid and convenient, you lose the benefit of rapid analysis," observes Robert "Chip" Cody, Ph.D., Mass Spectrometry product manager for JEOL (Peabody, MA). Laboratory automation (dispensing and labware handling) relieves this bottleneck and provides consistency as well.

In contrast to ambient ionization methods, techniques such as electrospray and MALDI (matrix-assisted laser desorption/ionization) require sample prep to remove interferences from salts. Many kits and consumables on the market have been designed for specific matrices such as pond water or biological fluids. Analysts employ solid phase extraction, microextraction fibers, and related products consisting of pipette tips and chromatography media. Even with DART™ (direct analysis real time), it often makes sense to remove the matrix before introducing the sample.

Because of its gentle ionization, MALDI is widely used in biomedical research. For example, scientists at University Hospital (Essen, Germany) use MALDI-TOF to identify bacteria in urine in 30 minutes. MALDI's kid-glove treatment preserves the bacterium's ribosomal proteins, plus lipids and polysaccharides.

"MALDI-TOF MS results are independent of assumptions about the putative genus of your isolate," lead researcher Dr. Frank Mosel explains. "You can use the very same protocol for any sample, which is not true for standard methods. And the MS method is very fast and inexpensive."

Sample prep for MS is a deep subject since so many permutations of samples, matrices, ionization techniques, and MS detector combinations are possible. Generally, sample prep needs to serve overall workflow objectives, which encompasses basic objectives in MS: to provide a sample that is appropriate for the analysis.

When JEOL introduced DART in 2005, the company touted the technique as one that required little or no sample preparation. "We found many interesting applications for DART," comments Robert Cody. "But after several years of trying to run everything that way, we modified our position." JEOL currently holds that the right sample preparation method for the analysis objectives, even with DART, provides analysts with the best "mileage" from MS.

DART is a plasma ion source that strips surfaces of analyte ions and sweeps them into the spectrometer. Analysts place raw samples into the ionization chamber where analytes are protonated. Anything qualifies as a sample: a shred of plastic, a fork, a swab from a fruit or piece of meat, a pharmaceutical tablet—as long as it fits within the gap between the source and the MS inlet. An interesting demonstration of DART ionization can be found at http://bit.ly/YkVMhP.

Two other ambient ionization techniques have been commercialized. DESI (desorption electrospray ionization), which resembles conventional electrospray ionization, also works with nonconventional substrates and requires minimal sample prep. LAESI (laser ablation electrospray ionization), developed at George Washington University and commercialized by Protea Bio (Morgantown, WV), generates 2-D maps of surfaces, including biological samples.

> "Prep can easily become a bottleneck when conducting rapid MS methods."

Many MS methods can proceed without sample prep with DART "ambient ionization" ion sources. "Nevertheless, sample prep can greatly expand the applications of the source and the benefit of rapid analysis with DART is not lost if the sample prep is rapid, inexpensive, and convenient," according to Robert Cody. "We have found benefits in combining techniques such as solid-phase microextraction and in-situ derivatization with DART."

▲ *Ultrapure LC/MS Reagents Optima® / Acros Organics (Thermo Fisher Scientific) www.acros.com*

LATE BLOOMER NOW A DRIVER

Pharmaceutical and biotechnology companies have become leading MS customers. Because they work with human and test animal biological fluids and low-dose drugs, sample preparation takes center stage. Many of these workflows are automated for both sample and standards preparation.

More critical with respect to MS instrument providers are the changes that these "sweet spot" industries are undergoing. Companies are reorganizing, merging, and outsourcing many of their traditional competencies like R&D, particularly the analysis-heavy "bookends" of pharmaceutical development: early-stage discovery and the management of clinical trials. "Their entire business model is evolving, not just the analytical part," comments PerkinElmer's Andrew Tyler.

Off-shoring and outsourcing have become a regular part of life science businesses, particularly with the emergence of R&D centers in Asia and central and eastern Europe. Instrument vendors need to embrace global tendencies related to language, corporate culture, and user experience levels.

Nearly every large pharmaceutical company today outsources preclinical testing to contract research organizations (CROs), many of them American. The challenge is that CROs tend to hire technician-level workers to carry out basic assays. Decisions based on test data occur elsewhere.

This presents the obvious challenge of creating interfaces that are intuitive and approachable by lab technicians. It also presses vendors to improve data handling, distribution, and storage since decisions are often made on data generated half a continent away, or even overseas. To meet these challenges, information technology groups at the sponsor and CRO must reach common ground with respect to data accessibility.

The high end of the instrument portfolio is where adoption of accurate mass, high-resolution systems operate for complex research in proteomics, metabolomics, and molecular biology. Biomedical research has emerged as another leading growth area for MS, particularly for systems biology, which unravels labyrinthine biological regulatory pathways involving the expression of genes, proteins, and small molecules, and their chemical communication.

Tandem methods like LC-MS can quantify and characterize putative therapeutic proteins long before a company commits to an expensive development program. During early-stage biological drug discovery, investigators screen hundreds of "clones"—lineages of identical cells—for their capacity to produce proteins in the correct form and commercially meaningful quantities. LC-MS now routinely delivers data on subtle differences in key transformations after a cell expresses a protein, known as "post-translational modifications."

▼ *Triple Quadrupole LC-MS / 8040 / Shimadzu / www.ssi.shimadzu.com*

◀ *GC-MS / SCION TQ™ / Bruker / www.bruker.com*

BACK END TO GC, LC

MS originated as a stand-alone technique for volatile compounds. Next came the ability to volatilize high molecular weight materials through heating. The emergence of electron-impact ionization MS was a natural, as GC analysis requires volatilization. Furthermore, derivatization enabled GC analysis and hence MS as well, even on high molecular weight molecules containing several polar functional groups.

Early spectrometer detectors for GC were large magnetic sector instruments. They worked well for the time, but they were large, difficult to maintain, and their spectrum acquisition was slow, particularly in high-resolution mode. "The marriage of GC and magnetic sector instruments was never very comfortable," comments Ian Jardine, chief technology officer at Thermo Fisher Scientific (San Jose, CA).

To the rescue came quadrupole MS, which was more compact and faster-scanning than magnetic sector spectrometers. Quads took off because they were sensitive, could keep pace with chromatography peaks, and gave quality spectra. Various improvements occurred during the 1980s, when Hewlett-Packard (now Agilent) could advertise a compact GC-quadrupole MS system for around $50,000. "HP revolutionized the GC-MS business because the price and performance were right for applications of the day," Jardine says.

"Quads took off because they were sensitive, could keep pace with chromatography peaks, and gave quality spectra."

By the 1990s, liquid chromatography was coming into widespread use. LC's strength is its ability to separate nonvolatile compounds without derivatization. A challenge in coupling LC with MS was that LC's complex buffer components deposited within the MS instrument. With the discovery that volatile mobile phases (e.g., ammonium acetate) did not foul MS instrumentation, the world appeared finally to be ready for LC-MS, but the lack of a suitable ionization method thwarted these efforts.

Momentous was the advent of electrospray ionization (ESI), for which John Fenn received the chemistry Nobel Prize in 2002. In ESI, the pressure drop from atmospheric to vacuum, with the addition of some heat, causes solvents to evaporate, leaving behind only the charged analyte.

The main drawback of ESI single quad systems is they do not induce fragmentation; hence, they are unsuited to structural analysis. Electron impact, by contrast, may or may not show a parent ion, but always provides fragmentation. The solution was to use multiple MS dimensions: The first quadrupole for parent ion selection, the second to fragment the analyte through interaction with a collision gas, and a third for detection. Hence, the term "triple quadrupole" or triple quad.

"LC-triple quad was a huge development because it provided separation by LC, high sensitivity ionization, molecular weight information, and structural information through fragmentation," says Jardine, who estimates that half of all LS-MS setups in the life sciences are triple quad systems. The technique significantly improves signal to noise and limit of quantitation. "It came along just in time for pharmaceutical companies working with potent, low-dose compounds."

The next major advance, in the 1990s, was quadrupole ion traps, which found greater application in LC-MS than GC-MS. Developed by Thermo, ion traps sequester ions for a time and permit both molecular weight determinations and fragmentation in a single device. With their small size, sensitivity, and fast scanning, ion traps became the instruments of choice for peptide sequencing.

High-resolution accurate-mass techniques were a subsequent game changer. Most elements possess a positive or negative molecular weight deficit relative to their nominal atomic masses. Thus, oxygen's nominal atomic weight is 16, but its actual mass, based on carbon's molecular weight of 12.0000, is 15.9994. MS instruments capable of mass resolution to about 5 ppm—four or five decimal places—can therefore provide not just accurate parent and fragment masses, but elemental composition. "When people talk about high resolution, they're actually referring to accurate mass MS. The high resolution part is how you get to the accurate mass part," Jardine explains. Since the early 2000s, accurate-mass MS has been available for fragments as well as parent ions. Quadrupole time-of-flight (QTOF) MS exemplifies this capability.

▲ *MS Detector / Flexar SQ 300 / PerkinElmer / www.perkinelmer.com*

▲ *Benchtop LC-MS System / Exactive Plus / Thermo Fisher Scientific / www.thermoscientific.com*

Further, more recent developments were the introduction, by Thermo in 2003, of Fourier-transform MS (FTMS), which surpassed any competing technology in resolution and mass accuracy. Two years later, Thermo replaced FTMS and its huge superconducting magnet with Orbitrap technology that, in addition to higher resolution and mass accuracy, was quantitative.

While GC-MS instrumentation is pretty much settled, at least for now, Jardine sees the evolution of LC-MS continuing. "Techniques like QTOF and Orbitrap will become smaller and more affordable. Just as single quad became a no-brainer for GC-MS, LC-MS/MS will become the standard for what people expect in an LC detector, that is, a black box." The adoption of LC-MS in clinical diagnostics will also drive this trend, Jardine says.

> "LC-MS/MS will become the standard for what people expect in an LC detector, that is, a black box."

A Q&A WITH SELECT MASS SPECTROSCOPY EXPERTS

OUR EXPERTS:

Kevin Soulsbury, Ph.D.
Instructor, Department of Chemistry
British Columbia Institute of Technology
Burnaby, BC

Shaun Loeffelman
Senior Analytical Chemist
Evans Analytical Group
Maryland Heights, MO

Suraj Saraswat, Ph.D.
Post-doctoral Fellow
Indiana University
Bloomington, IN

Chris Singleton
Scientist
Momenta Pharmaceuticals
Cambridge, MA

Q: Do you use MS as a stand-alone technique or as a detector for LC or GC? Describe the types of MS analyses and experiments you run.

A: **Kevin Soulsbury:** I use both GC-MS and LC-MS. In a college setting, most of the experiments I do are education-related, for example, scan/SIM mode analysis, basic introduction to LC-MS and GC-MS, and differences between ESI and APCI in LC-MS. We carry out simple quantitative analyses using internal standards, amino acid determinizations using the Phenomenex EZfaast kit, and theoretical experiments involving TOF-MS. We also occasionally work with other collaborators on a variety of GC-MS and LC-MS projects typically related to herbal or food analysis.

Shaun Loeffelman: I use the MS as a detector for GC. Full scan and selective ion monitoring (SIM) modes are used in analyses. Our experiments employ MS for both qualitative and quantitative purposes. For instance, MS identifies analytes in unknown samples, as well as analytes in complex matrices. We have used the MS as a detector for leachable chemicals in toys; to measure contaminants in food, packaging, and consumer products; and to identify components of off-odors, off-flavors, or foreign particles.

Suraj Saraswat: Most of the time, we use MS as a detector for LC separation. We separate peptides or proteins using 1-D or 2-D LC, and identify and characterize the contaminants through MS. We work on identifying labels on proteins and the extent of labeling.

Chris Singleton: We use MS as a detector for both LC and occasionally for GC. We use LC-MS for biopharmaceutical analyses, studying peptides and proteins and their modifications. Our instruments run the gamut from single quadrupole to triple quadrupole/QTrap, TOF and Q-TOF, orbital and linear traps, and ion mobililty, so we have all of the common mass analyzers. Most of the techniques employ ESI, every now and then MALDI, and on rare occasions I will use APCI when analyzing relatively nonpolar small molecules. For GC-MS it is almost exclusively EI with a single quad.

Q: How important is software and user interface in your MS work? How can vendors of MS or LC/GC-MS systems improve software and interface?

A: **Kevin Soulsbury:** BC Institute of Technology aims to introduce students to instruments, so when they enter the workplace they will understand MS workflows. In that regard, software vendors must consider the differing needs of industry and academia. For example, we need to tabulate results more easily, without setting up complicated templates.

Shaun Loeffelman: Software is very important in MS work because it processes data. User-friendly interfaces make data processing easier. Making data output, storage, and retrieval easier and more versatile among versions of software and operating systems would help in this regard.

Suraj Saraswat: Software that is easy to use and implement is critical. Sometimes, you have to move from one vendor's instrument to another's. Entirely different software that is difficult to use raises concerns. Software must be self-explanatory, and interfaces should provide easy access to this software.

Chris Singleton: They are extremely important to me. I have made specific purchase recommendations based on software that was usable and easy to navigate. The software impressed me as much as the physical specs. Few things are more frustrating than a great machine hobbled by poor software. In addition, reliable batch processing takes the tedium out of data processing and instrument maintenance (tuning, calibration, etc.).

Q: Please list and explain the top two factors you consider when purchasing or specifying MS instrumentation, and explain your answers.

A: **Kevin Soulsbury:** A big factor is the likelihood that a student will encounter systems similar to teaching instruments when they enter industry. The other factor is local service and support. Ironically, because our instruments are not used 24/7 we tend to have more service issues than one would expect for instruments in continuous use. Local service and support help us maintain less-frequently-used equipment.

Shaun Loeffelman: Reliability and sensitivity are the top two factors I would consider when purchasing a spectrometer. Customer support and experience in the industry would also help to influence my decision in which manufacturer to choose.

Suraj Saraswat: Service is extremely important. Sometimes brand new instruments cannot be made to operate correctly. If representatives come and set up the instrument, you might need them back again sooner than expected, so they should be available for on-site or over-the-phone service whenever necessary. Also, for some reason some instruments work better for one type of application than for another. Users must therefore select instruments that best suit their application, for example, fragmentation.

Chris Singleton: Software is one factor that makes tasks easier and more efficient. Also reliability. I have used many great research-type machines in the past, but I get tired of having to fix or modify them. At this point, I want an MS that just functions reliably and is a workhorse. I can't spare the downtime that comes from getting anything but a reliable machine.

Q: How can instrument vendors improve the MS analysis experience?

A: **Kevin Soulsbury:** Include more applications when instruments are introduced rather than releasing instruments without application support. Vendors should realize that the educational market is a way to introduce their brand to future users and purchasers.

Shaun Loeffelman: Vendors could offer hands-on demonstrations of their instruments so those in the field could get a better understanding of their instruments' capabilities.

Suraj Saraswat: Software could be more user-friendly, with more detailed online help functions. These days, more emphasis is on sensitivity and automation with higher resolution and mass accuracy. So, it would be good if they could come up with an MS instrument with all these characteristics that is also not too expensive.

Chris Singleton: I realize it's hard for vendors to push software, since users are more interested up front in the hard specs like resolution, mass accuracy, and linearity. But once the machine is installed, you understand the importance of software.

FUTURE: THE SHRINKING MASS SPECTROMETER

Q&A WITH DAVE RAFFERTY, PRESIDENT AND CTO AT 1ST DETECT (HOUSTON, TX)

Scientists from Sandia National Laboratory reported, in 2005, a microfabricated mass spectrometer-on-a-chip. This was followed by a report, in Nature Nanotechnology, that researchers at the California Institute of Technology had used nanoscale technology to create a microscopic "spectrometer" with single-molecule sensitivity. (See our May issue for a report on Microsaic's introduction of a chip-sized MS).

These inventions will require macro-scale interfaces and other components, and are years from commercialization. For now, we must be satisfied with miniaturization that is more in line with conventional instrumentation.

Last year 1st Detect introduced the first commercially available version of its MMS-1000™ Miniature Mass Spectrometer. Conceived as an industrial instrument, the MMS-1000 provides rapid MS/MS detection for airports, border security, military, agricultural, and process control markets—all in a package measuring 7.5 x 12.5 x 9 inches.

Q: Mass spectrometers used to be gangly, sprawling instruments. What does it take to shrink an MS?

A: In short: engineering know-how, a lot of clever tricks and ideas, hard work, and not knowing what isn't supposed to be possible. 1st Detect is a spin-off company from an aerospace firm called Astrotech Corp. Many of our engineers have aerospace design experience working with NASA and therefore have experience producing designs that had to be small, lightweight, and reliable. We have carried this experience and engineering discipline into our mass spectrometer design. Actually, our mass spectrometer was originally intended to be an air monitor for the International Space Station, but we realized it had huge potential here on Earth. Having a predominately aerospace background, our company has not had its design methodology bounded by the phrase "that's the way it's always been done," which I frequently hear in the mass spectrometry world. Also, keeping things small usually means keeping them simple. It has also helped to have had our early development guided by Dr. Guido Verbeck from the University of North Texas, who is a pioneer in mass spectrometer miniaturization.

Q: What are the limits of miniaturization for MS?

A: Our central component, the ion trap, is smaller than a thimble. It's actually the supporting components, such as vacuum pumps and electronics, that limit the size. In the future, with different pumping technology and highly integrated electronics, a mass spectrometer like ours could be as small as a cell phone.

Q: Are mini spectrometers fated for use as sensors, or will they find broader application?

A: The most exciting aspect of a miniature mass spectrometer is the breadth of potential uses that have yet to be developed. The uses seem endless. The examples include keeping our borders safe, optimizing power plant efficiency, making products more consistent and safe, and diagnosis of diseases like diabetes and cancer from a mere breath sample.

ANALYTICAL BALANCES

PRECISION, RANGE, AND STABILITY ARE MAIN CONSIDERATIONS

by Rachel Muenz

So, you're thinking of upgrading your analytical balance. Should you purchase the latest and greatest model or just repair your current instrument? It all depends on a variety of factors, but there are some major signs that it's probably best to buy a new instrument.

"There are several performance related warning signs that indicate a balance may need repair or replacement," says Tom Delano, vice president of business development at Adam Equipment (Danbury, CT). "Oftentimes replacement with a newer product is a better decision than repair."

One sign that could mean it's time for replacement is that the balance is unable to hold calibration, needing re-calibration after very few weighing tasks. If the displayed results drift up or down, jump for no apparent reason, or are consistently unstable, that's another indication that it's time to consider purchasing new equipment.

"Another reason to upgrade may be that the lab's weighing needs have changed," Delano says. "Perhaps the users could benefit

◀ Shimadzu AUW analytical balance.

◀ Adam Equipment PW analytical balance.

du•plic•i•ty (doo' plisitē) *n.* deliberate deceptior

du•ra•ble (door'ə-bəl) *adj.* Able to withstand wear, pressure; hard-wearing.

du•rance (dŏŏr'ens) n. confinement or restraint by force; imprisonm

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from more advanced features such as up-to-date data communication interfaces, statistical calculations, storage of readings, and product identification codes."

Gilbert Vial, physical measurements product manager, Shimadzu Scientific Instruments (Columbia, MD) adds a few other signs users should look for:

"Depending on the laboratory environment and how the balance is being used, the range and precision may not be sufficient," he says. "In addition, there may be signs that the stability and repeatability are no longer accurate. Finally, integration to a computer may be necessary and there may be definitive signs of corrosion."

However, if a user's current analytical balance performs well, holds calibration, has adequate range and precision, requires minimum maintenance, shows no signs of corrosion, and the user is certain they have no use for more modern features such as current computer interfaces, statistical calculations or data storage, upgrading is likely unnecessary, Delano and Vial say.

Delano notes the main benefits of upgrading are that the newest balance technologies allow labs to be more productive and cost efficient through improved processing speed and faster results. Upgrading also keeps labs on the cutting edge, he adds.

"Balance manufacturers continually introduce new products with updated features and capabilities driven by market needs and wants," he says. "Most labs need to stay current with procedures and more than ever, data collection and traceability. Periodic balance upgrades ensure the lab has the ability to conduct business as needs change."

To that list of benefits Vial adds improved precision, range, and stability.

"These are all important factors when utilizing an analytical balance," he explains. "Another benefit is the ability to transmit data to a computer seamlessly."

As with upgrading most lab equipment, the only main drawback to upgrading a balance is cost, but the price of a new balance is low compared to the expense of upgrading most other lab instruments, Delano says.

The only other con of upgrading Vial could think of was the relatively minor one of getting used to a new instrument.

"Adapting to anything new will take some time, especially if using a different manufacturer," he notes.

There are drawbacks to postponing an upgrade, including the potential to be less productive than labs with newer equipment. Manual data collection and analysis are time consuming and allow human error, Delano says.

ADDITIONAL POINTS TO CONSIDER BEFORE PURCHASING:

- If your lab isn't using automated data collection now, will it be in the near future?
- Is workload going to increase thereby requiring more samples to be measured in the same time?
- Would a new product with updated features be useful in another area of the facility? Would it help distribute the workload?
- Is an upgrade really needed?
- How well are your balances working? Do they meet your current requirements?
- Do your research. Find out what you need and be sure to investigate all your options.
- Readability, precision, stability, and cost of ownership.

A Third-Generation Biobanking System

Problem: A high percentage of biological samples are stored in first- and second-generation biobanks that may affect sample integrity. Even if initial sample quality is high, certain storage and handling techniques degrade quality over the long term[1], putting these samples at risk for degradation before they are used in downstream assays.

Earlier biobanks typically cobbled together sample storage systems in chest freezers or liquid nitrogen tanks, and used liquid handling and library information management systems (LIMS) from different manufacturers[2].

A door opened on a manual freezer for even a short period can result in a significant temperature rise. In figure 1, data gathered by Hamilton Storage Technologies shows that the temperature of samples taken from -80°C storage to ambient conditions increases at an average of 21.5°C per minute. Holding a manual freezer door open for more than one minute can raise the temperature of samples to above -60°C, dependent on their location in the freezer and the tube type. The tubes used in this study were 300 uL REMP tubes with 40 uL Fisher 10X TBS PH 7.4 buffer solution. This can happen countless times over the lifetime of a sample stored and retrieved manually. Accumulated temperature rises above this level are believed to damage the integrity of many types of biospecimens[3].

Introducing variability and inconsistency to sample storage can add unknowns into downstream assays, reducing sample quality.

Solution: One product that can solve this sample quality issue is BiOS, a new, third-generation biobanking system from Hamilton Storage Technologies. The BiOS system can store, retrieve, and manipulate samples at ultra-low temperatures (-85°C)[5].

Hamilton says BiOS is the only biobanking product that enables large-scale ultra-low temperature sample storage and integrated liquid handling from the same manufacturer.

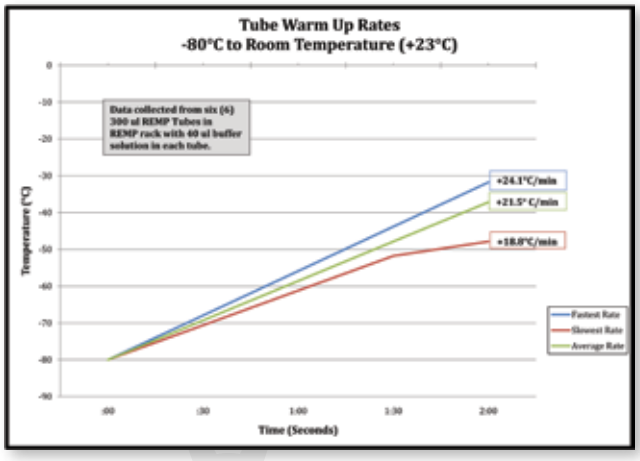
In this third-generation system, researchers do not open freezer doors. Using the BiOS system, they place a sample tube in a hatch and a robotic arm stores it in a unique interior cell. Tubes have 1-D or 2-D barcodes for tracking samples with the LIMS software and recording each sample's location. The system enables researchers to store and retrieve samples precisely, and it supports the FDA's 21 CFR Part 11 regulations.

When a researcher wants to retrieve a sample, they use the software to send their request to the automated biobank, and the robotic arm retrieves the sample. The arm deposits the sample in a delivery hatch and an email is sent when it is ready. The -80°C freezer also records the entire temperature trail of each individual sample and how many times each sample is removed from frozen storage[5].

This automated system reduces retrieval time, preserves chain of custody, and eliminates sample exposure to potentially harmful temperatures.

Three levels of redundant refrigerator systems make this system very reliable. An automatic defrost system keeps samples ultra-cold while removing frost. If the system ever needs to be serviced, a technician has easy access to the refrigeration compartments for quick and efficient servicing. In addition, all automation and sensor equipment of robotic components is located outside the ultra-cold environment, so instrument servicing does not compromise the temperature of the samples.

For more information, please visit http://www.hamilton-storage.com/



▲ *Figure 1: Tube warm-up rates over time: The samples are 300 uL tubes with 40 uL 10X pH 7.4 buffer solution.*

Sources

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2. Silberman, S., "Libraries of Flesh: The Sorry State of Human Tissue Storage," Wired, June 2010.
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A Multi-Prep Laboratory Homogenizing System

Problem: There are a few important concerns an end-user encounters when homogenizing. Complete sample homogenization is the goal for each homogenizing process; however, many end-users are faced with the difficulty of achieving consistent sample breakdown of multiple samples in a timely manner coupled with a large concern of cross-contamination. Even further, when you have a lot of samples to process per day, it becomes a very time-consuming and labor intensive task as well as tedious nature to stop and clean a generator probe between each sample process. Typical disposable plastic generator probes are not the answer either because of their inaccurate homogenizing results, and most labs can't accommodate or afford large automated systems to address their concerns.

Solution: The Multi-Prep Laboratory Homogenizing System is one product that can simplify the labor and time of the typical homogenization process and to make it easier for the end-user.

This particular system can process up to six samples at once in a quiet, compact, and timesaving unit while providing accurate processing speed during the homogenization cycle. With the Multi-Prep's small footprint similar to a micro-centrifuge, it takes up little counter space and fits in most flow cabinets and fume hoods.

The system allows for precision sample breakdown and repeatability with limited concern of variations in sample size or viscosity, which frees up a large amount of valuable lab time. A typical run time of six samples is done in seconds and with a maximum ability to process six samples per cycle can result in 300 homogenized samples per hour, which can provide significantly higher laboratory productivity.

By automating this process, users can also achieve more consistent results compared to traditional non-automated and standard manual homogenizing. Homogenizer protocols vary within any lab and the Multi-Prep's programmability function can store up to 10 different homogenizing programs in memory. For new homogenizing trials or quick-runs, the system can be used in the manual mode for individual sample processing. All processing is contained in a sound-abating enclosure with its rounded clear polycarbonate door for a full view inside. All program control can be done and seen on its ergonomically placed keypad and LCD screen.

The unique Multi-Pack of Multi-Prep Probes eliminates cross-contamination as well as the time consuming need to stop and clean a generator between samples because a clean Probe is used each time. Probes such as these are known as the better alternative to disposable plastic generator probes, because the reusable Multi-Pack Probes are made from 316 Stainless Steel and PTFE. This design provides the ability to process more difficult samples, including tough tissues and frozen samples. Their infinitely reusable nature means they can be used again and again. When homogenizing is complete, the Multi-Prep Probes can be sterilized by any cleaning method, including flaming and autoclaving. Furthermore, its interconnecting design with the Multi-Prep System, through its self-engagement and disengagement, takes away the hassle of typical manual hand-use.

PRO Scientific's Multi-Prep Laboratory Homogenizing System.

Another added benefit of systems like the Multi-Prep is that there is no need to alter or change the tube continuously being used in a lab's research. Whether processing in small tubes or larger centrifuge tubes, the system can accommodate tubes from 5ml - 50ml. Sample tube integrity is also maintained with the company's removable Spider Tube Rack design that incorporates easy tube replacement. This oscillating tube rack can perform 60 oscillations per minute for enhanced breakdown performance.

Homogenization is a basic but vital component of most research. New homogenizing methods are constantly evolving and moving toward quicker and more efficient processing that can be replicated again and again. The systems like the Multi-Prep take that advancement a step further by raising laboratory productivity and significantly increasing efficiency.

Learn more at http://www.proscientific.com

Automating Laboratory Workflows

Problem: How can you add automation to your laboratory workflows in a way that is effective, efficient, and future proof?

Researchers automate their workflows with the intention of increasing efficiency, throughput, data reproducibility, and walkaway time. However, simply inserting automation into the workflow does not always guarantee the intended results. For example, a researcher may add a liquid handler in order to remove a specific bottleneck, such as low throughput due to existing manual serial dilution methods. However, it is important to keep in mind that while automation may remove a bottleneck in one stage of the process, it can create a new bottleneck at a different point in the process. For instance, as you automate sample preparation steps upstream, you may unintentionally introduce a bottleneck downstream where plates begin to accumulate as they wait to be analyzed by other laboratory researchers.

Another challenge is that automation software is not always intuitive or flexible, making it difficult for novice users to get started and for experienced users to adjust to changing assay requirements. As you add more automation to your laboratory, it also becomes necessary to coordinate the integration of instruments, many of which may be provided by separate suppliers. This becomes an issue when there is poor communication between devices or when third party instrument drivers are not readily available.

➤ *The Agilent Encore Multispan System combines multispan pipetting with the reach of a built-in robotic arm and intelligent software control to deliver a new level of productivity and throughput.*

Solution: Focusing on integration-friendly, scalable automation solutions can help.

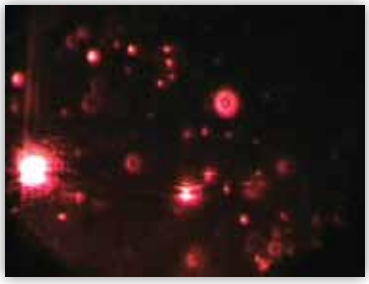
With regard to hardware, ease of integration with other instruments is critical because as time passes it is likely that you will add more steps and devices to your workflow. A liquid handler that features both a robotic arm and automated multispan pipetting capabilities in a single instrument makes it possible to remove multiple bottlenecks at once. For example, the Encore Multispan System uses a dual multispan liquid handling gantry that allows pipettors to move simultaneously in multiple directions across the instrument, thereby doubling liquid handling speed. Researchers can reap the full benefits of higher throughput as a potential second bottleneck is avoided with the Encore Multispan's built-in robotic arm that reaches off-deck and allows prepared samples to be passed to other integrated instrumentation.

When considering software, it is an advantage to have an optimized automation package that allows you to visualize your workflows. This makes it easy to recreate manual processes that involve multiple tasks and instruments, in ways that are meaningful to all researchers and not just experienced automation engineers. Scalability and future needs are also important considerations when evaluating the software controlling the automation instrument. For example, the Encore Multispan Liquid Handling System's software features innovative dynamic scheduling that enables researchers to adjust to varying sample numbers without rewriting protocols, saving precious time which can be spent analyzing your results.

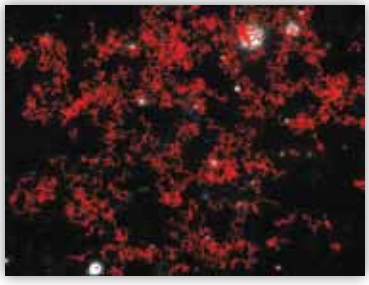
One final consideration to take into account is that while many automation providers can help automate your existing workflows, it is more efficient in the long term to use a single provider that acts as a focused point of contact. By choosing a partner that has experience in robotics, liquid handling, software, and detection, you stand the best chance of effective, efficient, and future proof automation for all your applications.

For more information, please visit www.agilent.com

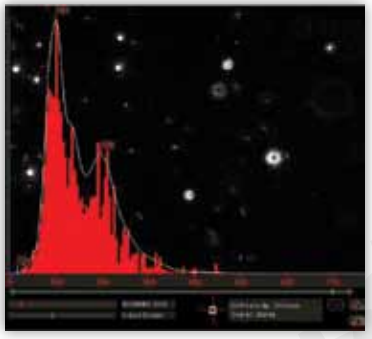
Nanoparticle Tracking Analysis



▲ *Figure 1a*



▲ *Figure 1b*



▲ *Figure 1c*

Problem: The measurement of polydisperse nanoparticles in the region from 10 nm to 1000 nm in liquid is a challenge. Traditional light scattering methods such as dynamic light scattering (DLS), while being excellent for monodisperse samples, tend to skew results to larger sizes (and numbers). This is particularly important in making real time measurements such as in the study of protein aggregation, viral vaccines and exosomes/microvesicles.

Solution: Nanoparticle Tracking Analysis (NTA) from NanoSight visualizes, measures and characterizes virtually all nanoparticles (10-2000nm). Particle size, concentration, zeta potential and aggregation can all be analyzed while a fluorescence mode provides speciation of suitably-labeled particles. The NanoSight technology provides real time monitoring of the subtle changes in the characteristics of particle populations with all of these analyses uniquely confirmed by visual validation.

From loading the sample into the cell to getting results can take as little as 2-3 minutes, with the ability to run batches of samples under the same conditions and directly compare results.

NTA is a method for direct and real-time visualization and analysis of nanoparticles in liquids. Based on a laser-illuminated microscopy technique, Brownian motion of nanoparticles is analyzed in real-time by a CCD or CMOS camera, each particle is simultaneously but separately visualized and tracked by a dedicated particle tracking image analysis program. The NTA program simultaneously identifies and tracks the center of each particle on a frame-by-frame basis throughout the length of the video—typically 30 seconds. The average distance each particle moves in the image is automatically calculated. From this value the particle diffusion coefficient can be obtained and, knowing the sample temperature and solvent viscosity, the particle hydrodynamic diameter is identified. Because each particle is visualized and analyzed separately, the resulting particle size measurement and size distribution does not suffer from the limitations of being the intensity weighted, z-average distribution from DLS. The ability of NTA to simultaneously measure particle size and particle scatter intensity allows heterogeneous particle mixtures to be resolved and particle concentration can be measured directly; the particle size distribution profile obtained by NTA being a direct number/frequency distribution. Because this is an absolute method, no user calibration is required.

The schematic shows the process of an NTA measurement. Figure 1a shows the particles present in liquid illuminated by the laser. Figure 1b shows the individual tracks of each particle. Finally, figure 1c shows the distribution of the particles under study.

NTA technology has found wide acceptance across multiple fields of application with users in industry and academia, as, to date, NanoSight has installed more than 500 systems worldwide. NTA has also been validated by over 600 third party papers citing results obtained using NanoSight instrumentation. This leadership position in nanoparticle characterization is consolidated further with publication of an ASTM International standard, ASTM E2834, which describes the NTA methodology for detection and analysis of nanoparticles.

For more information, please visit http://www.nanosight.com/

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PARTING POINTS

Takeaways from this month's issue:

GOING GREENER

Laboratory equipment manufacturers are putting much more effort in the name of efficiency and energy reduction into the design of their products. When considering green technology, buyers should consider:

- The products being purchased
- The environmental practices of the manufacturer
- Where and how their labs use the most energy
- How best to control the use of consumables and automate for efficiency

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SHOPPING AROUND

The acquisition of equipment is a strategic business and operational decision that balances a variety of costs with the value the equipment purchase could bring to the lab. Important aspects to consider include:

- Is there a capability that comes up frequently which the lab doesn't have?
- The age of current equipment and its remaining shelf life
- What is needed to increase capacity and productivity
- Current equipment usage and future needs

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QUIT MICROMANAGING

Many lab professionals have worked for micromanagers and some have even *been* micromanagers. People micromanage for four main reasons:

- They may be more confident in their hands-on problem solving skills than their management abilities
- Managers are usually chosen based on their accomplishments through doing, not managing
- They may feel uncomfortable delegating authority because they worry they'll lose control
- Micromanagers are ambitious and want to achieve superior results

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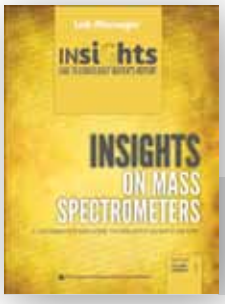
OPTIMIZING EXHAUST SYSTEMS

Laboratories are the focus of many reduction efforts as they are some of the largest consumers of energy due to the specialized equipment and ventilation systems they require. Labs can reduce energy usage by their exhaust systems through:

- Engaging with a building professional that has knowledge of laboratory environments
- Performing an audit of their existing exhaust systems to identify areas for improvement
- Creating a plan showing current energy use by the system based on the audit
- Properly training staff once the upgraded system is in place



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INSIGHTS ON MASS SPECTROMETERS

One trend evident in science generally, and for laboratories in particular, is the desire to do things faster, more reliably and economically, at a higher level of hardware and method robustness, and all with a less-specialized workforce. This is especially true of mass spectrometry where main trends include:

- Users now are more likely to be technicians than Ph.D.s
- Users are discovering and developing more applications and methods
- Instrumentation has become easier to use
- Computerization and the instrumentation's shrinking footprint

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