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May 2010 Volume 5 • Number 4

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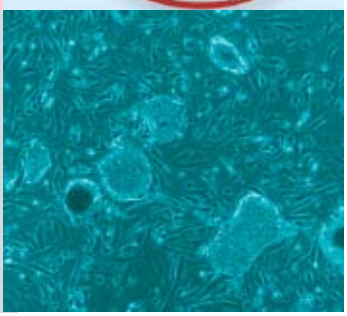

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In February, the NIH released a report showing the annual support level for various research, based on grants that are funded by the ARRA. The report, based on data ranging from the actual 2006 totals to the estimated totals for 2011, revealed increased funding for stem cell research as: Human Embryonic increased 232%; Non-Human Embryonic increased 86%; Adult Stem Cells, which includes umbilical cord blood/placenta and other non-embryonic, increased 96%; and Stem Cell Research, an all-inclusive category that defied categorization, increased 71%. Visit http://report.nih.gov/rcdc/categories/default.aspx for the complete report.

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Quality as Good Business

Years ago, Ford Motor Company launched an ad campaign based around the slogan "Quality is job 1," which was meant to convey its commitment to producing well-made cars. However, before that Ford slogan and phrases such as "quality merchandise," the word "quality" simply meant "an inherent or distinguishing characteristic; a property." Over the years, however, the word has morphed into an adjective assigning excellence and superiority to all sorts of things, including labs.

If "quality" were a stew, its ingredients in the lab would include audits, inspections, training, data collection, data recording, data archiving, regulation compliance, equipment, GLP, GMP, calibration, method validation, traceability and more. And the person mixing and balancing those ingredients would be the lab manager. So says Dr. Shib Mookherjea in this month's cover story. "One of the most essential factors in the implementation and enforcement of quality in any setting is management. And if managers do not pay attention to the quality side of their business, despite good science and the best people, the entire structure can collapse," he says. The same sentiment is echoed by Dr. Henry Nowicki, president of PACS (Professional Analytical and Consulting Services), who says, "Paying close attention to quality and validated methods and data has been credited with helping laboratories to retain their competitive edge." Turn to page 10 to find out what you can do to improve quality in your lab.

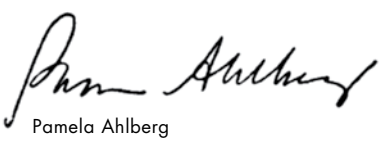
In this month's issue we also turn our attention to the more practical aspects of running a lab, such as team meetings. In Cyrus Farivar's article on page 16, we learn that all team meetings are not alike and that with more thoughtful planning, managers or meeting leaders can make much more effective use of their meeting time. Ron Pickett in "Managing Change," identifies the issue of change as the underlying nut to be cracked before other productivity improvements can be made. Turn to page 20 to learn a few simple steps to help your staff move from resistance to embrace the change inevitable in all organizations.

While we all recognize that the amount of data and information in our personal lives continues to grow exponentially, laboratory data makes that look like a mole hill to its mountain. John Borchardt in this month's Technology & Operations article discusses the forces behind this ever growing "exaflood" of data and the challenges and R&D possibilities it presents.

Our "Safety Guy," Vince McLeod, this month talks about IEQ (indoor environmental quality), while Sara Goudarzi in "Perspectives On: An Environmental Lab" (page 48) takes us into Florida's Advanced Environmental Laboratories where Bob Dempsey shares its proud history and keys to continued success.

On a separate note, be on the lookout for a new online survey from *Lab Manager Magazine* concerning laboratory safety. In the survey we ask you to rank your current lab safety practices, from safety inspections to hazardous material handling to safety training. Please help us help you by taking a few minutes to respond. From the results we will produce a report in the September issue sharing what we learn and hopefully providing direction for your own lab safety efforts.

As always, we hope you find value in everything we offer here and online.



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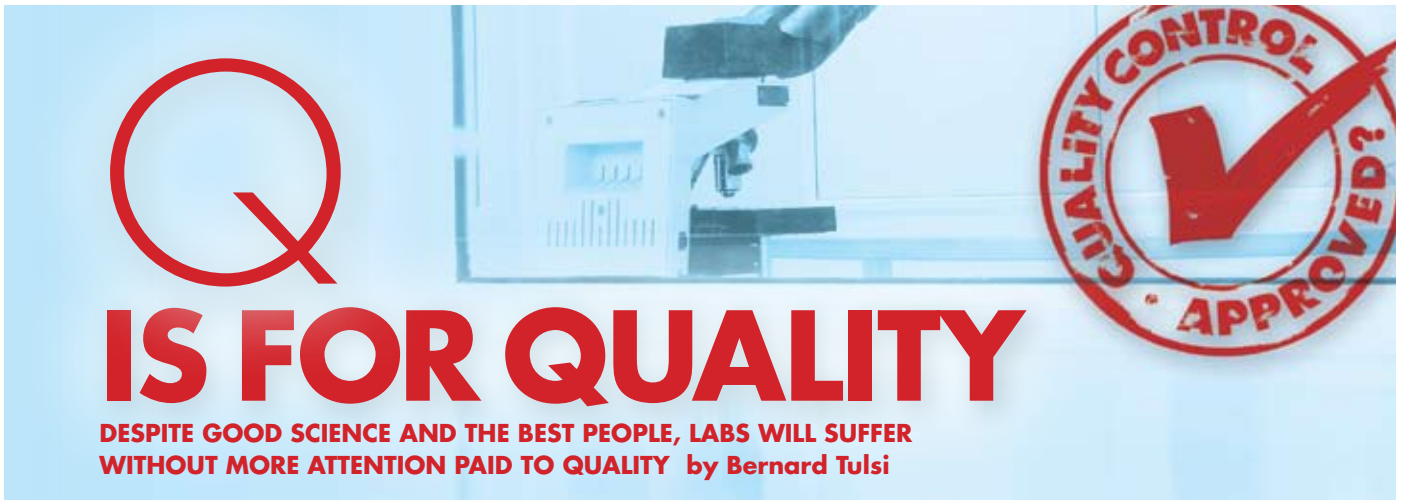


Q IS FOR QUALITY

DESPITE GOOD SCIENCE AND THE BEST PEOPLE, LABS WILL SUFFER WITHOUT MORE ATTENTION PAID TO QUALITY by Bernard Tulsi

In the laboratory context, quality is a measure reflecting how effectively laboratory management and staff are able to deploy their instrumentation, tools, reagents and software to conduct laboratory tests and investigations with validated methods and regulated procedures to produce accurate and consistent results on a routine basis.

The majority of laboratories are organized along in-house models—within companies, government agencies and universities—or as service entities that provide an array of analytical testing for a variety of customers. Irrespective of the end user of the output generated by laboratories, "Good quality translates into greater demand for services. Bad quality carries the risk of losing customers, and in a competitive environment, laboratories cannot afford to lose good customers," says Dr. Henry Nowicki, president of PACS Testing, Consulting, Training, which offers a number of training courses in chromatography, mass spectroscopy and related areas for laboratory personnel.

> "... the development and maintenance of quality in laboratories are constant concerns."

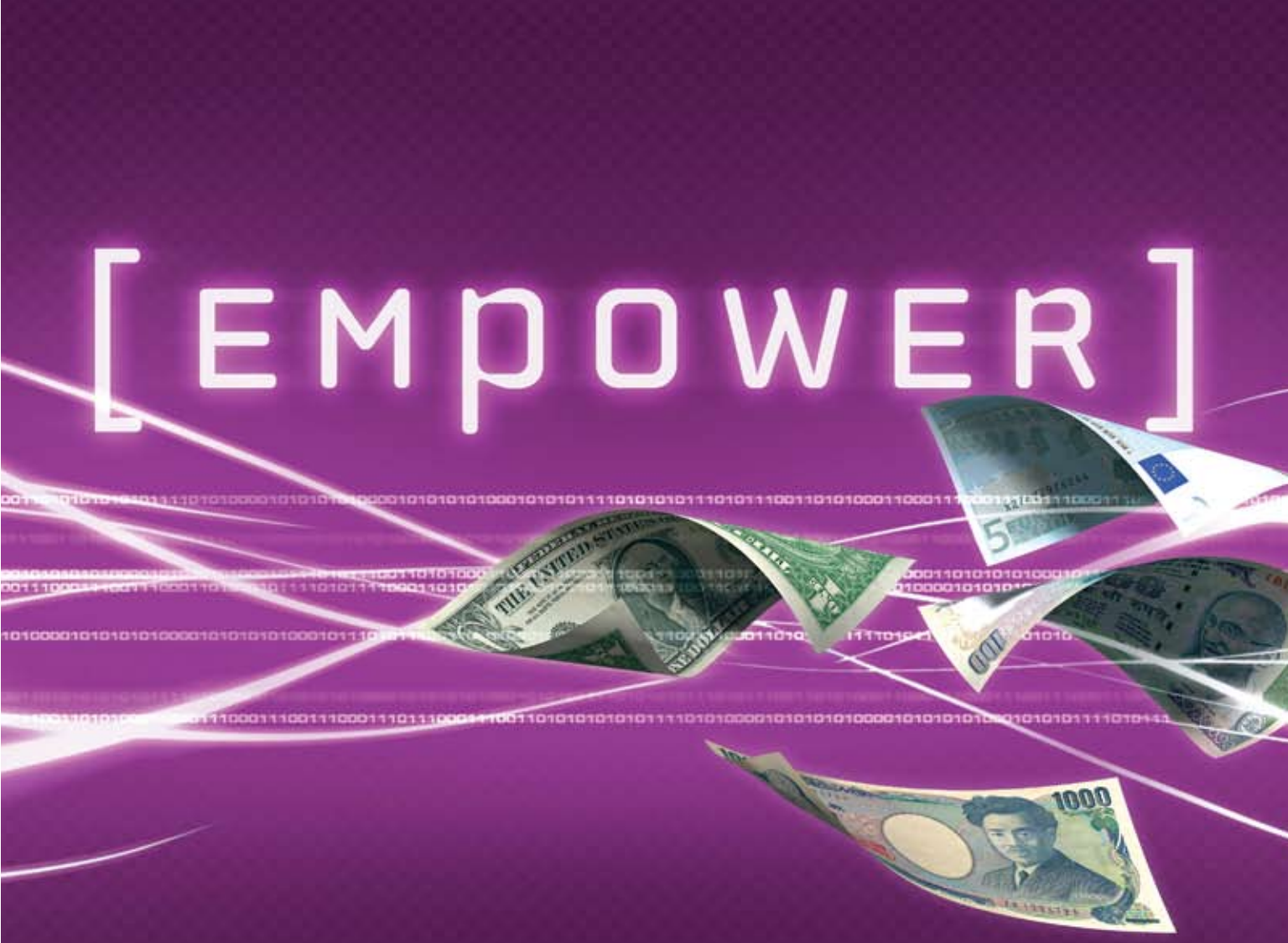
Despite the vigilance of federal, state and local regulators and of accreditation organizations that evaluate and certify laboratories, the development and maintenance of quality in laboratories are constant concerns. Because much can and does go wrong and quality can be undermined by a variety of variables, laboratories may find it necessary to commission audits aimed at ascertaining the quality of their operations.

Laboratory audits and inspections are listed among the capabilities of Nowicki's group. "Before inspecting and auditing a lab, it is important to get a solid understanding of its equipment and the standard operating procedures, preferably of its most widely used tests. This is essential to get a good sense of a lab's activities and processes and an understanding of the measurements it uses.

"Furthermore, it is important to know whether the lab uses state-of-the-art equipment and to have a good grasp of the staff's levels of training and experience. In highly specialized labs, which are common today, it is important to determine whether they have the right equipment, training, data collection, and recording and archiving, among other key attributes," says Nowicki.

If and when deficiencies are found, the next step for laboratory auditors is usually to make recommendations to management about corrective action. Some adjustments may be necessary to ensure that labs are compliant, and that they are able to stay out of regulatory trouble and avoid the enormous costs associated with it. In some cases strategic changes may help them to streamline their processes and improve productivity.

Nowicki says that once an audit is completed and evaluated, it is important to bring anything amiss to the attention of the lab managers. It is also vital to inform them about potential remedies and to show them how to implement changes capable of fixing deficiencies in the operation as well as delivering key benefits. "It helps to show them the marginal returns for taking the recommended action. Lab managers really take note when they realize that they may be deficient compared to other labs



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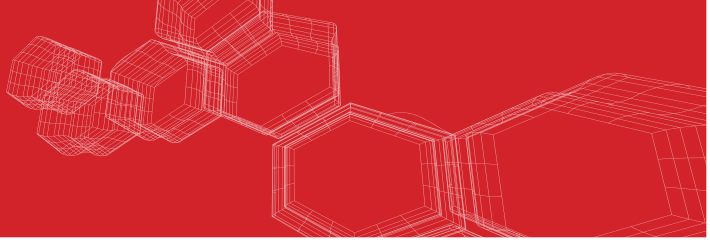


and that changes are essential to stay competitive." In fact, paying close attention to quality and validated methods and data has been credited with helping laboratories to retain their competitive edge, he says.

"In highly specialized labs ... it is important to determine whether they have the right equipment, training, data collection, and recording and archiving ..."

"In fact, insufficient attention to quality, validation and inadequacies in proper management oversight has been known to lead to the demise of laboratory-related business enterprises," says Dr. Shib Mookherjea, who is currently senior manager for analytical services at Allergan, Inc. (Santa Barbara, Calif.), and whose lab quality experience has been honed in a number of large pharmaceutical companies and as an instructor on quality issues with the American Chemical Society and other professional organizations.

"We have to build and maintain quality and validation from the very outset; otherwise our measurement processes and our data will become questionable. People are realizing more now that they have to do increased due diligence and can't go on taking shortcuts, an approach that has created big problems for labs in the past."

He says that while there are still some laggards, more lab managers are inculcating in their staff the idea that regulations set out by agencies such as the FDA or the EPA are binding requirements, not merely suggestions. Sometimes that connection is missing in labs, and it would serve these organizations well if top management were to take repeated measures to instill the understanding that regulatory requirements have serious meanings.

Mookherjea says that quality practices vary by industry and by setting within industries and organizations. What cuts across several situations, however, is quality management system infrastructure, which may either be part of a regulatory regimen or optional. He says that some companies, especially in the pharmaceutical sector, are required to conform to regulatory guidelines such as good laboratory practice (GLP) and good manufacturing practice (GMP), often without exception.

"The infrastructure of the quality system is very important in maintaining GLP, GMP or ISO 9000 focus. With GLP, elements have to be defined at the outset because GLP is a very structured environment. For instance, it is not sufficient to say that there is document control, which is a GMP task, in the case of GLP. There has to be an archivist for GLP final reports, which is not required in GMP."

Mookherjea points out that in a number of companies there are questions about where GMP starts and GLP ends. He says management needs to be aware of this and to understand clearly the purpose of GMP and the tenets of GLP.

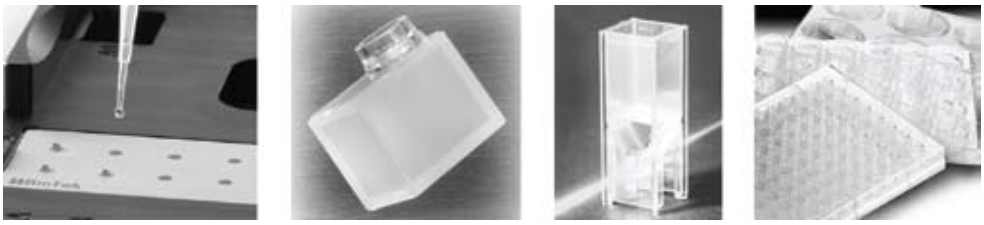
"This is essential in a regulated environment, but even in nonbinding situations there is a need to maintain an infrastructure of the quality system—and that is where quality control (QC) becomes very important."

He says that QC is more or less the general lab procedure that is needed to maintain the focus on data quality. "It is basically concerned with how to calibrate instruments and how to maintain the documentation associated with sample management systems and other procedures," Mookherjea says.

By contrast, quality assurance (QA) is more strategic. "Imagine QC as a small circle and QA as a slightly larger one, because QA gets into the development of infrastructure and how to maintain the quality control focus, and it may include auditing, documentation and training. What the two different circles portray is that QC is limited to day-to-day operations, while QA is more open and strategic," says Mookherjea.

Turning to the question of method validation, Mookherjea says that in every process, on a risk assessment basis, management has to make a decision on whether the process needs to be qualified or validated. He says, "If a lab is involved in developing a manufacturing process, then that must certainly be validated. If it is involved in a cleaning process, then the cleaning validation will take effect, or if it is a case of an aseptic method, then aseptic validation comes into play."

When dealing with methods, it is important to understand the goals of the methods, according to Mookherjea. "To do that, you need to go into the design stages of the method and assess what is needed to achieve the goal. Does the method require LC or LCMS or GC or AAICP? That depends on what parameters must be validated, what kind of resolution is needed and what level of laboratory



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quality assurance is required, among other factors."

Mookherjea says that method validation is only one of the components of QA. Another key component is traceability based on unique identification numbers for samples. "There are several cases of samples getting mixed up and misplaced because people do not take the time to develop distinct alphanumeric labels for them. They do not take the time to understand how an analytical work request is created, what the goals are, and whether it is specific enough to convey what is being requested by internal users or external customers."

> "Some adjustments may be necessary to ensure that labs are ... able to stay out of regulatory trouble ..."

Turning to the issues of management and leadership, Mookherjea says that all quality standards recognize that one of the most essential factors in the implementation and enforcement of quality in any setting is management. Invoking quality gurus such as William Edwards Deming and Joseph Moses Durant, Mookherjea says quality is everybody's responsibility, "but quality needs to start at the top, and management has to buy into quality first; then it has to be carried through the entire organization."

He says that quality is not static but rather a continuous improvement process. "Quality is not a project, it is a continuous process, and both Deming and Durant have maintained that quality must be a never-ending commitment of a company."

In describing the drivers of quality in the laboratory environment, Mookherjea says that there are three large buckets: one contains the fundamental science, which comes first and drives everything; the second contains the technology, software and information systems; and the third contains management techniques and roles and "the big letter Q for quality. If attention is not paid to the quality side, despite good science and the best people, the entire structure can collapse."

Prior to considering quality, it is important to know the science behind it. "If people do not understand the underlying analytical chemistry of an analytical process, for example, they will of necessity use a robotic rather than a scientific approach in their laboratory analyses."

As a result, well-trained personnel are another vital component of a well-functioning laboratory, according to both Mookherjea and Nowicki. "Training should be ongoing to keep up with rapidly changing technology and new regulations. Human resources are crucial, and management has to select and empower them and provide the resources for them to thrive in an environment of scientific discipline and professionalism", says Nowicki.

"Overall, there could be more training of personnel—training that includes the use of computerized systems and data interpretation—to produce a higher-quality staff for laboratories. A lot of the training that chemists receive lacks exposure to key instrumentation, and a number of academic universities do not teach fundamental skills such as how to interpret mass spectrometry data, which should be a core skill. Motivation is very important in the lab environment,

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and training helps tremendously in that process," says Nowicki.

Both experts acknowledge that new analytical technologies have been a huge help in maintaining laboratory quality. Mookherjea points to HPLC equipment, particularly the introduction of the autosampler, which he describes as a quantum leap in analytical instrumentation that provides laboratories with a tremendous advantage.

Despite some major gains, however, Nowicki points to the need for technology to make laboratory measurements faster and to deliver results in minutes instead of hours. "We need to push to have technology that can do analyses faster, better and cheaper. Instrument developers need to come up with new measurement technologies based on DNA and other techniques. They are doing that, but this is a continuous process, and there is still more ground to cover."

> "Lab managers really take note when they realize that they may be deficient compared to other labs ..."

To be sure, some major causes for concern still exist. Mookherjea says that in the past few years, "Quality has improved by leaps and bounds, but it is still not where it should be. The focus is not there because companies are changing rapidly and dynamically.

"There is a lack of constant awareness by top management teams that build labs and focus on the building rather than on the far more valuable and essential human resources. They do not promote ongoing training but instead rely on the skill sets that workers are recruited with. They need to find ways to expand on those skills. Lab workers need to be trained on regulations and new technologies—that is where a big gap exists."

Despite strong optimism about the future of analytical laboratories, Nowicki was more emphatic about some of the current shortcomings. "I think that laboratory leadership has largely failed. Management has cut the head count in labs to such an extent that the remaining personnel are overworked—and when people are overworked and worn out, quality suffers."

The other side of the problem is that when leaders try to run their operations with too many workers, cost-effectiveness suffers, he says. "There must be a careful balance between the number of people needed and the quality of the output," he says.

In addition, the quality should match the business. "Some areas must have high, precision quality all the time, while some others may be able to operate at a lower quality threshold. In every laboratory, the key question that must be addressed at all times is, 'What level of quality is required?'"

Still, Nowicki is confident that labs will deliver on the desired quality goals. "Laboratories know their problems, and they know their strengths and weaknesses.… I am encouraged that over time laboratories will get better."

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HOW TO RUN AN EFFECTIVE MEETING

MAKE YOUR MEETINGS MATTER by Cyrus Farivar

Have you ever sat through a pointless meeting and calculated just how much money was being wasted as a dozen well-paid professionals zoned out around a deathly boring conference table? Horror stories of bad meetings are legion, but the qualities that characterize a good meeting are harder to define. Whether they're team check-ins or department updates, the regular meetings we hold every week or every month are often the hardest to get fired up about. But making them better isn't simply a matter of ordering coffee and bagels (or even pretzels and beer). Productive, valuable and engaging meetings require a clear goal, an open dialog, and a strong leader. Here's how to make your meetings matter.

"Productive, valuable and engaging meetings require a clear goal, an open dialog, and a strong leader."

Make every meeting matter—or don't meet at all

Goal: Decide if a meeting is needed and invite only the necessary people

The vast majority of meetings never need to take place. Massive amounts of valuable time are wasted simply because managers think that face-time is important, or because, like an old milk horse making the rounds, they've become accustomed to a particular routine. "The best way to determine whether a meeting is a good idea is to ask whether the transfer of information is one-way," says J. S. O'Rourke IV, a professor of management at Notre Dame University. If you want to give your team an update or a status report, e-mail will usually suffice.

"A second question to ask is whether you require feedback from all participants," O'Rourke adds. If so, e-mail has limitations: "In a meeting you get different kinds of feedback, with greater detail or texture." Finally, he adds, it's helpful to ask whether the real purpose of the meeting is to build consensus: that's much easier to do face-to-face.

Once you've decided that you absolutely need to hold a meeting, invite only the people who have something to contribute and will get something out of it: team members who work directly on the project in question, decision-makers who have the power to move an idea forward, or specialists who have knowledge and insight that the group needs in order to fully understand an issue. If you want but don't need an invitee's input, and they're overwhelmed with other work, let them know it's okay not to attend but that some decisions may be made without them. If they can live with that outcome, then it's their call how best to use their time.

Define goals and distribute an agenda

Goal: Create a structure for your meeting

Productivity expert David Allen recommends starting every meeting with a "statement of wild success," a clear definition of the best possible outcome for the meeting. Just stating the ideal result often inspires participants and makes meetings more productive. At the very least, it underscores a feature that every meeting needs: a goal.

Before the meeting even begins, make sure everyone understands the objectives by writing an agenda. If you're a procrastinator, write the agenda before you call the meeting. (This exercise should also help you confirm whether

a meeting is necessary and who should attend.) Include everything your group will need to discuss or decide on but keep it brief, using bullet-pointed items instead of full paragraphs. Be clear about who will lead each agenda item and whether it's an update, a discussion or an action item that requires group decision-making.

Email the agenda to your colleagues a day in advance, so that potential naysayers will have the opportunity to make their objections known privately—rather than during the meeting. (If necessary, you'll then have time to include their suggestions in a revised agenda.) Always paste the agenda into the body of the email; if it's an attachment, no one will bother to open it. Phrase your agenda in a way that will increase the sense of urgency and importance. An item called "sales challenge for this quarter" is much more captivating than "sales quarter update."

"You want to interest people," says Bert Decker, a communications consultant who has worked with Siemens, Charles Schwab, and Representative Nancy Pelosi. "It gives them a guide to where you're going. It has a point of view and an action step. You're influencing them towards something, not just informing them."

In bigger meetings that require more bodies and more time, give the conversation a clear structure by assigning topics an allotted amount of time. Decker recommends picking odd numbers—25 minutes instead of 30, for example—to show that you're serious about sticking to a precise schedule.

To increase involvement, consider giving everyone a role or assignment. Team heads or those with specialized knowledge should handle the agenda items that apply to their areas. For longer meetings, if the material covered is not relevant to some people, arrange to have them excused from that portion of the meeting, so they can get back to work rather than waiting through issues that don't concern them.

Essential ingredients

Jobs for meeting attendees:

Meetings run more smoothly when the organizer enlists others to help handle the details. It's also a good way to engage coworkers who might otherwise stare out the window or pass the time by twiddling with a Blackberry.

Timekeeper: Makes sure the meeting starts and stops on schedule, reminds facilitator when agenda items are going over their allotted time.

Note Taker: Records what was said and distributes minutes as needed.

Whiteboard Wrangler: Writes ideas on the whiteboard during brainstorming sessions, makes sure every idea is recorded, whether or not it seems promising at first glance.

"If you want to give your team an update or a status report, e-mail will usually suffice."

Own your meeting

Goal: Take charge and keep your meeting moving forward

Good meetings are products of good leadership. Take charge and make it clear that you intend to keep the discussion timely, useful, and relevant. Begin by writing the meeting goal on the whiteboard to remind everyone

why they're there. If you've asked people to do some kind of homework and they haven't done it, stop and reschedule the meeting. It won't pay to continue, and meanwhile you'll send a strong message that preparation is not optional.

Show your colleagues that you respect their time by making sure a clock or timer is visible to all. At Google, facilitators project a four-foot-tall timer onto the wall to enforce the idea that meetings should begin and end on time.

Of course the number-one way to get people to show up on time is to start on time. "My calendar is scheduled for the entire day," says Catherine Smith of software company Linden Lab, makers of the online virtual world Second Life. "If someone's not there at 8, then the meeting will go on without them. I'm not going to wait, because I can't."

Hank Lambert, director of business development at Cisco Systems, warns not to take this approach to extremes, however, especially in a meeting with co-workers who outrank you. "I usually wait for higher-ups," he says. "Especially if I'm trying to convince them of something." If you have a senior VP who's habitually late, find out where she'll be before the meeting and escort her to the meeting place yourself.

Staying on topic is also key to maintaining a schedule. If the conversation runs off the rails, refocus the group by saying something like: "Interesting, but I don't think we're advancing our goals here. If I could, I'd like to return to the agenda." This is where an agenda becomes invaluable: Without one, it's far too easy to get sidetracked. When a tangent turns out to be important, don't let the rest of your schedule go out the window. Decide whether it's worth pursuing and direct the conversation accordingly: "We're talking about a new issue—do we want to swap out one of our agenda items to continue discussing it?"

Case study: Let's be careful out there

Meetings, and the way they're held, can help determine the culture of a business. Since 1924, UPS has held daily Pre-Work Communications Meetings at the beginning of every shift. At these highly structured three-minute meetings—held at all 1,700 UPS centers worldwide—managers deliver important information before their drivers head out for the day: weather and road conditions, reminders about safety and customer service, and announcements like employee anniversaries. Implicitly, the meetings also help instill company values—particularly safety and efficiency—by reinforcing them on a daily basis.

Make it a meeting of the minds

Goal: Get the constructive input you need from everyone present

Since the point of a meeting is two-way communication, it's crucial to get honest input from everyone. Successful companies know that disagreement and debate are healthy signs of a passionate work force. "We require that people speak up and are challenged," says Gary Kelly, CEO of Southwest Airlines. No one should feel afraid to say what they really think, and no one person or group should dominate the discussion.

"... a good manager should be an active listener who encourages participation."

It's the meeting leader's responsibility to make sure everyone is heard. Nudge the quiet types, curb the longwinded, reign in tangents, and control outbursts. To build consensus or come to a group decision, avoid wearing your opinion on your sleeve; it's easy for a leader to stifle a discussion if everyone assumes the outcome is already determined. Avoid the temptation to dismiss ideas immediately—even when they're terrible. For meeting participants, it's embarrassing to be told "no," and over time that kind of discouragement has a corrosive effect on brainstorming efforts. Instead, keep track of every idea, thank people for their input and praise good ideas in front of the group.

Irv Schenkler, director of management communication at New York University's Stern School of Business, says a good manager should be an active listener who encourages participation by asking "door-opening questions"—inquiries that show you're paying attention and you value your co-workers' input. For example, when attendees are reticent or reluctant to speak, Schenkler advises calling on them: "Sue, you seem to know a good deal about what Beth just said. What are some things you would like to raise at this point?" Likewise, you can divert a conversation dominator with a neutral comment like, "Bob has made his opinion clear. Does anyone else have something they would like to add?"

"The best way I've found to get consensus is to make everyone feel like they had a chance to be heard," Lambert of Cisco says. If people still don't feel like their points of view are being understood or taken seriously, allow them a final opportunity to distill their disagreements down to one or two key points. That way, Lambert explains, a dissenter has a chance to articulate his or her rationale, and the group's decision can be adjusted to address those concerns.

Hot tip: The eyes have it

According to A. Barbour, author of "Louder than Words: Nonverbal Communication," only 7 percent of communication is what we say—the rest is how we say it. Pitch, volume, and rhythm carry 38 percent of a message, while body language, facial expressions, and eye movement account for a whopping 55 percent.

As a meeting facilitator, you can use non-verbal cues not only to communicate your message but to influence the group dynamic and make all attendees feel included. When people speak during meetings, often they'll look at the facilitator. Avoid their eye contact and look at other members of the group, which will encourage the speaker to do the same.

Close with a plan of action

Goal: Make sure everyone leaves knowing the next step

Close the meeting with a review of what decisions you reached and what the next action will be. Everyone should leave knowing what's expected of them and when—by the end of the week, the end of the cycle, or the next meeting. End by asking everyone whether they thought the meeting was useful and, if not, what could be done better next time.

It's easy to walk out of a meeting room, go back to your desk, and immediately forget every change, decision, and new idea that your group came up with. Make sure that your meeting didn't happen in isolation by letting the right people know what was decided and what will happen next. Sending out complete meeting minutes may not be necessary, but make sure you have a system to keep track of what was decided and what assignments everyone agreed to take on, so you can follow up and keep things moving.

Technically speaking: The easy way to preserve whiteboard ideas

Say you and your colleagues had an intense whiteboard session and came up with a complex diagram that will solve all your problems. But copying it onto a notepad will take hours, and another group is standing outside waiting to use the conference room. What to do? Take a picture of the board with a camera phone and e-mail the photo file to wb@scanR.com. They'll clean up the image, improve the contrast and legibility, turn it into a PDF, and e-mail it back so you can forward it to everyone on your team (all the while securing the confidentiality of your file).

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WHAT YOU WILL NEED:

LOCATION: Lounges and coffee shops have a better ambiance for small groups of three or four. If your meeting is large enough to require a conference room, reserve one ahead of time.

AGENDA: Know what you want to cover and how much time you want to devote to each topic. Set a goal for the meeting and stick to it.

VISUAL AIDS: Get the most out of your gathering with a whiteboard or flip pad, and make sure to have a clock or timer visible.

LEADERSHIP: It's your meeting, so it's your job to keep people focused. If they're bored, that's your fault.

WHAT NOT TO DO:

UPDATES: If the flow of information is one way, send an email instead.

GETTING SLACKERS ON TRACK: Berating or embarrassing people in front of their peers doesn't improve motivation, and it wastes everyone else's time. Have a one-on-one conversation instead.

GETTING EVERYONE ON YOUR PAGE: If there's disagreement about a project, approach team members individually and find out what they need to move forward. In a group setting, they might gang up on you.

WHIPPING UP ENTHUSIASM: Motivation is a daily management challenge, not a one-time fix. If your team is losing steam, find out why in private conversations and address each person's issues separately.

LEADING CHANGE

RULES FOR SUCCESSFULLY IMPLEMENTING CHANGE IN YOUR ORGANIZATION

by Ron Pickett

My staff is bright, well educated, mature and motivated, and we communicate well. Still, when I try to institute a change, there seems to be a lot of resistance! Why is that?

In each of my last four articles—"Honing Your Interview Skills"; "Motivating 21st Century Lab Staff," Parts 1 and 2; and "Life-Work Balance"—the underlying theme requires a change: a change in behavior, in attitude or in lifestyle. None of these changes are easy to achieve, and some seem near impossible. However, the change process can be understood, and change can be implemented more successfully and more reliably by following a few rules.

"The professional literature suggests that up to 75 percent of change efforts end in failure." (http://www.cepworldwide.com/pdf/Conquer_02.pdf)

"... follow-up and reinvigoration are almost always required in order to make a significant change 'stick'."

Resistance to change

Why do people, even smart people, resist change? Here are the most frequent reasons:

1. People feel awkward and uncomfortable. They are comfortable doing things the way they always have and don't want to move out of their routine.
2. People think first about what they will lose. It may be status, routine, position, prestige or income. It takes a skillful manager to get the staff thinking about what will be gained.
3. People feel alone even when others are having the same experience. Change has a way of isolating people. They talk about rumors, they wonder about what the impact of the change will be, but they probably don't share their concerns and anxiety, so they feel alone.
4. People can handle only so much change. Change seems to be a constant, and it is easy to move into a state of overload without even knowing it.
5. People are at different levels of acceptance. Our tendency is to listen to the people who agree with us and to hear what we want to hear. It takes special effort to ferret out the negative positions.
6. People are concerned that they will lack the needed resources. Does the manager really understand what the change will take? Time, space, training, physical resources, computer access, communication, contacts—the list is long.
7. People revert to old habits when the pressure is off (or ON!). This is one of the reasons so many change efforts fail—follow-up and reinvigoration are almost always required in order to make a significant change "stick." (Hint: This is one of the most frequent failures of managers! We love to change things—we hate to follow up!)

(Incidentally, be afraid, be very afraid, if there is no resistance to a major change—it may be that you aren't picking up on the vibes!)

(For more on resistance to change, check "Overcoming Resistance to Change: Top Ten Reasons for Change Resistance" by A. J. Schuler, Psy.D. www.schulersolutions.com/resistance_to_change.html.)

"Don't manage—lead change before you have to."—Jack Welch

Assessing readiness for change

1. Do key stakeholders understand and support the initiative?
2. Are available financial and physical resources adequate?
3. Are current staff skills and experience adequate?
4. Does staff have access to the needed tools and information resources?
5. Is effective sponsorship and project management in place?
6. Are effective issue-management and decision-making processes in place?
7. Are feedback and accountability systems sufficiently developed?
8. Are there unacknowledged barriers to successful implementation?

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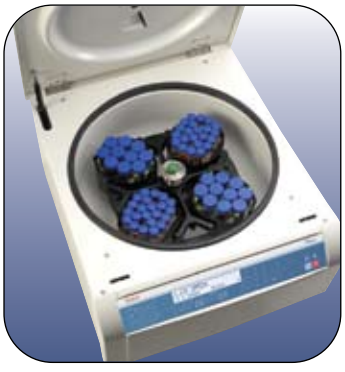

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(In workshops on change management, I usually play Amy Winehouse singing "Rehab" —the best example I know of *unreadiness* for change.)

If you score your group low on readiness for change, you will need to spend much more time in the preparation phase, basically the first four items on the list that follows.

The most-used term in the last election, and in every election, is CHANGE! Except by the incumbents.

Successfully leading change

Here is the model from John P. Kotter's book *Leading Change.*

1. Establish a sense of urgency.
2. Create a guiding coalition.
3. Develop a vision and strategy.
4. Communicate the change vision.
5. Empower broad-based action.
6. Generate short-term wins.
7. Consolidate gains and produce more change.
8. Anchor new approaches in the culture.

(See "Communicating a Vision" by Kerri Harris from Leadership and Staffing, *Lab Manager Magazine*, 2/8/2010.)

Let's take a fairly common and simple example—the introduction of a new piece of equipment.

1. The purchase decision will probably provide you with most of the information you need to establish the need for the new piece of equipment. You will probably have costs, savings, improved accuracy, etc., to make a good case for the new equipment. Now the challenge is to convert your decision into a sense of urgency. Why us? Why now?
2. Who should you use in your guiding coalition, and what do you want them to do? Opinion leaders, regardless of their position, are the people you want to involve in this group. Think through the different age cohorts on your staff and ensure that each is represented. (Note: Some of the "right" people may not be the easiest to work with!)
3. How can anyone resist the new Whizbang 9300 integrated digital analyzer with Internet interface? Check the section above on overcoming resistance to change.
4. The future state. The problem here is Pollyanna! Our human tendency, at least for us optimists, is to exaggerate the positives and underestimate the negatives! The partial answer is to be realistic in your assessment, assume more problems and challenges than you hope for, and get your staff, especially the pessimists, involved in plotting the future. They will have a better sense of what is going to be required, since they deal with the foibles and idiosyncrasies of day-to-day life with high-tech equipment—the Wizbang 9100. (Hint: This is a great

technique for overcoming resistance.)

5. One of the most difficult problems for managers is empowering their staff. For successful change, people must have the authority to make decisions and respond to on-site problems. They have to know what decision you would make in a similar situation and to feel strong in making important decisions. Your role is mentoring, coaching and encouraging those involved. "… top performers rapidly alternate between teaching and questioning or otherwise testing. Then, when required, they make immediate corrections." (*Influencer: The Power to Change Anything*)
6. The route to follow. This step is more involved than simply deciding where to park the new monster. Ensure that your waypoints cover the bases that came up in your assessment of the resistance to change, capitalize on small wins and achievements, keep the guiding coalition involved and change your implementation strategy as new information emerges. Use numbers, cost per test, improvements in accuracy and endorsements by users to make your case for the advantages of the new equipment.
7. Establish the change as "the way we do things around here!" Many change efforts fail because managers don't take the time to enforce—and reinforce—the new process or piece of equipment or system. Then they wonder why people revert to old habits. Reward successful examples of people performing as you want them to, and sanction poor behavior. Challenge negativity.

Short checklist for change managers:

- What exactly is the change you want to institute? Be specific.
- Why is this change needed?
- Why now?
- Who should be in your guiding coalition?
- Who will be affected?
- How can you communicate the vision—the urgency?
- What short-term wins can you expect?

When to get formal

To many readers, this sounds great for major changes, but they wonder what the trigger should be to signal when a change is big enough to warrant a formal approach. There is no simple answer. For example, it is unlikely you need a guiding coalition to rearrange the workbenches in the lab. (If you do, you have much bigger problems than can be solved here!) As general guidelines: if the change will affect more than a few people, if someone's position is threatened, if the change has impact across several work units, if this is another in a string of recent changes or if you have had difficulty instituting change recently, then you should consider the more formal approach described here.

"For change efforts to succeed, managers and change agents must develop and use power skills."—John P. Kotter

Unintended consequences

There will always be unintended consequences of any change. Things that you didn't expect to happen as a result of the change. (Recall that when we increased the use of ethanol for fuel, food riots broke out in some areas of the world! I doubt that your changes will have a similar consequence.) So, good change managers expect such consequences, look for them, acknowledge them and try to ameliorate their impact; really good change managers take credit for unintended consequences when they are positive.

If you would like to review a PowerPoint presentation on this subject, check out www.labmanager.com/docs/Leading_Change.pdf

For further discussion on this topic, visit Ron on YouTube at http://www.youtube.com/watch?v=VnsongFxWS4.

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Take a minute to think about the last major change that you successfully instituted. What did you do, and what can you learn to improve the chances of success in future changes? The best management skills learning comes from analysis of and generalization from our own experiences.

THE POLITICS OF STEM CELL RESEARCH

LATEST NIH REPORT PROVIDES A SNAPSHOT OF WHERE STEM CELL RESEARCH SUPPORT DOLLARS ARE GOING by Richard Daub

The National Institutes of Health (NIH) recently published its annual report on support levels for the funding of various research, condition, and disease categories. The report, which included 218 research and disease areas, had data ranging from the actual 2006 totals to the estimated totals for 2011. Since the NIH is a government institution, it should come as no surprise that the biggest changes came in areas that have been the subject of fierce political debate, and perhaps the most volatile area of all research funding has been that of stem cell research.

In the report, the stem cell areas were broken into numerous categories that changed during the reporting period from broader to more specific categories, and some simply categorized at all beyond "Stem Cell Research". Therefore, for the purposes of this article, we combined the following statistics into four basic categories:

- **Human Embryonic,** which in 2006 received $38 million in funding, is expected to receive $126 million in 2011 (an increase of 232%)
- **Non-Human Embryonic,** which in 2006 received $110 million, is expected to receive $155 million in 2011 (an increase of 86%)
- **Adult Stem Cells,** which includes umbilical cord blood/placenta and other non-embryonic, which in 2006 received $534 million, is expected to receive $717 million in 2011 (an increase of 96%)
- **Stem Cell Research,** an all-inclusive category (where everything else NIH was not able to categorize more specifically was thrown), which in 2006 received $643 million, is expected to receive $1.1 billion in 2011 (an increase of 71%)

To put it simply, there has been a dramatic rise in government funding for stem cell research of all kinds since 2006.

> "... the most volatile area of all research funding has been that of stem cell research."

At the beginning of his presidency in 2001, George W. Bush established embryonic stem cell research as a partisan political issue when he signed an executive order that froze funding for embryonic stem cell research and limited researchers to using existing stem cell lines. The Republicans fell into line with Mr. Bush while the Democrats voiced strong support for stem cell research, and the battle was waged along party lines in the years that followed.

Perhaps it was this restriction on embryonic stem cell research that led American scientists to start focusing more on adult stem cells. Non-embryonic stem cells (also referred to as "adult stem cells"), such

as those derived from the blood in umbilical cords, began to show more promise for the treatment of a wide range of diseases. This was an encouraging sign for some, including Republican senator and presidential candidate John McCain, who eventually reversed his initial opposition.

"Non-embryonic stem cells ... began to show more promise for the treatment of a wide range of diseases."

Celebrities such as Michael J. Fox and Christopher Reeve also became the faces of the issue and helped sway public opinion to the pro side.

Yet, despite the growing optimism for the potential of non-embryonic stem cell research and the gradual shift in public opinion, the term "stem cell" still has a negative connotation for some because of its association with the word "embryonic." Therefore, it remains a controversial sociopolitical issue, which may be due to simple misunderstanding.

"I think people most often mistakenly think that all stem cells are equal," says Dr. Jack Mosher, a research assistant and lab manager at the Life Sciences Institute at the University of Michigan. "When they hear the generic term 'stem cell,' they assume that it can make any particular cell type. But there's a big distinction between adult and embryonic stem cells that sometimes gets overlooked, either because the people talking about stem cells are purposely being misleading or are not being clear."

With the election of Barack Obama, an avid supporter of embryonic stem cell research, a new era in American stem cell research has begun. One of President Obama's first acts in office in early 2009 was an executive order to melt the freezes that George W. Bush implemented eight years earlier. However, because of the work that was being done with adult stem cells during the Bush administration—work that perhaps may not have been done if scientists had open access to embryonic stem cells—funding for adult stem cell research is also expected to increase dramatically in 2011. Some of the new grants awarded for adult stem cell research include projects such as "Cell Therapy for Improving Cardiac Function," "Cancer Stem Cells in Acute Lymphoblastic Leukemia and Ovarian Carcinoma," and "SiRNA Gene Therapy for HIV/AIDS."

The Burnham Institute for Medical Research in La Jolla, California, was a beneficiary of one of the new grants for a project that explores the homing of stem cells in stroke therapeutics. This grant was awarded under the umbilical cord blood/placenta category, not the embryonic (human) category, and lab manager Andrew Crain says this research probably would not have been possible without this new grant because of the large expense.

"We started to hire more people, form more collaborations, and increase the magnitude of the projects," Andrew says of the grant. "We're able to do bigger and better things."

Although embryonic stem cells are generally considered to be more flexible than adult stem cells and to hold more potential for eventually leading to cures for diseases, continued research on adult stem cells may be pivotal to the future of all stem cell research. Another political swing to the right could once again put embryonic stem cell research on hold, and if adult stem cell research has been put on the back burner during this period of embryonic allowance, it can effectively delay work that could lead to a major breakthrough. Additionally, the most important aspect of adult stem cell research may be that if it ever catches up to or surpasses embryonic as the primary form of stem cell research, it could effectively end the controversy once and for all.

"Stem cell research is probably one of the most important types of research because you not only have that ability to model diseases, but also to exploit the properties of the stem cells to your advantage," Andrew Crain says.

"Stem cell research has a real chance of being able to treat diseases that currently have either limited or no treatments," Dr. Mosher says. "It allows us to look for treatments or cures for these diseases in ways that we really haven't had the ability to do before."

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MANAGING THE COMING DATA FLOOD

TO REALIZE THE VALUE OF DIVERSE AND VOLUMINOUS DATA REQUIRES EFFECTIVE DATA MANAGEMENT, INSTITUTIONAL ARRANGEMENTS AND POLICIES by John K. Borchardt

Lab managers will face an increasing challenge in the next decade—managing a rising tide of data. The amount of data generated annually is forecast to double every two years for the next decade as the cost of computing and networking declines.[1] Laboratories will contribute to this data flood as the number of people and data-generating instruments connected to the Internet increases. George Gilder referred to this phenomenon as the "exaflood." (Gilder is senior fellow at the Discovery Institute and chairman of George Gilder Fund Management, LLC.) An exabyte is equal to one billion gigabytes, or approximately 50,000 times the contents of the U.S. Library of Congress. From the laboratory perspective, some research projects routinely generate terabytes and even pentabytes of data. (A terabyte is 1 trillion bytes; a pentabyte is 1,000 terabytes.) Many other projects result in smaller, heterogeneous collections with valuable attributes. To realize the full benefit and value of these diverse and voluminous data requires effective data management techniques, institutional arrangements, and policies.

Factors promoting the exaflood

From the laboratory perspective, factors promoting the exaflood include globalization of research, open innovation and the increasing use of supercomputers. Global corporations perform research in different countries scattered across the globe. For example, Dow Chemical, the largest U.S. chemical maker, has research facilities in the U.S., China, India, Saudi Arabia and other countries. Global corporations often have shared research projects performed at facilities thousand of miles apart. Data sharing required by open-innovation projects performed at two or more organizations requires sharing data and reports.[2] U.S. federal laboratories license technology to the private sector. These and other activities contribute to the increasing volume of scientific and engineering data moving over the Internet.

IBM Roadrunner Supercomputer. PHOTOGRAPH COURTESY OF LOS ALAMOS NATIONAL LABORATORY.

Supercomputers enable the creation and processing of large volumes of data. Supercomputing resources available on the Internet are located at http://userpages.umbc.edu/~jack/supercomputer-resources.html. The federal government's national laboratories, including Oak Ridge National Laboratory and Sandia National Laboratory, are the home of supercomputers that can perform astonishing numbers of calculations at amazing speed. For example, Oak Ridge's Jaguar, a Cray supercomputer, often achieves sustained performance of over a pentaflop (a quadrillion mathematical calculations per second).

National Oceanic and Atmospheric Administration (NOAA) Supercomputer. PHOTOGRAPH COURTESY OF NOAA.

Some universities operate supercomputing centers that provide services not only to their own researchers but also to researchers across the country and even worldwide. For example, the University of California, San Diego, operates the San Diego Supercomputing Center. Academic scientists and engineers nationwide use its computing equipment and the services of its 250 staff members to work on a wide variety of problems. These include cardiovascular disease, protein structure, molecular dynamics, materials flow and mixing, earthquakes, and mathematics. Increasingly, supercomputing is being used in the social sciences and liberal arts. Environmental and climate studies require the processing of enormous amounts of data.

These large volumes of data and calculation results are increasingly moved on the Internet. Supercomputing centers and the Internet make it possible for relatively small research centers and research groups to avoid the expense of purchasing their own supercomputers and setting up information technology administrative staff. For example, the Open

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Science Grid associated with Argonne National Laboratory promotes discovery and collaboration in data-intensive research by providing a computing facility and services that integrate distributed, reliable and shared resources to support computation at all scales.

The largely Texas-based Petroleum Engineering Grid (PEGrid) is another example of an open-grid project. According to senior scientist Alan Sill of Texas Tech University, it began in late 2009 with the objective of allowing the best practices in academia and industry to be shared. Having spent huge sums to generate seismic and other oilfield data, data security is a major worry for oil and gas companies and the firms generating this data. These concerns discourage many companies from exploring grid technologies. According to Sill, one reason for this is that, compared with the best practices of grid computing, many firms use outdated data security methods. PEGrid provides a means for these firms to become familiar with grid computing security practices. As they do so, they are more likely to employ grid computing techniques extensively.

> "... data security is a major worry for oil and gas companies and the firms generating this data ..."

Cloud computing

Cloud computing is a trendy way of describing web-accessible data storage and processing.[3] It offers an efficient way for organizations to deliver and use information technology infrastructure, applications and services. Examples of data stored in the cloud include your product recommendations from Amazon.com based on your previous purchases. Social networks such as Facebook and professional networking sites such as LinkedIn save information about you in the cloud where others can retrieve it. Photo-sharing sites store images in the cloud. Web-based e-mail programs keep messages in the cloud. People also are starting to back up the contents of their computers to the cloud. This makes files accessible from almost anywhere when using an Internet connection.

Protecting proprietary information and preventing unauthorized access to data stored in a public cloud is a serious concern. Consequently, many organizations have concerns about storing these data and their own personal data elsewhere other than on their own computer system. Private data clouds exist on an organization's own computer system, protected by corporate firewalls. They enable organizations to decrease capital costs by reducing the number of servers, minicomputers and mainframe computers they need since these resources are shared by people adding to and processing data in the cloud.

Technologies promoting the data flood

Several technologies in particular are promoting the flood of scientific data needing to be transmitted and processed. The discovery and evaluation of oil and gas reservoirs have long required powerful computers and processing of very large amounts of data. These requirements have intensified as the industry has increasingly explored for hydrocarbons under ocean waters. Offshore oil and gas exploration requires "immense levels of information processing," according to Robin West, chairman of consulting firm PFC Energy.[4] Seismic imaging is the key technology in discovering these oil and gas fields. This technology has become steadily more sophisticated, requiring increased data-processing capacity. As the industry explores for oil in deeper rock formations at greater ocean depths, large oilfields are being discovered under salt layers. These thick layers disrupt sound waves, blurring the seismic images. Sharpening these images requires the use of supercomputers.

The U.S. Food and Drug Administration requires the pharmaceutical industry to collect and report increasingly large volumes of clinical trial data. Often these trials are conducted in other countries such as India. The amount of data required to support new drug applications is growing rapidly.

Another field with huge data generation and processing requirements is weather forecasting. Both local weather data stations and satellites collect and transmit large volumes of data for analysis. Since the December 26, 2004, tsunami tragedies in the Indian Ocean that killed over 200,000 people, networks of detectors have been placed in the ocean in many locations to detect tsunamis and predict their size and course to permit timely evacuations of coastal areas. For example, just three hours after the February 27, 2010, earthquake in Chile, a sensor on the ocean floor 205 miles from the epicenter transmitted the first evidence that a tsunami was headed across the Pacific Ocean toward Hawaii.[5] Scientists at the National Oceanic and Atmospheric Administration Pacific Warning Center calculated the course of the tsunami and how powerful it would be when it hit coastlines. Emergency sirens gave coastal residents more than ten hours to evacuate before destructive waves washed ashore. As a result, there were no significant injuries or major damage.

Speaking at the AAAS annual meeting, Hal Varian, on the faculty at the University of California, Berkeley, and chief economist for Google, Inc., described a new data analysis tool called Google Insight for Search. It permits the correlation and prediction of data with the number and distribution of individual Google searches. For example, by mining past data on Google searches for information on Toyota automobiles and correlating them with Toyota sales, Varian was able to predict current sales volume with a reasonable amount of accuracy before industry sales data was released.

Sciences

Virtually all fields of science are increasingly performed by researchers scattered over the globe who both generate and process increasing amounts of numeric and image data. For example, "metagenomics" is a relatively new field of research that uses the latest developments in DNA sequencing technologies to study genetic material recovered directly from environmental samples. The vast majority of life on earth is microbial. Previously, most research on microbes depended on the preparation of laboratory cultures. However, since 99 percent of microbes cannot be cultured, it is only recently that modern genetic sequencing techniques have allowed determination of the hundreds to thousands of microbial species present at any given environmental location.

The amount of data defining the metagenomics of these microbial ecologies is growing exponentially as researchers acquire next-generation sequencing devices, said Larry Smarr of the University of California, San Diego, who spoke at the 2010 annual AAAS meeting. As an example, he cited Community Cyberinfrastructure for Advanced Marine Microbial Ecology Research and Analysis (CAMERA), funded by the Gordon and Betty Moore Foundation. Its data repository at the University of California, San Diego, presently contains over 500 microbial metagenomics datasets plus the full genomes of approximately 166 marine microbes. Over 3,000 registered end users from 70 countries can access existing data and contribute new metagenomics data via the Internet.

The increasing number of scientific research space probes launched by NASA and other countries requires both supercomputer power and transmission around the globe for data analysis and study. Climate studies require supercomputing power to perform the complex simulations required to study global warming and other phenomena.

According to Les Cottrell, director of computer services for the Stanford Linear Accelerator Center (SLAC), high-energy physics has become a global enterprise, with data needing to be available to many sites around the world for analysis. SLAC and other facilities are generating huge amounts of data that must be transmitted over great distances. Data is flowing into, as well at out of, the United States. For example, CERN's Large Hadron Collider in Switzerland is providing enormous amounts of data to U.S. researchers.[6]

Challenges and opportunities

There are several unresolved issues facing lab managers. How can research organizations ensure that data are properly archived and made available to all the researchers who might find them useful? How can the origin and accuracy of data be ensured and properly documented? What new approaches are needed to ensure that the preservation and access to data of great scientific and social value is a priority?

Despite Greer's concern and the challenges raised in the opening paragraph of this article, symposium attendees were excited about the new possibilities for R&D offered by the exaflood. They felt that laboratories would surf the flood of data rather than be overwhelmed by it.

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GREENING UPS

WHEN IT COMES TO DETERMINING THE ENVIRONMENTAL FOOTPRINT OF A UPS SYSTEM, FACTOR IN THE BATTERY

by Ron Seredian

Today's industrial, scientific research and production laboratories all have a common goal—to maintain a high rate of throughput, which can be measured in a number of ways. Most of these labs are highly automated, and in many cases standard systems, instruments and procedures are codified to meet stringent guidelines mandated by the industry and internal to the organization. This common goal drives investing in the new instruments, automated laboratory systems and techniques that lab managers are constantly seeking.

Labs that make a product or test samples run a constant cycle of lab instrument upgrades in order to maintain a high level of productivity and throughput. The logic driving the decision to update a mass spectrometer, for example, is typically based on an exponential increase in the number of tests that can be performed by the up-to-date instrument. In addition to keeping throughput at peak levels, today's lab manager is also faced with the challenge of leaving a smaller carbon footprint in terms of the resources a lab uses. The resources that probably come to mind are costly reagents and other essential materials required to perform these tests.

> "... when UPS maintenance is viewed from the perspective of overall impact on the environment, the resources required to recycle batteries are significant."

When we look at this "greener lab," we can look at a number of layers. In the 1980s those developing computer networks adopted the Open System Interconnection Reference Model (OSI model) to ensure that all hardware, software and internetworking elements shared common communications, hardware and other protocols so that everything could connect and operate as a single system. If, for example, we use this model to look at a lab and all the elements that give a mass spectrometer the materials it needs to perform its tests, AC power quality and reliability will be at the bottom layer of the resources being acquired.

Many laboratories use a smaller UPS system at each instrument—a line-interactive, or "switching," Smart-UPS for equipment using less than 3kVA or 2100W, mostly due to a lower cost. This approach has several advantages and a few drawbacks in terms of leaving a smaller carbon footprint.

In the June 2009 issue of *Lab Manager Magazine*, author Michael Stout discussed the impact of power problems affecting the precise operation of labs by focusing on a common issue that most lab managers face when they deploy one of these smaller, computer-grade line-interactive UPS, to combat the effects of the dirty, unregulated AC power found in most laboratories.

The device more suited for laboratory equipment, from the perspective of output power regulation and power backup time required, is clearly one that regulates AC power continuously—an online UPS. This better UPS will transfer seamlessly without switchover time and deliver the same clean sine-wave power to the instrument when the power drops out.

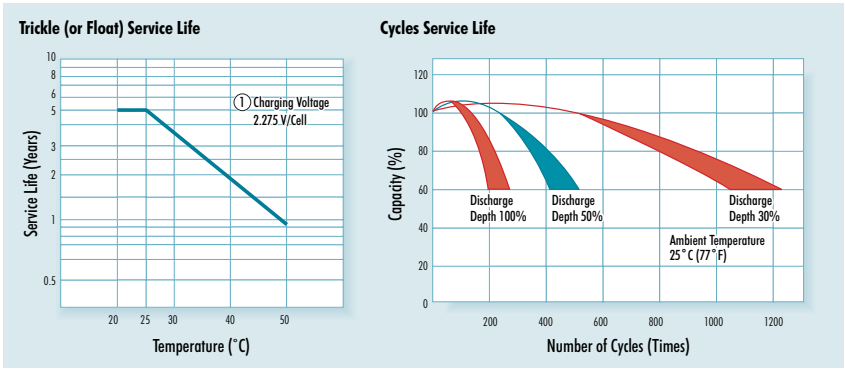
In addition, in endeavoring to create a greener laboratory, the primary impact any UPS has on the environment in terms of maintenance is the battery replacement cycle. The line-interactive, Smart-UPS carbon footprint is significantly higher due to its very design.

Battery overview

At the heart of every UPS you will find a battery, and due to the large number of smaller UPS units typically used in laboratories of all stripes and sizes, the cost of ownership may be much higher when this element is factored into the equation. Typically the referenced UPS topologies use valve-regulated sealed lead-acid (VRLA) batteries, as they provide the highest power density at the

lowest cost. Until recent developments in technology, the five-year-rated VRLA battery used in a UPS typically had a four- to five-year service life if maintained in a 77°F (25°C) environment and properly charged.

In addition to not maintaining the battery at the proper charge, the VRLA battery's service life can be shortened further by high temperatures and too-frequent discharge and recharge cycles. Line-interactive UPS models can switch to battery mode too often if installed where utility voltage regulation is poor. This is not the case with double conversion online UPS models, as they draw power from the battery only when the utility voltage is extremely low or lost completely. As the online UPS typically costs more to make, the battery chargers often are better designed and better at maintaining the battery's



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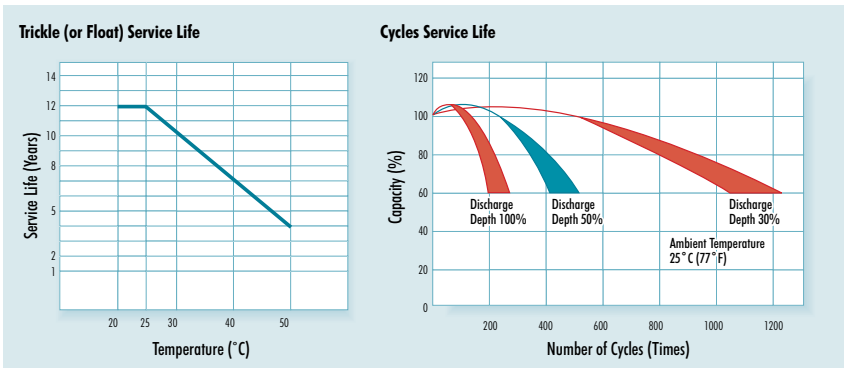

charge, resulting in a longer service life.

Though the VRLA battery's design has changed little in the last several years, a new VRLA battery is rated to last up to 12 years. Similar to a standard five-year-rated VRLA battery, these batteries will last their rated life when operated at room temperature and used in "stand-by service" mode, as described in the previous paragraph. In simple terms, these new batteries have a higher lead content, as well as a larger internal surface area. The result is slower overall degradation of the chemicals and internal components.

The charts outline the effect of higher temperatures on battery life. Though most labs are temperature-controlled, these charts show how drastically battery life is reduced at higher operating temperatures.

Lab managers who install a line-interactive Smart-UPS enjoy an overall lower cost up front. However, the total cost of ownership shows a very different picture. The typical life of a standard battery in a line-interactive device is two to two and a half years, so over a 10-year period the user will experience three to four battery replacement cycles. This ends up costing the lab user more because of the need to buy and replace batteries. Also, this cost increases exponentially as the size of the UPS increases, since larger models use more batteries. Another factor that will drive this cost higher is a run-time of 20 or 30 minutes that draws on reserve battery power, which typically requires a UPS with an additional external battery pack.

When UPS maintenance is viewed from the perspective of overall impact on the environment, the resources required to recycle batteries are significant, both from a recycling viewpoint as well as the number of times a battery needs to be changed out. From the time replacement batteries are ordered, the energy required to deliver new and return old, heavy lead-acid batteries has an impact on the environment. Recycling requires the battery manufacturer to use resources when taking old batteries, recharging their chemicals, reconditioning metal and making other efforts to repackage batteries. The impact on resources such as water and energy must be taken into consideration.

A UPS that leaves a smaller footprint

Recent snowstorms and corresponding power outages may have caught your lab without an adequate power protection "parachute" in place. In many cases lab managers who use the ubiquitous line-interactive Smart-UPS device find that it costs a lot to maintain. Many lab users give up on maintaining the device, but this is not recommended, as the batteries can swell and even leak gas if not replaced. However, an online UPS that uses internal batteries if—and only if—there is a power outage gives users a much longer battery replacement cycle. A new 12-year-rated battery will have a much smaller carbon footprint but, equally important, it will be ready to supply clean power when your instrument and other automated test equipment are exposed to utility power.

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THE FOUR CHARACTERISTICS OF SUCCESSFUL NETWORKERS

Each day, scientists have the opportunity to use their talents and work ethic to change the world in which we all live. Through the application of scientific principles to research efforts in human health, environmental and energy issues, product development, and other disciplines, scientists have the greatest opportunity to positively impact society and their fellow humans in a myriad of ways.

Whether by training and education or by moving up through the ranks of their respective organizations, fortunate research professionals make their way into fields that offer meaningful work and the opportunity to use their skills to contribute to society. In addition to good fortune however, there is one important talent that researchers and managers need to achieve success in their respective careers. That talent is the ability to network.

Through the fine art of networking, science professionals are able to reach their full potential within their fields of work. Whether they are seeking employment in industrial laboratories, university research facilities or world-class government research centers, networking offers a powerful tool.

By continuously meeting new people and increasing their professional contacts in the scientific industry, scientists can learn about new opportunities within their fields. At the same time, some individuals might want to consider positions outside of their current career fields.

> "The most successful networkers... have two common characteristics—an open mind and the desire to meet people within all professions."

By practicing the following four characteristics of successful networkers throughout their careers, many science professionals may be well-prepared to not only positively impact the world around them, but also obtain exciting research and employment opportunities.

Maintain an open mind

As scientists meet and interact with professionals who work in all types of industries, they may choose to develop relationships with them. By treating each contact equally, whether or not the person is a scientist, science professionals may be pleasantly surprised by the opportunities they are able to uncover.

The most successful networkers in the world typically have two common characteristics—an open mind and the desire to meet people within all professions. Experienced networkers know that career opportunities arise when they least expect them. By maintaining an open mind, many scientists may be able to pursue such opportunities once they are available.

Carefully consider new career opportunities

Experienced networkers can learn about new positions that are not publicly posted. With a broad base of professional contacts, they may gain access to a variety of meaningful positions and use their education, skill sets, and natural talents to positively impact the scientific industry, as well as cultures outside of their own. Some new positions can lead to higher pay and exposure to new contacts, while allowing scientists to develop new skills that will be invaluable throughout the rest of their careers.

In the past, many scientists may have turned away from new career opportu-

nities simply because they were afraid to take risks, fearing that the consequences of failure may outweigh the positives of success. In today's workplace, many employees are responsible for their own careers. As such, some employees are taking "risks" in order to attain progress.

Develop lifelong connections

Many scientists acquire a variety of networking contacts, yet fail to remain in touch with them for long periods of time. In order to network properly, science professionals should talk to their contacts not only for a few months or a couple of years, but for an extended period of time. Efficient networking requires years of connections that may lead to lifelong relationships, as well as new career opportunities.

"Experienced networkers can learn about new positions that are not publicly posted."

Listen to contacts and then follow up with them

As scientists meet new contacts, they typically want to ask them a lot of questions. While it is important to communicate with new contacts in an efficient manner, science professionals should listen to them as well, rather than bombard them with dozens of questions.

New contacts will feel more comfortable conversing and networking with their fellow scientists if they are able to tell their stories first, without being interrupted. Out of courtesy, scientists should always listen first. They will likely receive more information by listening, rather than by continuously asking questions.

Once scientists have initiated new relationships, they should follow up. Through continuous follow-up with professional contacts at lunches, banquets and various events, scientists will appear to be interested in not only discovering new career opportunities, but also in learning more about science in general.

By remaining open minded, carefully considering different career opportunities, listening to and following up with contacts, and maintaining lifelong connections, scientists can be successful networkers throughout their careers and lives. While meeting new contacts, science professionals may encounter a variety of opportunities to positively impact the world and fully develop their talents and skill sets. Simply put, networking will help scientists perform to the best of their abilities in order to achieve goals they previously thought were unattainable.

"Efficient networking requires years of connections that may lead to lifelong relationships as well as new career opportunities."

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« EXPERT: Dr. David Hachey

ASK THE EXPERT

HOW TO OVERCOME CHALLENGES WITH MASS SPECTROMETRY

by Tanuja Koppal, Ph.D.

David Hachey, Ph.D., talks to Tanuja Koppal, contributing editor to* Lab Manager Magazine, *about his role and responsibilities as the director of both the mass spectrometry (MS) and proteomics core laboratories at Vanderbilt University. He elaborates on how the two facilities are run and the types of services they provide. He also offers valuable insights into the common challenges users are faced with when using mass spectrometers and in running an open-access core facility.

Q: Are there many differences between the mass spectrometry and proteomics core labs that you oversee?

A: There is a significant difference between the two, although they both use only mass spectrometers. The small molecule MS core is run as an open-access instrument facility, while the proteomics core is not. Proteomics involves a relatively sophisticated and technically challenging series of measurements, and casual users like graduate students don't necessarily gain the skills to use the instruments efficiently. Hence, it is operated as a closed-access facility where users prepare samples in their own lab and we process the samples, perform the analysis and then share the results with the investigator. The two labs also differ significantly in terms of their MS capabilities. In the small molecule core we depend mainly on triple quadrupoles and ion trap MS instruments and have limited access to high resolution MS. We also use only conventional HPLC and do not use nano-flow HPLC. However, in the proteomics core we exclusively use nano-flow HPLC and the primary workhorse there is Thermo Scientific's LTQ ion trap and Orbitrap instruments. We also have a MALDI-TOF-TOF instrument. Nano-flow HPLC is quite tricky and again, casual users lack the expertise to use the demanding microfluidics that is involved and to detect problems. They are welcome to do limited proteomics in the small molecule core but femto or attomole level detection of proteomic samples must be done in the proteomics core.

Q: Are there different sets of challenges due to the different instruments and applications being pursued in the two labs?

A: Absolutely. In the small molecule core we work mainly with graduate students and post-doctoral fellows who often do not have a lot of technical experience working with mass spectrometers and hence, they don't work very efficiently. We do have a training program to bring them up to speed in terms of what is required to run the instrument and to optimize for a particular assay and we later also help them interpret their results. The downside is that we face more wear and tear on the instruments and they need to be cleaned more frequently, since students often tend to be less critical of sample preparation. Students also don't immediately recognize when there is a problem and hence they are less efficient. But I accept that as a part of the training mission at the University.

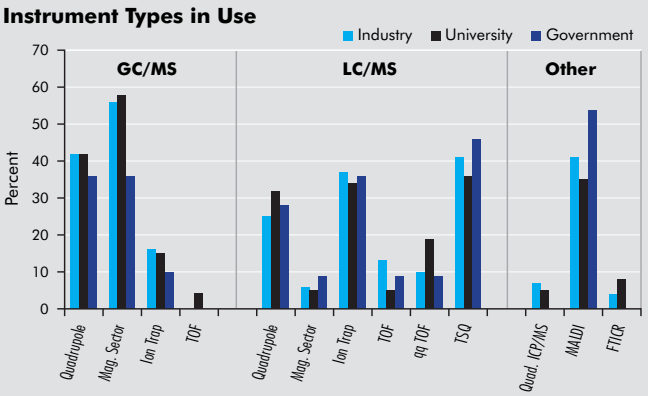
Q: What does your in-house training cover?

A: Training courses are given approximately once a month, as well as on an *ad hoc* basis, as new students come in. The first half of each course consists of two to three hours of lectures covering both theory and operation. The second half is a hands-on tutorial covering instrument setup, operation and shutdown. The facility personnel then work with the user on a one-on-one basis to cover their specific experiment and application. We also review the data with them during the early stages so the user can learn to interpret it correctly. We have two or three people available every day to help out if any problems arise. We are open from eight AM to six PM and during late evenings and weekends we provide access to users, but only those who are technically proficient. Only in certain cases, when we don't have the time or the technical expertise, we recommend that the user go to a vendor to get trained on a specific class of instruments.

Q: Any advice in terms of selection of instruments or vendors?

A: We have standardized based on a single vendor in order to have a single software platform. The students struggle a bit if the software systems are not user-friendly and tend to get

David L. Hachey, Ph.D., is the professor of Chemistry, Biochemistry and Pharmacology at Vanderbilt University in Nashville, Tennessee. He has been the director of the mass spectrometry core laboratory at Vanderbilt since 1998 and in 2007 he assumed the responsibility as director of proteomics core as well. The service labs provide instrumentation and analytical expertise to Vanderbilt's research community. They also offer an active MS training program to teach new users how to design experiments, do the sample preparation, operate the instrument and interpret the results. The MS core lab is used by about 175 investigators each year from ~75 research groups at the University. As the director, Dr. Hachey is responsible for establishing policies and procedures for the equitable use and maintenance of the facility, preparing grants for obtaining funds to support the facility and in assisting the development of new analytical methods.



▲ *Source: Data collected from a survey of mass spectrometry service facilities conducted in 2000.*

confused if they have to move across instruments using different operating systems. We have done the same for the proteomics core in order to build a continuous workflow from sample prep to the bioinformatics analysis and found it much simpler to have a single data file structure to work with. If you have the luxury to work with a single vendor then life is definitely easier for you. We also have no service contracts on any of the instruments. We have our own in-house engineer, so we do our own servicing and routine maintenance. We have had good success with Thermo Scientific and I am sure the other vendors are equally qualified. They walk you through the diagnosis of a problem without charge, which is quite a cost savings.

Q: What are some of the common problems you encounter?

A: The big one is, "I can't see my molecule!" Well, how do you know it is present in the sample? Have you run a calibration curve with standards and blanks? There are a number of standard protocols you use in diagnosing a problem. Sometimes it's an instrument problem. For instance, the heated capillary in the ion source becomes clogged and has to be cleaned or the HPLC columns go bad. Sometimes the user cannot recognize the problem and we have to go through the experiment step-by-step to determine what is going wrong.

Q: How has the field evolved in the last decade?

A: When I joined Vanderbilt in 1998 the main emphasis was on gas chromatography/mass spectrometry (GC-MS) measurements of small molecules and that was 65 to 70 percent of the workload. The other 25 percent was liquid chromatography-MS (LC-MS) and about 10 percent was matrix-assisted laser desorption/ionization (MALDI). Today, probably 85 percent of our work depends on LC-MS. The main advantage to using LC-MS is that it has solved a lot of problems with sample prep and is less demanding than GC-MS. We now have a total of 10 mass spectrometers in the small molecule core lab—four triple quadrupoles, three ion trap instruments, one MALDI, one GC-MS and one high resolution Q-TOF (time-of-flight). So if I were to set up a lab today I would probably get a triple quadrupole or an ion trap, a high resolution instrument like a Q-TOF or Orbitrap and finally a GC-MS. But then again, this depends very much on the user base. Our work is mostly quantitative and in the biomedical area, which is reflected in our choice of instruments.

Q: How have your own responsibilities evolved over the years?

A: Initially the biggest challenge was changing the culture at Vanderbilt. We wanted to make the core an open-access facility and we realized that in order to do so we needed a training program in place. Over the past 10 to 12 years we have trained nearly 600 to 700 people and the expertise has now been disseminated into individual laboratories. These investigators are now taking on more responsibility for training incoming students in their lab in the various techniques. So we have been fairly successful on that front. The challenge we now face is to keep our extensive operations funded with a mix of funding from individual investigators, center grants, and from the University.

EVOLUTION OF THE LAB CENTRIFUGE

BY JOHN BUIE

The laboratory centrifuge, one of the most important sample preparation instruments in use today, is considered to be one of the most efficient ways to separate samples of different densities. Many types of centrifuges are available, ranging in size from bench top models with a capacity of 1.2 L and a maximum load of 1.5 kg, to large, free-standing centrifuges with a capacity of 5 L and a maximum load of 6 kg or larger. Some of the larger instruments are able to reach speeds of up to 10,000 rpm, while the smaller centrifuges usually have maximum rotational speeds below 300 rpm.

Bench top centrifuges capable of speeds of about 3,000 rpm have been in use since the mid-1800s. Early instruments were hand powered, but in 1912, with the introduction of electric centrifuges, that changed. The early centrifuges were mostly used for non-biological applications, such as separating milk and collecting precipitates.

The process of centrifugation can be traced back to the mid-15th century, when hand-driven centrifuge systems were used to separate milk.

1850

In **1864**, this *ad hoc* system of milk separation was commercialized by Antonin Prandtl, who developed the first dairy centrifuge for the purpose of separating cream from milk.

The potential of the centrifuge in the laboratory setting was first exploited by Friedrich Miescher. In **1869**, Miescher used a crude centrifuge system to isolate a cell organelle. This process led to the discovery of an important new class of biological constituents, later to be known as nucleic acids.

The work of Miescher was quickly recognized and developed further by others. In **1879**, the first continuous centrifugal separator was demonstrated by Gustaf de Laval. This development made the commercialization of the centrifuge a possibility for the first time.

During the early **1930s** Martin Behrens developed improved centrifugation techniques using density gradients of nonaqueous solvents for the separation of nuclei. His approach to tissue fractionation aimed to isolate one or more identifiable components from disrupted cells that could be physically and chemically characterized.

1900

In **1942** Albert Claude and James Potter published a landmark paper, "Isolation of Chromatin Threads from the Resting Nucleus of Leukemic Cells." This paper outlined a series of centrifugation steps in which either the supernate or the sediment was collected until "chromatin threads" were retrieved from the final sediment.

The next major step forward in the evolution of the centrifuge came during the **1920s** and **1930s**, when the ultracentrifuge—capable of achieving 900,000 g—was developed by the Swedish colloid chemist Theodor Svedberg. Models capable of reaching 900,000 g tended to have small rotors, so ultracentrifuges with larger rotors that could operate at around 260,000 g were more commonly used in routine work. Svedberg used his centrifuge to determine the molecular weight and subunit structure of highly complex proteins, such as hemoglobin. This information started a revolution in the understanding of the structures of proteins. In 1926 Svedberg received a Nobel Prize for the invention of the ultracentrifuge and for his work in colloid chemistry.

Svedberg's ultracentrifuge, however, was essentially an analytical instrument, specifically designed for the accurate recording of sedimentation boundaries. It would have been impossible to convert it for preparative processes for the simple reason that its rotor axis was horizontal. The transition from these analytical instruments to the modern preparative ultracentrifuges came through the efforts of the French physicist Emile Henriot, who was able to achieve very high rotational speeds by means of a bearingless top, driven and supported by compressed air.

Interest in the isolation of viruses brought Edward Pickels and Johannes Bauer together to build the first high-speed vacuum centrifuge suitable for the study of filterable viruses. Later, Pickels went on to develop the more convenient, electrically-driven ultracentrifuge.

In **1954**, Beckman Instruments (now Beckman Coulter) purchased Spinco, forming the basis of its Spinco centrifuge division. Beckman immediately began improving the design of centrifuges—many of which are still used today. For example, the drive systems were replaced with high speed motors, and the material used for the rotor blade was upgraded.

In **1949**, Spinco introduced the Model L, the first preparative ultracentrifuge to reach a maximum speed of 40,000 rpm. This marked a dramatic change in the fortunes of Spinco.

In **1971** HEINKEL developed the first inverting filter centrifuge HF.

In **1991** HEINKEL introduced Hypercentrifugation® for high-pressure dewatering.

In **1992** the PAC® (Pressure Added Centrifugation)-System was developed by HEINKEL.

In **1976** the world's first microprocessor-controlled centrifuge was launched at ACHEMA by Hettich. This innovation was considered ahead of its time, and arrived many years before this technology became standard.

During the **1980s**, Beckman launched the first floor ultracentrifuges.

In **2000** Eppendorf innovated its line of classic microcentrifuges with the cooled 5415D centrifuge, which was the smallest and quietest cooled microcentrifuge on the market. Also in this year, Eppendorf launched the MiniSpin and the MiniSpin Plus, known as personal centrifuges—a new era for the centrifuge market.

1950

2000

In **1962** Netheler & Hinz Medizintechnik, a company based in Hamburg, Germany, and known today as "Eppendorf", developed the first microcentrifuge for laboratory use. This 'microliter system' (model 3200) was introduced for use in routine analytical labs on a microliter scale, and offered just one dial to control centrifuge time. The "Microliter System" was the basis for a broad range of tools for the molecular laboratory, which were subsequently developed by a variety of biotech and labware companies.

The early **1950s** saw the introduction of density gradient centrifugation for tissue fractionation, a process developed by a plant virologist, Myron K. Brakke, working at the Brooklyn Botanic Garden.

In **1946**, Pickels cofounded Spinco (Specialized Instruments Corp.) in Belmont, California, and marketed an ultracentrifuge based on his design. However, sales of the technology remained low and Spinco nearly went bankrupt in the early years.

During the **1990s**, Beckman launched the Avanti® high-performance centrifuge, which went on to be one of the most popular centrifuge models in history. Also during this decade, the first centrifuge capable of robotic operation was developed by Hettich. This centrifuge also offered PC-control and adjustable rotor positioning.

FUTURE OF CENTRIFUGES

Centrifugation has come a long way since the process was first commercialized for laboratory use in the 1940s. The original rotors, such as those built by Svedberg, were made of tensile steel. Today materials such as aluminum alloys and titanium are used in order to withstand high centrifugal forces. Standard features now include processes for cooling, programming, automatic imbalance detection, noise reduction and changeable rotor systems.

Vacuum systems have also been added to modern centrifuges to reduce friction and maintain temperature control. The development of other tools, such as electron microscopes, has allowed researchers to better examine and investigate the particles being centrifuged.

With research into proteins and cell nucleic matter becoming more and more important and gaining pace all the time, the centrifuge will continue to be a vital piece of laboratory equipment for the foreseeable future. Further from home, the Human Research Facility of the Destiny Laboratory of the International Space Station is currently making use of centrifuge technology from Hettich as part of its ongoing effort to improve medical research and technology for human life in the future.

SENSITIVE, QUANTITATIVE METALS ANALYSIS

by Angelo DePalma, Ph.D

Atomic absorption (AA) has been known since the 19th century, but it was not until the 1950s, thanks to efforts by Alan Walsh at Australia's CSIRO research center, that use of AA spectrometers became routine for metals analysis.

A true Beer's law absorbance technique, AA measures ultraviolet light absorbed by hot, atomized metals. The absorbance wavelength is unique to every metal, but the signal intensity varies by concentration. Instrumentation is straightforward, consisting of a light source, atomizer and detector. Atomizers are traditionally high-temperature flames, but graphite furnaces and various plasma sources are also used. Light sources include hollow cathode lamps (most common) and diode lasers. Detectors are most usually photomultiplier tubes.

AA handles many sample types, but operation requires that metal analytes exist as freestanding atoms in the gas state, rather than as ions in solution or solid metals or salts. Solution samples must first be dried, a process known as "desolvation," before they are atomized and pumped with UV light.

AA could be considered for nearly any application that requires the identification and/or quantification of metals. For example:

- environmental analysis
- quality control for contaminant, ingredient, or trace metal in foods, drugs, personal care products, paper, materials, and other products
- forensics, archeology, mining, agriculture
- natural science experimentation

Interesting developments in AA include the introduction of the single xenon arc lamp, which permits a single light source or instrument to address all metals accessible by AA. Xenon lamps also provide up to ten times the sensitivity of conventional AA. Similarly, the introduction of solid-state charge-coupled device detectors, improved background detection, direct analysis of solids (without atomization), and the ability to detect nonmetals has extended the capabilities of modern AA spectrophotometers.

"... graphite furnace instruments require less sample than flame AA spectrophotometers."

Analyzer types

Chuck Schneider, business unit manager for PerkinElmer's (Shelton, Conn.) inorganic analysis products, breaks AA instrumentation down into three categories: flame, graphite furnace, and dedicated analyzers. PerkinElmer further delineates these into entry-level systems and higher-end systems with more extensive automation, software, data handling, and the ability to switch back and forth from flame to graphite furnace operation.

Graphite furnace AA spectrometers are significantly slower than flame-atomizer instruments, but they provide several benefits. Because they concentrate the cloud of atomized metals, graphite furnace instruments require less sample than flame AA spectrophotometers—20 microliters vs. up to five milliliters. Sensitivity (ppb vs. ppm) is also higher in graphite furnace models.

On the business side, AA can be divided into instruments serving developed countries and those in developing nations. "More so than other inorganic analytic techniques, AA is very much divided into the primary instrument, consumable sales into that market, and service," Schneider explains. "There is a very large installed base of AA systems around the world, so the service component is quite large." The Chinese drug regulatory agency, for example, has recently ordered one hundred PerkinElmer AA instruments, Schneider says.

"AA could be considered for nearly any application that requires the identification and/or quantification of metals."

Yong Xie, product manager for AA instruments at Aurora Biomed (Vancouver, B.C.), notes higher demand for AA in the environmental (particularly for heavy metal analysis) and biomedical industries. The former is driven, he says, by government mandates to measure ever-smaller concentrations of metallic contaminants. AA is not typically thought of as a "life science" technique, but that is changing. Xie notes emerging applications in the pharmaceutical industry, particularly for measuring the function of potassium ion channels—physiologic structures in cells that allow ions to enter and leave—that are critical for cardiovascular health.

What customers look for

PerkinElmer has recently completed a large survey of inorganic analysis customers and found that the top two factors entering into purchase decisions are customer service (including the salesperson's knowledge and service support) and ease of use and setup for hardware and software. The third factor is the vendor's reputation. Price is "fifth or sixth on the list," Mr. Schneider says. "AA has got to be dead simple to use, because instruments are used by a lot of different people who may not have specific training in the technique. Years ago a lab might have had five people operating six or seven instruments. The number of techniques has remained the same, but the number of analysts might be down to two. Lab workers need to be generalists."

With more or less the same hardware technology accessible to all manufacturers, Yong Xie believes that some vendors err in focusing on the hardware and automation alone and not enough on the ease of use—a factor noted in the PerkinElmer study. "The computer industry has made huge progress in both hardware and software," he says, as have advances in automation, autosampling, and unattended operation. Since these advances won't help with detection limits or other fundamental performance factors, "they are best applied to enhancing the user experience, to provide the most convenient environment for operating the instrument and achieving desired objectives."

"AA is very much divided into the primary instrument, consumable sales into that market, and service ..."

Angelo DePalma *holds a Ph.D. in organic chemistry and has worked in the pharmaceutical industry. You can reach him at angelo@adepalma.com.*

Atomic Absorption (AA Spectrometers)

Analytik Jena	Jena, Germany	49 (0) 3641 77-70	www.analytik-jena.com
Buck Scientific	East Norwalk, CT	800-562-5566	www.bucksci.com
GBC Scientific	Hampshire, IL	800-445-1902	www.gbcscientific.com
Hitachi High Technologies	San Jose, CA	800-548-9001	www.hitachi-hta.com
PerkinElmer	Waltham, MA	617-225-0400	www.perkinelmer.com
Shimadzu Scientific Instruments	Columbia, MD	800-477-1227	www.ssi.shimadzu.com
Thermo Fisher Scientific	Waltham, MA	781-622-1000	www.thermo.com
Varian	Walnut Creek, CA	800-926-3000	www.varianinc.com

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STEPCHILD OF VIBRATIONAL SPECTROSCOPY COMES OF AGE

by Angelo DePalma, Ph.D.

Raman spectroscopy is based on the interaction of visible, near-infrared, or near-ultraviolet light on chemical bonds. When excited with light energy, bonds experience short-lived, higher-energy vibrational states. As bonds relax they emit light at several wavelengths, among which are weak "Raman scattering" effects.

Raman has become the "go-to" analytical method in materials science, pharmaceuticals, and homeland security. Raman's advantages are that it is nondestructive, detects analytes through packaging, and requires no sample preparation. The principal drawback is that Raman provides only confirmation, not quantitation.

Richard Larsen, Ph.D., spectroscopy products manager at Jasco (Easton, MD), divides Raman instrumentation into three categories: macro, micro, and imaging. Macro measures bulk properties in traditional "spectrophotometer" mode, micro instruments incorporate microscopy to analyze particles or very small samples, and imaging Raman involves spectral analysis of materials in 2D and 3D mode. Higher-end Raman spectrometers provide exquisite spatial and spectral resolution.

"Traditional Raman spectrophotometers were bulky instruments," says Kevin Carr, director of new business at Agiltron (Woburn, MA). "Low-cost portable instrumentation allows you to bring Raman where it needs to be."

Portable Raman spectrophotometers come in plug-in and battery-powered formats. The latter, which are mostly handheld field analyzers, are popular for inspecting materials on loading docks, in oil exploration, for crime scene analytics, and for detection of narcotics and explosives. What makes handheld instruments possible are inexpensive 785 nm diode lasers (originally developed for telecommunications) that consume less than 1 amp.

The huge drop in laser prices not only enabled portable Raman, but fueled the technique for benchtop and high-end research. But price tells only part of the story.

Joe Hodkiewicz, Raman product manager at Thermo Fisher Scientific (Madison, WI), notes that Raman is spreading well beyond its original domain of high-level chemical and materials research. "The technique is moving rapidly into disciplines where it traditionally lacked presence." Two reasons are the heightened focus on small-size domains (e.g., nanomaterials) and the enthusiastic acceptance of Raman microscopes, which today, according to Hodkiewicz, outsell more-traditional Raman analyzers.

Developers of products manufactured with nanoparticles increasingly turn to Raman microscopy to analyze not just chemical makeup but structural and physical phenomena such as stresses, fractures, and defects down to 500 nm dimensions. "As these materials migrate into applications and products, they pull Raman with them," Hodkiewicz says.

Imaging Raman has long been used to characterize surfaces for mechanical and physical phenomena such as strains, stresses or cracks. Raman can generate a three-dimensional picture, for example, when determining the homogeneity of a material or product such as a pharmaceutical tablet. "And the best part is, with Raman there is no sample prep," Dr. Larsen says.

Usability rules

Most users of Raman today view it as a tool like every other lab instrument. "To make systems appeal to these customers, vendors have to think a lot more about making self-optimizing instruments that are easy to operate, with little or no learning curve," Hodkiewicz explains. "This can be a challenge

to designers with a lot of Raman experience, to whom instrumentation is second nature. Telling them they have to simplify things is a challenge." Hodkiewicz compares the hurdles to making Raman accessible with the rise of digital cameras that allow users to take professional-quality photographs without worrying about such arcane knowledge as exposure times, apertures, and film speed. "That's the approach we're taking with spectroscopy," he says.

Another trend is the desire for flexibility and expandability. Users, Hodkiewicz tells *Lab Manager Magazine*, are purchasing not just for today but for anticipated applications that may require future upgrades, for example, the use of different excitation lasers, microscope and automation options, specialized sample cells, and remote fiber probes.

Larsen views Raman as being at approximately the same level of acceptance and use as FTIR was 20 years ago. "Back then an FTIR cost $100,000 to $200,000. Now we're down to sub-$20,000 FTIRs. Raman is going in the same direction. I don't think it will ever be as widely used as FTIR, but there's no doubt there is still plenty of room for growth."

Raman has traditionally been viewed as an exotic, if not problematic, analysis method. The main limitation, says Haydar Kustu, global marketing communications manager at Bruker Optics (Billerica, MA), was the laser which was difficult to operate. "Today, manufacturers are improving their Raman spectrometers by paying more attention to the laser." This has led, he says, to greater adoption of Raman in labs, and notable handheld product introductions as well. The signature trait of these newer systems has been reliability and ease of use.

Another plus has been the realization that Raman and IR are complementary. "Raman doesn't take market share away from IR," Kustu tells *Lab Manager Magazine*. "Rather, users tend to add it to their existing IR capabilities." This trend has been reflected, in recent years, by instruments incorporating both techniques. "Once people familiar with IR gave Raman a chance, they realized the technique was a lot more stable and easier to use than they'd anticipated, and definitely less exotic."

Angelo DePalma *holds a Ph.D. in organic chemistry and has worked in the pharmaceutical industry. You can reach him at angelo@adepalma.com.*

Raman Spectrometers

Agilent	Santa Clara, CA	877-424-4536	www.agilent.com
B&W Tek	Newark, DE	302-368-7824	www.bwtek.com
BaySpec	Fremont, CA	510-661-2008	www.bayspec.com
Bruker Optics	Billerica, MA	978-439-9899	www.brukeroptics.com
DeltaNu	Laramie, WY	866-301-6328	www.deltanu.com
Enwave Optronics	Irvine, CA	949-955-0258	www.enwaveopt.com
HORIBA Jobin Yvon	Edison, NJ	732-494-8660	www.jobinyvon.com
JASCO	Easton, MD	800-333-5272	www.jascoinc.com
Malvern Instruments	Westborough, MA	800-932-0101	www.malvern.com
Ocean Optics	Dunedin, FL	727-733-2447	www.oceanoptics.com
PerkinElmer	Waltham, MA	617-225-0400	www.perkinelmer.com
Renishaw	Hoffman Estates, IL	847-286-9953	www.renishaw.com
Shimadzu Scientific Instruments	Columbia, MD	800-477-1227	www.ssi.shimadzu.com
Thermo Fisher Scientific	Waltham, MA	781-622-1000	www.thermo.com
Varian	Walnut Creek, CA	800-926-3000	www.varianinc.com

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LAB MANAGER MAGAZINE'S INDEPENDENT GUIDE TO PURCHASING A UV/VIS SPECTROPHOTOMETER

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INDEPENDENT GUIDE TO PURCHASING A UV/VIS SPECTROPHOTOMETER

Consider the applications for which you will be using this spectrophotometer to determine the detection range you require, but also consider any future applications that may require a broader range. The UV/Vis range is from 190 to 900 nm. **The spectrophotometers below have a UV/Vis wavelength detection range of 190 to 900 nm. Next, choose what range of stray light performance you are comfortable with for your application and budget.**

A The degree to which the instrument eliminates stray light is an important specification for UV/Vis spectrophotometers and often dictates the purchase price. Defined as unwanted radiation picked up by the detector, it is measured using the ASTM method. **Continue on this path if you are looking for a high-performance stray light measurement of less than or equal to 0.00003 %T @340 nm in a UV/Vis wavelength range of 190 to 900 nm.**

Absorbance range is another specification to consider when evaluating whether a unit will fit your needs and it also separates higher-priced units from lower-priced equipment. Think of the sample in your application: if it is a turbid or concentrated liquid or a solid sample that is optically thick, you may require a working absorbance range between 5 A and 8 A or higher. Below is a short list of spectrophotometers that meet the following selection criteria: **absorbance range of greater than or equal to 5 A, high performance stray light measurement of less than or equal to 0.00003 %T @340 nm in a UV/Vis wavelength range of 190 to 900 nm.**

Hitachi
U-0080D
www.hitachi-hta.com

Analytik Jena AG
SPECORD® 250 PLUS
www.analytik-jena.com

Analytik Jena AG
SPEKOL® 2000
www.analytik-jena.com

Cecil Instruments
Series 1000 Visible
www.cecilinstruments.com

PerkinElmer
LAMBDA 1050, 950, 850
www.perkinelmer.com

Varian
Cary 4000
www.varianinc.com

Absorbance range is another specification to consider when evaluating whether a unit will fit your needs and it also separates higher-priced units from more value-based ones. For most clear liquids, measurement between 3 A and 8 A is acceptable. Below is a short list of spectrophotometers that meet the following selection criteria: **absorbance range less than 5 A, high performance stray light measurement of less than or equal to 0.00003 %T @340 nm in a UV/Vis wavelength range of 190 to 900 nm.**

Hitachi
U-1900
www.hitachi-hta.com

BioTek Instruments, Inc.
Epoch Microplate Spectrophotometer
www.biotek.com

BioTek Instruments, Inc.
PowerWaveXS
www.biotek.com

BioTek Instruments, Inc.
PowerWaveHT
www.biotek.com

Analytik Jena AG
SPECORD® 210 PLUS
www.analytik-jena.com

Analytik Jena AG
SPEKOL® 1500
www.analytik-jena.com

Cecil Instruments
Series 1000 UV/Visible
www.cecilinstruments.com

PerkinElmer
750 and 650
www.perkinelmer.com

Shimadzu
UVmini-1240
www.ssi.shimadzu.com

Varian
Cary 100
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B The degree to which the instrument eliminates stray light is an important specification for UV/Vis spectrophotometers and often dictates the purchase price. Defined as unwanted radiation picked up by the detector, it is measured using the ASTM method. **Continue on this path if you are looking for stray light measurements greater than 0.00003 %T @340 nm in a UV/Vis wavelength range of 190 to 900 nm.**

Absorbance range is another specification to consider when evaluating whether a unit will fit your needs and it also separates higher-priced units from lower-priced equipment. Think of the sample in your application: if it is a turbid or concentrated liquid or a solid sample that is optically thick, you may require a working absorbance range between 5 A and 8 A or higher. Below is a short list of spectrophotometers that meet the following selection criteria: **absorbance range of greater than or equal to 5 A, stray light measurements greater than 0.00003 %T @340 nm in a UV/Vis wavelength range of 190 to 900 nm.**

Jasco
V-660
www.jascoinc.com

Hitachi
U-2900/2910
www.hitachi-hta.com

Analytik Jena AG
SPEKOL® 1300
www.analytik-jena.com

Analytik Jena AG
SPECORD® 200 PLUS
www.analytik-jena.com

Cecil Instruments
Aurius UV/Visible
www.cecilinstruments.com

Thermo Scientific
NanoDrop 8000
www.nanodrop.com

Thermo Scientific
NanoDrop 2000c
www.nanodrop.com

Thermo Scientific
NanoDrop 2000
www.nanodrop.com

PerkinElmer
LAMBDA 650
www.perkinelmer.com

Varian
Cary 300
www.varianinc.com

Absorbance range is another specification to consider when evaluating whether a unit will fit your needs and it also separates higher-priced units from more value-based ones. For most clear liquids, measurement between 3 A and 8 A is acceptable. Below is a short list of spectrophotometers that meet the following selection criteria: **absorbance range of less than 5 A, stray light measurements greater than 0.00003 %T @340 nm in a UV/Vis wavelength range of 190 to 900 nm.**

Jasco
V-650
www.jascoinc.com

Jasco
V-630
www.jascoinc.com

Agilent
8453 UV-Vis Spectrophotometer
www.agilent.com

Hitachi
U-3900/3900H
www.hitachi-hta.com

Analytik Jena AG
SPECORD® 50
www.analytik-jena.com

Cecil Instruments
BioQuest
www.cecilinstruments.com

Beckman Coulter
DU 800
www.beckmancoulter.com

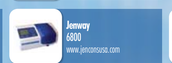
Beckman Coulter
DU 720/730
www.beckmancoulter.com

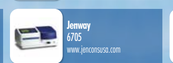
Aurora
UV-VIS 230
www.aurorabiomed.com

S. I. Photonics
440
www.si-photonics.com

S. I. Photonics
420
www.si-photonics.com

Hach
DR 5000
www.hach.com


Jenway
6800
www.jenconsussa.com


Jenway
6705
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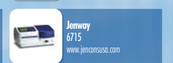
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PerkinElmer
LAMBDA XLS & XLS+
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Shimadzu
UV-2550
www.ssi.shimadzu.com

Shimadzu
UV-1800
www.ssi.shimadzu.com

START HERE

INTRODUCTION:

There are many features of a high performance UV/Vis spectrophotometer to consider before making your final purchase. Those features include analysis speed, ease of use, sample compartment size, flexibility and reliability. This guide will assist you in short-listing a few models by examining three main selection criteria: the detection wavelength range; its stray light measurement; and the instrument's working absorbance range. UV/Vis spectrophotometers from different manufacturers come in a variety of detection wavelength ranges, spanning from 175 nm to 3,300 nm, but as a guideline you can generally group a UV/Vis spectrophotometer into one of the three ranges outlined in this guide.

Consider the applications for which you will be using this spectrophotometer to determine the detection range you require, but also consider any future applications that may require a broader range. The Far-UV range is up to 175 nm.

Analytik Jena AG
SPECORD® 40
www.analytik-jena.com

Cecil Instruments
GeneQuest
www.cecilinstruments.com

PerkinElmer
LAMBDA 25, 35, 45
www.perkinelmer.com

PerkinElmer
LAMBDA XLS & XLS+
www.perkinelmer.com

Analytik Jena AG
SPECORD® S 600
www.analytik-jena.com

Cecil Instruments
Super Aurius
www.cecilinstruments.com

Analytik Jena AG
SPECORD® S 300 UV VIS
www.analytik-jena.com

Cecil Instruments
Super Aurius Dissolution Spectrophotometers
www.cecilinstruments.com

Cecil Instruments
DietQuest
www.cecilinstruments.com

Consider the applications for which you will be using this spectrophotometer to determine the detection range you require, but also consider any future applications that may require a broader range. The NIR range is up to 3,300 nm.

Cecil Instruments
ReflectaScan Reflectance
www.cecilinstruments.com

Jasco
V-670
www.jascoinc.com

Cecil Instruments
Super Aquarius
www.cecilinstruments.com

PerkinElmer
LAMBDA XLS and XLS+
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Cecil Instruments
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Cecil Instruments
AquaQuest
www.cecilinstruments.com

Shimadzu
UV-3600
www.ssi.shimadzu.com

Varian
Cary 5000 and 6000i
www.varianinc.com

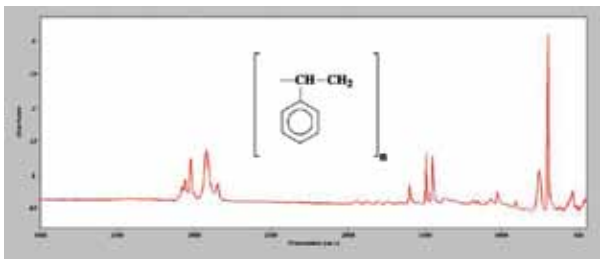
Author: John Buie

PICKING UP STEAM IN NONTRADITIONAL MARKETS

by Angelo DePalma , Ph.D.

Fourier transform infrared (FTIR) spectroscopy, a subset of infrared (IR) spectroscopy, uses a mathematical algorithm, Fourier transform, to translate raw infrared data into a spectrum.

Conventional IR spectroscopy is an absorbance technique that produces spectra that are unique for every IR-absorbing compound. The spectrum from 4000-1000 cm^{-1}, known as the "functional group" region, is diagnostic for alcohols, ketones, hydrocarbons, halogenated materials, and others. While functional groups may absorb at precisely the same wavelength, the spectrum below 1000 cm^{-1}, the "fingerprint" region, is unique for every compound.



FTIR spectrum of polystyrene.

By replacing the monochromator with a single, discrete light pulse transmitting all IR wavelengths simultaneously, FT represents a revolutionary improvement. FTIR generates a representation known as an interferogram, from which a computer subsequently performs an operation, known as Fourier transformation, to generate the spectrum. FTIR acquires a spectrum in one pulse, or collect many pulses and adds them to improve signal-to-noise. Thirty-two one-second pulses are about average for FTIR analysis.

Like IR, FTIR is useful for the analysis of organic and inorganic compounds that exhibit changes in polarity as a result of the vibration, spinning, or perturbation of molecular bonds. FTIR methods are common in such industries as foods, materials, chemicals, pharmaceuticals, forensics, and others. Advantages of FTIR over conventional IR are higher resolution, better signal-to-noise, easier analysis of very small samples and poorly-absorbing species, and much more rapid analysis.

Instrumentation

"FTIR instrumentation may be categorized according to specific end-user and application types," says Brian C. Smith, Ph.D., founder of FTIR training firm Spectros Associates (Boston, MA).

- Routine instruments that test raw materials or final products, about the size of a laptop computer, employing a single detector and costing about $20,000.
- Troubleshooting instruments that measure product impurities or defects, usually equipped with an IR microscope adapter for evaluating micron-sized materials. A microscope option adds $20,000-$40,000 to the cost of a basic FTIR spectrometer.
- Spectrometers that are used in pure research or high-end applications in academia or large corporations. These instruments perform sophisticated tasks such as IR imaging of cells, or biopsies and inspections of semiconductors. Depending on the bells and whistles, these instruments can cost more than $100,000.

"Changes in basic FTIR technology have slowed as the technique has matured, but subcomponents continue to improve," says Jerry Sellors, Ph.D., manager for FTIR at PerkinElmer (Beaconsfield, U.K.). Among these are underlying electronics, digital sampling, more reliable lasers, and generally better performance for a given price.

"Instruments are rapidly becoming turnkey solutions while getting smaller and easier to use," observes Haydar Kustu, global marketing communications manager at Bruker Optics (Billerica, MA).

"There's a lot of pressure to bring FTIR out of the lab and into the field." One of the most exciting scientific advances in this regard are MEMS (microelectromechanical systems), which enable rugged, low-cost handheld devices. "MEMS shrink the interferometer," Kustu says. Another enabling technology has been quantum cascade lasers (QCLs), which are brighter and more sensitive than conventional lasers. "MEMS and QCLs will open up many more niche or field applications for FTIR."

Unlike laboratory instruments, field analyzers are typically dedicated for single analytes. "These are built for specific purposes. You cannot swap out accessories, change from transmission to reflectance, or change the detector or the source. You cannot configure them on the go," says Kustu.

"There's a lot of pressure to bring FTIR out of the lab and into the field."

today are more likely to be nonspecialists or occasional users than IR spectroscopists," Dr. Sellors says. In this environment instrument makers must emphasize user-friendliness for both hardware and software. "Users today are less interested in buying an FTIR spectrophotometer than they are in acquiring a biodiesel or contaminant analyzer. Purchase decisions are influenced more by how well an instrument performs a specific task than by its technical specifications."

Cost and the performance/price ratio remain factors, perhaps more so due to the economic downturn, but remain unchanged in nature over the past two decades. Another factor that still matters very much is the perception of how well vendors support their products, both around the sale and afterward. In this regard, Sellors suggests that global communication within and among companies helps spread the word about which instrument manufacturers make the cut.

"In addition to budget issues, purchasers need to be clear, before they buy an FTIR spectrometer, on their applications," advises Dr. Smith. "It's too easy to get taken in by the 'gee whiz' factor. Most vendors offer quality instruments; the difference for the average user may be the software. It's imperative to take the software for a test drive, and not just let the salesman show you how it works. Take a spectrum yourself before you buy, and get references [from people] who can vouch for the manufacturer's service."

Angelo DePalma *holds a Ph.D. in organic chemistry and has worked in the pharmaceutical industry. You can reach him at angelo@adepalma.com.*

"In addition to budget issues, purchasers need to be clear, before they buy an FTIR spectrometer, on their applications."

Purchase factors

The proliferation of FTIR into materials, fuels, biology, environmental testing, and homeland security raises issues of usability and user-friendliness that did not exist a decade ago. "Users

FTIR Spectrometers

Bruker Optics	Billerica, MA	978-439-9899	www.brukeroptics.com
JASCO	Easton, MD	800-333-5272	www.jascoinc.com
Newport Corporation	Irvine, CA	949-863-3144	www.newport.com
PerkinElmer	Waltham, MA	617-225-0400	www.perkinelmer.com
Shimadzu Scientific Instruments	Columbia, MD	800-477-1227	www.ssi.shimadzu.com
Varian	Walnut Creek, CA	800-926-3000	www.varianinc.com

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BEST OF BOTH WORLDS

by Angelo DePalma, Ph.D.

Among the "hyphenated" mass spectrometry (MS) techniques, gas chromatography-MS (GC-MS) and high-performance liquid chromatography-MS (LC-MS) are the most notable. These methods combine the resolving power of high-resolution chromatography with the specificity and sensitivity of MS.

GC-MS has been around since the 1950s, although the technique was impractical for routine analysis until the advent of small, inexpensive mass detectors. LC-MS came into its own later, with the introduction of "soft" ionization methods such as electrospray (ESI) and atmospheric pressure chemical ionization (APCI).

The power of LC-MS and GC-MS derives from the orthogonality of their components. Chromatography's principal drawback is the co-elution of different chemicals, which complicates their definitive identification by ultraviolet or flame ionization detection, while mass spectrometry may not distinguish between isomers. Together, chromatography and MS practically eliminate these shortcomings.

LC-MS and GC-MS are complementary with respect to the types of molecule they work best with. GC is most appropriate for small, apolar, "traditional" organic compounds that volatilize easily, while LC shines with larger, polar compounds such as peptides, proteins, genes, and pharmaceuticals. In their native forms, LC treats molecules more gently than GC, which is even more true when comparing LC-MS and GC-MS.

Because LC-MS employs soft ionization, it generates a molecular ion peak corresponding to the molecule's molecular weight, but few fragment peaks. GC-MS, by comparison, tears the molecule apart to provide information-rich fragmentation patterns. Users may apply tandem MS (referred to as MS/MS) to induce fragmentation in LC-MS, but tandem detectors are costly. Software is used to "piece" fragments together and compute the molecular weight.

> "The power of LC-MS and GC-MS derives from the orthogonality of their components."

Comparing the methods

LC-MS is extremely effective for polar pharmaceutical molecules, metabolites, and smaller biomolecules. "But analysis of intact proteins is still a difficult, complex problem," observes Lester Taylor, Ph.D., LC-MS platforms and program manager at Agilent (Santa Clara, CA). Factors such as aggregation, folding, large size, and the presence of disulfide bonds or bound membranes don't interfere with LC, but they do confound mass analysis. Analysts can circumvent these challenges through chemical treatments or by using enzymes to break the molecules into manageable pieces.

"Most customers acquire LC-MS instruments as complete systems, but piecemeal purchases are possible if a particular LC or MS instrument is preferred. Turnkey systems," says Dr. Taylor, "are much less likely to suffer from LC-MS interface or communications issues."

GC-MS is more predictable. "Pretty much anything that goes through a GC can be analyzed by GC-MS," observes Ron Snelling, Ph.D., senior GC/GC-MS product specialist at Shimadzu Scientific Instruments (Columbia, MD). "The bad news is that GC is innately molecular-weight limited (to about 500-1000, depending on volatility). In the past, very large, polar molecules were derivatized (often by silylation), but this practice is dying out since LC-MS is so accessible."

As many as 25 percent of GC systems today ship with MS instead of flame ionization, conductivity, or electron capture detectors. This is a relatively new development resulting from the miniaturization of and falling prices for MS instruments. Customers most

often purchase complete GC-MS systems rather than components for the same reasons as for LC-MS. "In situations where labs decide to upgrade to MS detection for an existing GC," Snelling says, "they generally purchase a new GC-MS system instead because the cost of the GC component is fairly small. Customers considering high-end GC systems with two columns and two detectors should also consider a GC-MS instead. For an additional $15,000, you can have GC-MS and only have one column and one detector to worry about."

Common ground

Mass detectors have revolutionized LC and GC by providing unequivocal identification and exquisite detail to every analytical run. Iain Mylchreest, Ph.D., vice president and general manager for life sciences MS at Thermo Fisher Scientific (San Jose, CA), calls MS the "ultimate detection tool" that provides qualitative and quantitative information. "UV, FID, and PD tell you something is there but not what it is. MS tells you something is there and provides absolute identification."

> "LC-MS and GC-MS are complementary with respect to the types of molecule they work best with."

GC and LC labs interested in mass detectors have a range of choices. Single-stage quadrupole MS instruments return a molecule's nominal mass for LC, and more detailed mass plus fragmentation in GC mode. More advanced MS detectors utilizing tandem MS/MS are significantly more expensive, but provide very accurate mass to one or two parts per million, and accurate elemental ratios.

According to Dr. Mylchreest, dissatisfaction with derivatization is driving customers from GC-MS to LC-MS. An exception is for EPA methods, which are based on GC-MS for historical reasons. "It would take a lot of work to revalidate those methods," he says. Dr. Taylor of Agilent disagrees, attributing the perception that LC is "taking over" to the explosion of life sciences LC-MS applications, particularly in genomics, proteomics, and metabolomics.

Regardless, both GC and LC have staunch supporters whose loyalty is magnified with the addition of MS. "There has been a huge shift toward MS being the detector of choice for LC and GC," Dr. Mylchreest tells *Lab Manager Magazine*. "Mass detectors are slowly making inroads into the midpriced instrument market. MS won't replace UV detection for $30,000 LC systems, not for a while, but maybe some day."

Angelo DePalma *holds a Ph.D. in organic chemistry and has worked in the pharmaceutical industry. You can reach him at angelo@adepalma.com.*

GC/MS Systems

Agilent Technologies	Santa Clara, CA	877-424-4536	www.agilent.com
Applied Biosystems	Carlsbad, CA	800-327-3002	www.appliedbiosystems.com
Bruker Daltonics	Billerica, MA	978-663-3660	www.bruker.com
JEOL USA	Peabody, MA	978-535-5900	www.jeol.com
Konik Instruments	Miami, FL	305-252-0506	www.konik-group.com
LECO	St. Joseph, MI	800-292-6141	www.leco.com
PerkinElmer	Waltham, MA	617-225-0400	www.perkinelmer.com
Shimadzu Scientific Instruments	Columbia, MD	800-477-1227	www.ssi.shimadzu.com
Thermo Fisher Scientific	Waltham, MA	781-622-1000	www.thermo.com
Varian	Walnut Creek, CA	800-926-3000	www.varianinc.com
Waters	Midford, MA	508-478-2000	www.waters.com

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IT'S ALL IN THE CHROMOPHORES

by Angelo DePalma, Ph.D.

Ultraviolet-visible spectroscopy (UV-Vis), an absorbance-based analytical technique, measures and identifies chemicals that absorb in the contiguous ultraviolet and visible regions of the electromagnetic spectrum. UV wavelengths range from 10 to 400 nanometers, while the visible spectrum—colors visible to the human eye—lie from approximately 400 to 800 nanometers.

Compounds analyzed by UV-Vis possess "chromophores," or color-absorbing carbon-carbon, carbon-oxygen, or carbon-nitrogen double bonds, as well as carbon-halogen single bonds. Depending on the extent and type of unsaturation, particularly whether the bonds are conjugated (alternate with single bonds), compounds may absorb in the UV or visible region of the spectrum. Chemicals such as carotene and certain dyes, which have extensive conjugation, are brightly colored and absorb in the visible region. Conjugation causes a shift in absorbance to higher wavelengths (i.e., toward the visible region).

Grant Drenkow, product manager for UV-Vis at Agilent (Loveland, CO), describes UV-Vis as "the screwdriver of the laboratory," for its ubiquity in nearly all science- or engineering-based industries.

Because compounds have unique UV-Vis spectra, including a maximum absorption wavelength (λ_{max} or "lambda max") and molar extinction coefficient (ε, absorbance per mole), UV-Vis can be used to identify the presence of chemicals *and* their concentrations. For this reason, UV-Vis is a popular technique in chemistry, foods, pigments, pharmaceuticals, polymers, and the life sciences, for basic or applied research as well as quality control.

For determining a chemical concentration, users typically scan the entire UV-Vis spectrum, although dedicated applications may only examine λ_{max} and the absorbance. The latter approach is useful in measuring kinetics—the appearance or disappearance of a chemical species over time. However, the distinction between single-wavelength and full-spectrum analysis has become almost moot since modern instruments "scan" the entire UV-Vis spectrum in about one second.

At one time, vendors routinely offered separate instruments for UV and Vis, but today the two tend to be combined. Some manufacturers add a third capability, near-infrared (NIR), which is immediately above the visible region.

UV-Vis spectrometers come in four basic models: low-cost single-beam, dual-beam, array-based, and handheld. Single-beam techniques must apply a correction for the loss of light intensity as the beam passes through the solvent. Dual-beam spectrometers use a second solvent reference cell and perform the correction automatically. Single- and dual-beam benchtop instruments use a broad-spectrum lamp as the light source, and most use a photomultiplier tube as the detector. Some instruments (e.g., from Agilent) employ photodiode array detectors.

Handheld instruments are usually dedicated to one wavelength and analyte, for example, for water testing in the field. Handhelds employ single-wavelength light-emitting diode light sources and photodiode detectors.

Array-based instruments use a very broad-spectrum tungsten lamp emitting between 200 and 1000 nm, and use a photodiode array or charge-coupled device as the detector. Array instruments do not scan the UV-Vis spectrum in the traditional sense, but rather send and collect the entire spectrum at once. Array instruments are useful when spectra must be acquired quickly, for ex-

"... the distinction between single-wavelength and full-spectrum analysis has become almost moot ..."

ample, from an HPLC trace or fast kinetics experiments.

UV-Vis instruments have become much faster, more compact, and feature-laden. Array instruments, in particular, provide a level of detail and throughput that was previously unavailable. "Although they may have originally been interested in just one or two wavelengths, users love capturing the entire spectrum in seconds," Drenkow says. Other factors entering into purchase decisions are cost, throughput, and the reliability of data.

> "Array instruments are useful when spectra must be acquired quickly ..."

Getting small

Sample size (or lack thereof) has for some time been an ongoing issue in analytical science. "People want more from less," notes Philippe Desjardins, scientific marketing manager at NanoDrop (Wilmington, DE), a subsidiary of Thermo Scientific. From this need has emerged microvolume UV-Vis, which analyzes liquid samples in the 0.5 to 50-microliter range.

Several vendors offer microvolume-only instruments or microvolume cells for conventional UV-Vis spectrophotometers. In its most elegant configuration, a microdrop of sample is deposited atop a small pedestal and a second pedestal immediately approaches to complete the optical path by contacting the sample's meniscus. Embedded in each pedestal is an optical fiber—one serving as a conduit for the light source, the other for the detector. The sample stays in place due to surface tension, but the path length may be optimized by adjusting the distance between 0.05 mm and 1 mm, depending on the sample concentration. This eliminates the need, as occurs frequently in conventional UV-Vis, to remove the cuvette and dilute or concentrate the sample.

Different models possess varying capabilities to adjust the path length, spectrum acquisition time, light source, and detector. For example, instruments from NanoDrop employ a xenon flash lamp that delivers source light across the entire UV-Vis spectrum at once, so spectrum acquisition takes just a few seconds.

Angelo DePalma *holds a Ph.D. in organic chemistry and has worked in the pharmaceutical industry. You can reach him at angelo@adepalma.com.*

UV/Vis Spectrometers

Agilent	Santa Clara, CA	877-424-4536	www.agilent.com
Analytik Jena	Jena, Germany	49 (0) 3641 77-70	www.analytik-jena.com
Beckman Coulter	Fullerton, CA	800-233-4685	www.beckman.com
BioTek® GET A BETTER REACTION	Winooski, VT	802-655-4740	www.biotek.com
Buck Scientific	East Norwalk, CT	800-562-5566	www.bucksci.com
Cecil Instruments	Cambridge, UK	44 122 342 0821	www.cecilinstruments.com
GBC Scientific	Hampshire, IL	800-445-1902	www.gbcscientific.com
Hach Company	Loveland, CO	800-227-4224	www.hach.com
Hitachi	San Jose, CA	800-548-9001	www.hitachi-hta.com
Ocean Optics	Dunedin, FL	727-733-2447	www.oceanoptics.com
Shimadzu Scientific Instruments	Columbia, MD	800-477-1227	www.ssi.shimadzu.com
S.I. Photonics	Tucson, AZ	520-293-6911	www.si-photonics.com
Thermo Fisher Scientific	Waltham, MA	781-622-1000	www.thermo.com
Varian	Walnut Creek, CA	800-926-3000	www.varianinc.com

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STRONG MANAGEMENT SUPPORT AND SMART HIRING MAKES FOR SUCCESS

by Sara Goudarzi

Meeting client needs is the number one goal of Advanced Environmental Laboratories, Inc. (AEL). And with more than a thousand clients across the state of Florida, that's not an easy task. However, thanks to professional staff who are well versed in local regulations, the projects of each client—be they a billion-dollar corporation or a small homebuilder—are handled with care and expertise.

The teams at AEL take on more than 35,000 projects and perform hundreds of thousands of individual tests each year. Projects include analytical investigations of soil, water, and air at RCRA (Resource Conservation and Recovery Act), CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act, or "Superfund"), landfill, UST (Underground Storage Tank), remediation, and O&M (Operations and Maintenance) sites. They also analyze drinking water and wastewater and investigate samples for commercial property transfers.

"... success is achieved through a combination of proper scheduling, communication, and a trained and dedicated staff."

How do they do it? Bob Dempsey, the laboratory manager of the corporate branch of AEL located in Jacksonville, Florida, says their success is achieved through a combination of proper scheduling, communication, and a trained and dedicated staff.

AEL's clients include 75 city, county, and state agencies across Florida; federal agencies that include the Environmental Protection Agency (EPA), Navy, Air Force, and Army Corps of Engineers; many of the world's largest environmental consulting firms; and dozens of commercial firms from small fabrication shops to huge breweries and theme parks. The challenge is to meet the needs of each client, Dempsey explains.

Lab structure

Founded in 1994 and still owned by the same sole proprietor, AEL was the dream child of Charles

Ged, who wanted to build one of the best labs in Florida. Today, with five laboratory facilities across the state—Jacksonville, Gainesville, Miami, Orlando, and Tampa—AEL is a National Environmental Laboratory Accreditation Program certified, full-service environmental analytical laboratory. The great bulk of the work performed by AEL is testing and sampling of drinking water and wastewater and monitoring of wells.

"AEL also was the very first lab in the nation to be selected and to undergo the Army Corps of Engineers audit/approval/review process to perform work on the Everglades Restoration Program," Dempsey says. "And AEL was awarded and holds a standing GSA (General Services Administration) contract with the federal government, allowing it to work for any federal government agency."

The Jacksonville lab, which Dempsey now manages, started with two chemists who worked on UST sites and performed quick-turnaround remediation projects. Now with 35 employees, the lab handles about 12,000 projects each year, including wastewater analysis and investigating Superfund sites. On average, each project requires analysis of five to 10 samples.

The 8,400-square-foot building was custom designed by AEL and specifically engineered to serve as an environmental testing laboratory and as the corporate headquarters. The site encompasses state-of-the-art laboratory design and instrumentation and offers sampling and courier services.

Each AEL facility has a quality assurance officer and a lab manager who oversees department supervisors and technical staff, such as analysts and technicians.

"Most of the people that work here are degreed," Dempsey says. "However, we do have some people that aren't but have years of experience in the environmental field."

"Now with 35 employees, the lab handles about 12,000 projects each year, including wastewater analysis and investigating Superfund sites."

In Dempsey's branch, there are two department supervisors who each lead a team of about seven. Together, with support staff, he manages 24 employees. "Our department consists of organics and inorganics for the most part," he explains. "However, some of our labs also have microbiology supervisors."

The supervisors schedule and coordinate all the analytical work in their department from the bench level. In addition to being responsible for making sure each setup is properly prepped, they also perform some of the tests themselves.

"Everything we do goes through a pretty extensive review process, and the supervisors are also part of that review process," Dempsey says.

The staff works five days a week. However, there's a skeleton crew that comes in on the weekends, plus additional staff based on clients' needs.

"Some of our tests are what we call a short hold, meaning when their sample is collected, it has to be analyzed within a matter of hours, so for those clients that have to collect those samples on the weekend, we have a staff in place that will accept them," Dempsey says.

Other samples, such as those that involve microbiology, may be placed in an incubator for a certain number of hours. If that incubation period ends on a weekend, then a staff member must come in to take care of reading and recording the results.

Day-to-day routine, challenges, and management tips

As a lab manager, Dempsey doesn't perform any lab work himself. Most of his day is taken up with managing his staff, tending to clients, acquiring new sales, and working on business development.

"I have an operations meeting every day with the supervisors and project management staff to communicate client due dates, any upcoming large projects, rush work, and to make sure we have enough coverage to meet our clients' needs and any other issues they may have," he says.

"Additionally, I answer many emails each day and communicate with our clients, our current staff, and other AEL laboratories about projects and technical issues," Dempsey adds. "I [also] serve as project manager for a couple of our larger clients."

Because the needs of each client vary for each project, Dempsey and his team must set up a custom-tailored schedule per job. For example, if a client requires a quick turnaround time, the lab must arrange to receive the samples and get them processed, analyzed, and reported quickly.

"We utilize a LIMS (Laboratory Information Management System) to log in our samples and track them

throughout the laboratory—from logging them in to analyzing them on the instruments to reporting them via e-mail," he says.

It's not easy juggling all this work, but Dempsey says he looks forward to the challenge and to coming in to work each morning.

"I truly enjoy the work I do and the people I associate with," Dempsey says. "The owner of Advanced Environmental Laboratories is a genuine person, easy to work for, and treats me and the rest of his employees extremely fairly, and that makes a difference in terms of enjoying the work you do. All of this, I believe, rubs off on our clients, which is why we have been growing and expanding as a laboratory over the last 15 years."

Communication is another reason AEL is successful, according to Dempsey. Whether it's between the employees or with the clients, a clear understanding of what needs to be done allows everyone to utilize their time and efforts effectively. "Singly, it is probably the most important skill set we need to utilize," Dempsey says.

"Each month, we provide what we call communication lunches—this allows everyone to get together in one group and talk," he explains.

A good staff is also very important. "We have some very key staff here. I can tell them right now, 'Hey, I've got some samples coming in; we're going to have to work a little later tonight to get this stuff done,' and they'll do it. They work in a team like that," Dempsey says. "I can't do all the work myself, so if I don't have good people working with me [things won't get done]."

When time and resources allow, Dempsey and AEL's owner show their gratitude to their staff by organizing functions where everyone can get together in a relaxed atmosphere.

"Last year, the owner bought Jacksonville Jaguar football tickets for employees and their spouses for the last game of the season," Dempsey says. "He provided transportation to and from the stadium along with a catered tailgate party before the game."

"Because staff members are such an instrumental part of AEL's success, Dempsey and his team take extra care when hiring."

Instrumentation, maintenance, and inventory

All AEL labs follow EPA-approved methodologies. Some of the instruments they use regularly include gas chromatography-mass spectrometry (GC-MS), gas chromatography-electron capture detector (GC-ECD), gas chromatography-flame ionization detector (GC-FID), gas chromatography-nitrogen phosphorus detector (GC-NPD), inductively coupled plasma mass spectroscopy (ICP-MS), high performance liquid chromatography (HPLC), and cold vapor atomic absorption (CVAA).

"We actually have three pieces of equipment that are under service contracts in our metals laboratory," Dempsey says. "All of our organics equipment we maintain ourselves."

Department supervisors take care of inventory. When technical staff notice that an item is running low or missing, they communicate this to their supervisors, who will place an order for the item.

"Each of our department supervisors is responsible for his or her specific inventory and order submittal," Dempsey says. "A lot of what we do is electronic and the approvals and purchase orders do come through me. [However,] large purchase orders have to go through the owner."

Hiring

Because staff members are such an instrumental part of AEL's success, Dempsey and his team take extra care when hiring. When looking for a new employee, they solicit résumés through a service, ads, or word of mouth and will ask to interview those whose work seems promising.

"I'll be part of the interview process and so will the department supervisors, and every once in a while we pull in a senior staff person, if it's a specialty type task that they do," Dempsey says. "And we collaborate on the interviewees and make a decision."

When hired, the new AEL employee undergoes a training period, which varies based on the work he or she will be performing.

"Having a solid, experienced staff working behind you is really key to a successful operation," Dempsey says.

Sara Goudarzi *is a freelance writer based in New York City. Her Web site is www.saragoudarzi.com.*

THE ABC's OF IEQ

DESIGN CONSIDERATIONS FOR LABORATORY INDOOR ENVIRONMENTAL QUALITY

By Vince McLeod

In recent years, a few new buildings have come back to haunt us after occupants have moved in. Even though Environmental Health and Safety was plugged into the design review and dutifully examined and signed off on construction specifications, important considerations were being overlooked and we forgot about what conditions would be like for the actual occupants.

Sometimes it would be something immediately after occupancy, such as noise from the ventilation system. Often it would be delayed until transient smells or nuisance odors were repeatedly drawn into the building. And a few took much longer, maybe years, until the black particles began pouring from the supply vents. But all these affect indoor environmental quality (IEQ) and thus employee comfort, productivity and possibly health. Further, most of these conditions are preventable.

> "... develop an IEQ design policy and make sure all architects and engineers receive a copy when beginning a project."

The following recommendations have been culled from years of dealing with IEQ complaints. Often the fix is very simple and costs almost nothing. However, more often than not the problem is traced back to poor design and ends up costing lots of money for renovations, not to mention the disruption to normal operations. If you can catch any of these during design, it can save immense sums down the road. We would strongly recommend that you develop an IEQ design policy and make sure all architects and engineers receive a copy when beginning a project.

Ventilation system

First and foremost, you want to ensure that the ventilation systems are generally consistent with all appropriate recommendations of the latest version of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62, Ventilation for Acceptable Indoor Air Quality.[1] Isolate all areas utilized for containment and any odor- or contaminant-generating activities from the return air system, and ensure that adequate exhaust air is provided. Examples include laboratories; lavatories; autoclave rooms; animal housing areas; kitchens; and document printing, copying and reproduction areas. Maintain laboratories and other such areas at a slightly negative pressure with respect to surrounding office and reception areas. In other words, slightly more air is exhausted from these spaces than is supplied to ensure that contaminants or odors do not migrate into surrounding areas. In addition, the overall building pressure dif-

ferential should remain slightly positive in relation to the outside atmosphere.

If local exhaust ventilation (LEV) systems are used, such as specialized hoods or snorkel systems, their design should follow the most recent version of the American Conference of Governmental Industrial Hygienists' (ACGIH) *Industrial Ventilation: A Manual of Recommended Practice for Design.*[2] Be sure to include the exhaust stack discharge design and proper height when evaluating the LEV system.

Finally, consider the maintenance personnel and require proper roof access provided by adequate openings with stairs, not ladders, not even fixed-ladder systems. It is not easy to climb vertically with a heavy tool belt and your hands full of spare parts.

Duct systems

One of the most important (and potentially troublesome) components is the system of ducts that moves the ventilation around the facility. The black particles pouring from supply vents mentioned above—nine times out of ten are due to internally insulated ducts eroding over time. Therefore, all ductwork associated with the HVAC systems supply and return air distribution as well as outside air intakes (more on these later) must not have internal lining or insulation. We highly recommend only metal ducts in industrial settings; duct board is just not acceptable. Construct all ducts so that they are effectively sealed.

We recommend that flexible duct, if used at all, only connect diffusers to the main trunk duct and lengths should not exceed six feet. By all means, avoid long, convoluted runs of flexible duct, a common trick used for sound attenuation.

All supply and return air runs should go through sealed ducts. Do not allow ceiling plenums (the space above ceilings and below the roof deck or floor above) or hallways to be used for moving supply or return air.

At the terminal ends, where supply air is pushed into the workspace, verify and test all diffusers to show that throw and mixing is adequate and drafts on occupants are minimized. Ensure enough space between supply and return grills to prevent short-circuiting.

HVAC controls

Controls are becoming very sophisticated and complex, with sensors and feedback loops that can call for air of a certain temperature and even the amount of outside air. However, the simpler things can still get overlooked. Make sure that thermostats are located away from drafts, direct sunlight or heat from nearby equipment. Question your mechanical contractor to guarantee that temperature control zones do not combine areas with very different heating or cooling loads.

Manual damper controls, still used frequently for cost savings, must have their full open and closed positions clearly and permanently marked. After final system balancing, mark their positions and lock or fix in place.

"Make sure that thermostats are located away from drafts, direct sunlight or heat from nearby equipment."

Mechanical equipment

Air handlers and filters come in many configurations and price ranges. However, providing a few specifications at the beginning can go a long way toward narrowing the field of choice and minimizing potential problems down the road. In general, system design must provide dehumidification during full occupancy as well as during partial cooling load conditions. Also, be kind to your maintenance workers and provide sufficient clearance on all sides of the equipment. If equipment is elevated, install walkways with railings for safe access. Here are our must-haves:

- Double-walled air-handler housings with no internal insulation
- Well-sealed filter banks or cells to prevent infiltration of bypass air
- Filters located upstream of the cooling coils
- Condensate pans located under the coils and made of stainless steel, also double walled (Design should be pitched, tapered and bottom drained to prevent water stagnation.)
- Drain lines that include a standard plumbing trap and discharge to the sanitary sewer (Also, provide an air gap to prevent back-drafting of sewer gases during times of low condensate flow.)

Filters and air-cleaning devices

As we all know from maintaining our home units, filters are critical to system performance. Better filters remove more dust, pollen, spores, etc., but they must match the system. It is harder to push air through more efficient filters. We recommend pleated, extended-surface-area filters with a minimum dust spot efficiency of 60 percent (MERV 11). Routine checking and replacing is also paramount.

New technologies continue to emerge for IEQ and HVAC systems. Ultraviolet (UV) lighting arrays for controlling microbial growth in drain pans and on coil surfaces appear to work well in our experience, but they must be specifically designed for use in air-handling units. Other devices include negative and/or positive ion generators, electrostatic precipitators, and ozone generators. We

strongly recommend a thorough review of all available independent data prior to choosing one of these designs.

Outside air intakes

ASHRAE Standard 62 recommends minimum amounts of outside air to mix with conditioned air in order to maintain good indoor air quality.[1] These are based on types of use and occupancy. Locating fresh-air intakes during design must prevent introduction of pollutants into the building's air supply. You must ensure adequate distance between outside air intakes and all potential pollution sources. Give careful consideration to driveways, exhaust outlets, plumbing vents, hood exhausts, cooling towers, streets and highways, and garbage storage and treatment areas. In addition to keeping clear of pollution sources, protect intakes from rain intrusion by installing louvers or rain hoods. Preclude birds and other unwanted animals by installing ¼-inch mesh screening. Modulated damper systems should account for occupancy or contain mechanical stops to ensure a minimum supply of fresh air. Finally, when planning your new building design, consider outside air intakes of all adjacent existing buildings so construction activities do not impact occupants in those neighboring buildings.

Comments or questions are always welcome. Contact thesafetyguys@labx.com.

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1. "Ventilation for Acceptable Indoor Air Quality." American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62-2009. Atlanta, GA.
2. "Industrial Ventilation: A Manual of Recommended Practice for Design." American Conference of Governmental Industrial Hygienists (ACGIH). 26th edition, 2007. Cincinnati, OH.

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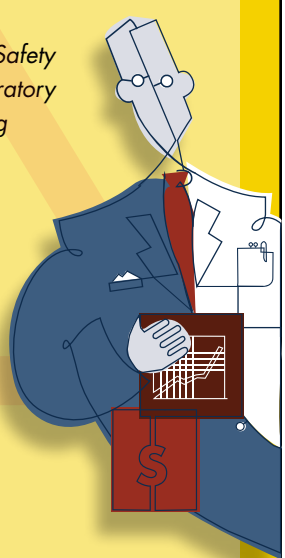
For example: "It is the responsibility of our (name of company or institution) and its employees to ensure that our business activities (or educational programs and other activities) protect and promote the health and safety of our customers (students), our employees, and the environment."

Your department may want to draft a sample policy statement for recommendation to your administration or board of education. It is virtually impossible to have an excellent safety program without their support. Your written safety policy will provide the foundation of your safety program.

Policy statements of this type need to be signed by the highest ranking official of the organization, dated, laminated, and mounted in the entrance of every building.

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



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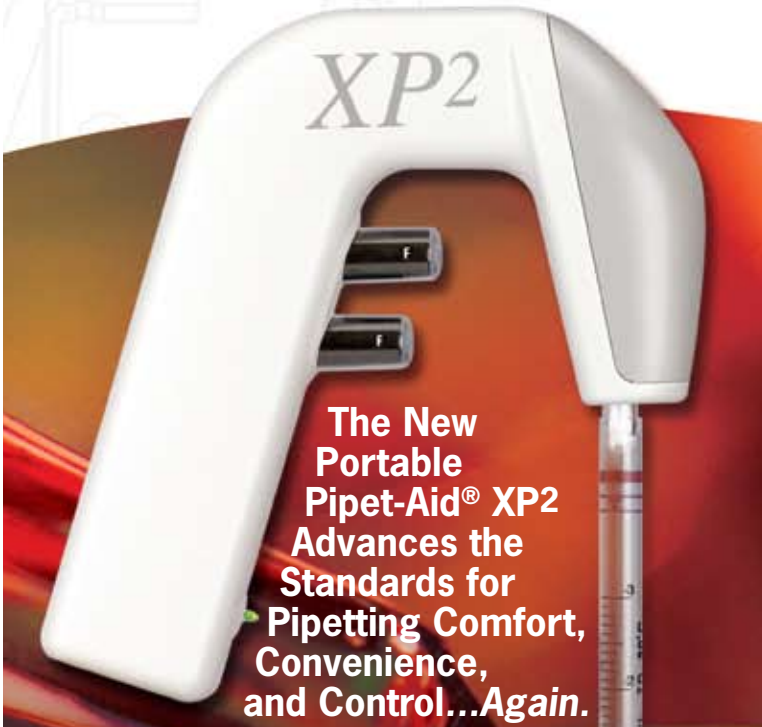

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MANAGING OBSOLESCENCE

WEIGHING THE BENEFITS OF TECHNOLOGICAL IMPROVEMENTS AGAINST THE COST OF A NEW INSTRUMENT TO DETERMINE ROI

by Wayne Collins

While living in my house in Houston, Texas, I managed to keep the original builder's quality air conditioner, which is heavily used for approximately seven months per year, operating for nearly sixteen years. I learned to make repairs myself, replaced parts, and even did a complete rewiring when a relay fault started a fire and burned the original wiring. When the system was finally beyond repair, I grudgingly spent several thousand dollars to purchase a new high-efficiency system. It was only after I received the first electric bill after installation of this system that I realized how foolhardy I had been to preserve the original equipment for so long. The more than 50 percent reduction in the electric bill with the high-efficiency system means I would have saved thousands of dollars (not to mention hours of my time) if I had only replaced the old inefficient system years earlier—but the fact that it kept me cool in the summer heat, coupled with the expense of a new system, blinded me to the cost that I was incurring. As lab managers, how often do we make this same mistake by continuing to use lab instruments long after they are obsolete, simply because they continue to operate? These days, when budgets are shrinking and cost control is at the top of managers' business issues, it is time to take a close look at these hidden costs of maintaining obsolescence.

> "Manufacturers have developed technologies that in some cases reduce analysis time by as much as an order of magnitude."

While it is natural to focus on the high cost of replacing an instrument, the business benefits of updating obsolete technology might easily be overlooked. Technological improvements in instrumentation continue to bring real benefits that accrue from speed of analysis, increased capacity, labor savings, operational efficiencies, higher precision, greater ease of use, enhanced reliability, lower maintenance requirements, improved safety, reduced environmental impact, and numerous other intangibles. It behooves lab managers to weigh these types of benefits against the cost of a new instrument, to determine if replacement will yield a positive return on the investment. Table 1 summarizes some of the technological advantages that might come with a new instrument, as well as a few of the possible business benefits that it might deliver for the laboratory. Instrument salespeople can easily point out which technological advantages apply to their products, and the lab manager can estimate the worth of the benefit to the business. So, let's take a brief look at some of the advantages that might be realized by adopting these new technologies, in order to understand how they might affect lab operations.

Labs that measure customer satisfaction usually find faster sample turnaround time to be the number one improvement opportunity, or if not number one, almost surely among the top three. This is true even for labs that most managers would agree provide excellent service. Simply put, you can never get the answer back to the customer too soon. So, faster analyses are highly valued by lab customers who can use the data to solve problems or make decisions more quickly. In addition, faster analyses add value for the laboratory itself by extending the capacity of the instrument to allow more tests to be performed on it each day. And speedier methods may even allow testing to be consolidated onto fewer instruments, which can reduce maintenance, consumables, regulatory documentation requirements, and overall costs.

So, how much increase in the speed of analysis might a manager expect to gain by employing a new technology? Recognizing the benefits that accrue from speed, instrument manufacturers have developed technologies that in some cases reduce analysis time by as much as an order of magnitude. Rapid liquid chromatography and high heat-

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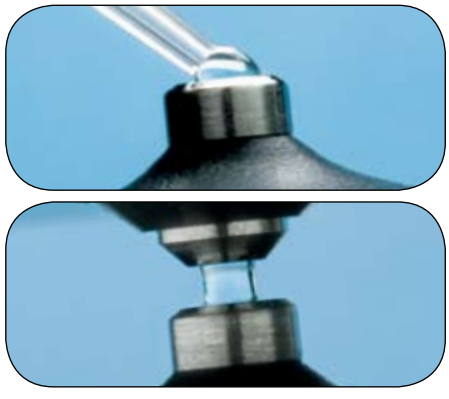

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Technological Advantage	Possible Business Benefit
Speed of Analysis	Allows more tests per day to increase revenues Faster sample turnaround time increases customer satisfaction Permits consolidation of testing onto fewer instruments Delays or eliminates capital expenditure to increase capacity
Increased Capacity	More tests per day Increased revenue Need for fewer instruments Less maintenance, labor and expense Simplified validation documentation
Decreased Labor Required	Savings of ~$80 for each hour of technician time saved Frees time for other work or for improvement projects Shift some data interpretation from chemists to lower cost technicians
Safety Improvement	Reduced exposure of personnel to solvents or other chemicals Reduced fire/explosion hazard Reduced risk with latest safety devices and safeguards
Increased Precision	Reduced risk of analytical error Reduced lab contribution to process capability Reduced need for replicates to achieve required confidence level Less risk of false positives or negatives Less risk of release of out-of-spec product due to lab error Reduced warranty claims and tech service expense due to release of faulty product
Ease of Use	Reduced operator training time Less need for expert help Facilitates crosstraining to increase flexibility to shift resources
Higher Reliability	Less down time Lower maintenance requirements Less risk of loss of critical data
Lower Environmental Impact	Supports CMA's Responsible Care program Supports ISO 14001 initiatives Reduced waste disposal volume and expense Reduced lab contribution against environmental operating permit
Enhanced Laboratory Image	Improved staff morale and pride in workplace with modern equipment Higher customer confidence in results Reduction in retest requests and duplicate blind submissions to check test quality
Decrease in Expendable Costs	Reduced chemical costs with small volume samples Longer lasting expendables such as chromatography columns
Decrease in Operating Costs	Improved energy efficiency Reduction in other services such as water, gases, or IT Less bench space required
Additional Customer Benefits	Better quality and more timely results to control processes Faster resolution of customer problems Faster time to market for new products Opportunity to use increased capacity for additional testing Quicker decisions
Accessories	Accommodates latest automated accessories for sample preparation and testing to improve precision and reduce labor requirements

▲ *Table 1. Common business benefits derived from introduction of new technology*

ing rate/low thermal mass ovens in gas chromatography are but two examples of technologies that can significantly increase the speed of analysis without sacrificing test quality (in fact, possibly improving it). For commercial labs, speed translates directly into incremental revenue through higher volume and is easily assigned a dollar value. For captive labs, speed also has a monetary value, although pricing is less transparent. For example, speed might be priced in terms of reductions in analyst labor, typically valued at approximately $80/hour, or in terms of the even more valuable time saved in regaining control of an out-of-spec plant process, which can be worth tens of thousands of dollars per hour. It is hard to imagine a lab in which speed of analysis is not highly valued.

The "green" movement, along with other practical requirements, has inspired adoption of technologies that permit much smaller sample sizes without sacrificing measurement quality. Adoption of these technologies has both safety and environmental advantages for organizations. Reduced sample requirements can significantly reduce personnel exposure to potentially hazardous chemicals during sample preparation while also reducing waste disposal quantities and costs. Organizations are usually very receptive to funding these "green" initiatives, which can garner public praise for displaying social responsibility in the conduct of their business while simultaneously lowering their operating costs—a double win. Technological advances that positively affect safety and/or environmental performance typically provide very strong business justifications for replacement and are sometimes expedited through the capital budget process.

One of the paradoxes of the laboratory instrument market is that as the technology has become ever more complex and sophisticated, the instruments have actually become easier to use. Nearly every

instrument now has computer-running software that not only optimizes the performance of the instrument but also aids in the interpretation of the data. It is now possible for technicians to do material identifications using spectral libraries or to determine protein structures that required the skills of a highly trained chemist just a few years ago. Software is generally the first part of an instrument that becomes obsolete and thus become a major impediment to increasing productivity. This type of obsolescence is an especially insidious problem, becomes older instruments can lock labs into specific versions of software packages that are interfaced with other computer systems such as the LIMS, thereby limiting flexibility to upgrade. It is not uncommon to find labs that are held captive by obsolete software that severely limits their operational choices. Updating software should be a high priority because of both the advanced intelligence of newer versions and the potential reduction in the risks that are associated with maintaining obsolete versions. And lab managers can sometimes get these software upgrades funded through the IT budget rather than using lab funds.

Declining reliability is a sure sign of the impending need for replacement. As instruments age beyond a critical point, it is not uncommon to experience rising maintenance costs, the need for more frequent calibrations, more downtime, and other problems requiring intervention. Manufacturers may halt support for the instrument, and parts availability may become problematic. Prudent lab managers heed these signs as warnings that it is time to replace the instrument. However, relying solely on this replacement approach can be risky. First, many labs do not have an adequate data gathering and reporting structure to accurately identify the point at which reliability begins to decline, so the instrument may fail beyond repair before action is taken. Second, funding a new instrument typically requires a lead time of six months to a year in order to usher it through the capital budget process and obtain the necessary approvals. If the lab has no backup instrument, then it is best not to rely solely on conditional indicators to schedule replacement, lest customers be left without the data needed for their operations. Table 2 suggests several warning signs that should alert the lab manager to take a closer look at older instruments. These signs in and of themselves do not constitute grounds for replacement, but they should stimulate conversation about the state of obsolescence of the instrument.

Tax codes recognize the need for obsolescence in order for a business to remain competitive in the marketplace—the purpose of depreciation is to set aside funds to replace equipment as it wears out or otherwise becomes obsolete. This does not imply that lab instruments are expected to be unfit for use beyond the time that they have been fully depreciated or that it is not good business practice to continue to use them. The depreciation schedule or rate at which assets are written off is driven primarily by financial considerations and is only loosely related to the actual useful lifetime of the item. However, full depreciation should signal the lab manager to begin looking at the business case for replacement, regardless of how well the instrument continues to function. Also, the business case must consider that the depreciation deduction for the new instrument will likely recover as much as 40 percent of the initial cost in tax savings over the scheduled period.

One of the best approaches for proactively managing obsolescence is to develop and maintain a multiyear capital plan that explicitly designates a specific portion, perhaps 20 percent, for instrument replacement each year. The list of fully depreciated equipment obtained from

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Test (APHA/EPA)	Cat. No.	Description
Alkalinity	7185-16	Sodium Carbonate, 0.0500 Normal
Biomedical Oxygen Demand	3255-16	Glucose-Glutamic Acid Solution
Biomedical Oxygen Demand	5800-16	Phosphate Buffer Solution, pH 7.2
Chloride	6860-16	Silver Nitrate, 0.0141 Normal
Color	2230-4	Color Standard, Color=500 Units
Cyanide	2543-16	Cyanide Standard, 1000 ppm CN
Fluoride	3170-16	Fluoride Standard, 10 ppm F
Fluoride	8670-16	Total Ionic Strength Adjustment Buffer (TISAB)
Hardness	1780-16	Calcium Chloride Standard, 1mL=1mg $CaCO_3$
Hardness	2700-16	EDTA, 0.0100 Molar
Hardness	9200-16	Water Hardness Buffer
Nitrogen (Ammonia)	5455-16	Nitrogen Standard, 1000 ppm NH_3
Nitrogen (Ammonia)	7470-32	Sodium Hydroxide, 10.0 Normal
Oxygen (Dissolved)	540-16	Alkali-Iodide-Azide Reagent, Alsterberg
Phosphorus	3580-16	Hydrochloric Acid, 50% (v/v) Aqueous
Phosphorus	5830-16	Phosphate Standard, 50 ppm P as SO_4
Sulfate	8110-16	Sulfate Standard, 100 ppm SO_4
Total Organic Carbon (TOC)	1847-16	Carbon Standard, Organic, 1000 ppm C
Turbidity/Nephelometric Method	8830-16	Turbidity Standard, 4,000 NTU

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the organization's financial branch can identify candidates for this budget. Lab managers typically assign the chemist responsible for the depreciated instrument the task of evaluating potential replacement candidates by tabulating advantages such as those in Table 1. Assigning an approximate dollar value to the business benefits for each item and comparing that with the cost of replacement will produce a prioritized list based on return on investment. All that remains is to stage replacement of the highest-priority items (that is, those with the greatest financial potential over a three-to-five-year period) according to the expected available funds that can reasonably be devoted to replacement for each year. This simple evaluation process has the added advantage of providing excellent input into the development of the business case that will eventually be required to justify the selected capital items based upon the value that they bring to the business. And since replacements are scheduled over several years, the process provides a mechanism for maintaining a reasonable balance between acquisition of new capabilities and replacement of current assets within the allotted funds.

Screening Criteria	Potential Risk Point
Age	Electronic instruments aged 7 years or more
Depreciation	Fully depreciated equipment
State of Technology	One or more generations behind current
Maintenance Trend	Maintenance requirements increasing
Maintenance Support	Instrument no longer supported by manufacturer
Reliability	Down time increasing
Precision	Order of magnitude less than current
Safety	Absent current improvements
Software	One or more revisions behind current
Backup Capability	No backup instrument available
Serviceability	Lacks convenient service features
Automation	Does not support latest automation
Expendable Usage	Does not support minimization strategy
Environmental	Does not support waste reduction strategy
Parts Availability	Declining number of sources
Service Contracts	Contracts no longer available
Manufacturer's Support	Notification that support is ending
Accessories	Does not support latest accessories
Competitive	Declining presence in the industry

▲ *Table 2. Possible warning signs of obsolescence*

Keeping the lab furnished with modern, technologically advanced equipment not only keeps laboratory operations competitive by increasing productivity; it also provides such intangible benefits as staff pride in the workplace and enhanced stature with customers. It is understandable that one might have a special fondness for those old reliable lab workhorses that have served so well for so many years, but lab managers must recognize that this devotion comes at a cost. And a five-year capital plan to quantify the cost and manage obsolescence is just smart business.

Wayne Collins, Ph.D., *is worldwide marketing manager, Energy & Chemicals, Agilent Technologies, Chemical Analysis Group and serves on the Board of Directors of the Association of Laboratory Managers (ALMA). He can be reached at wayne_collins@agilent.com or by phone at 281-750-1763.*

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DIG DEEPER

This month's "Dig Deeper" video features Sara Goudarzi, NYC-based freelance writer and regular contributor to *Lab Manager Magazine's* "Perspective On" series. Sara holds an M.A. in journalism from New York University and has published more than 300 articles. Her writing has appeared in National Geographic News, Space.com, LiveScience.com, Science World Magazine, The Christian Science Monitor, CNN.com, Scientific American Mind, among others.

In this month's "Perspective on: An Environmental Lab" on page 48, Sara interviewed Bob Dempsey, the laboratory manager of the corporate branch of Advanced Environmental Laboratories, Inc. located in Jacksonville, Florida. "The Jacksonville lab started with two chemists who worked on UST sites and performed quick-turnaround remediation projects. Now with 35 employees, the lab handles about 12,000 projects each year, including wastewater analysis and investigating Superfund sites."

To meet Sara and learn more about her interview with Advanced Environmental Laboratories' Bob Dempsey, visit www.qorpak.com/labmanager.

Look for more "Dig Deeper" video links in upcoming issues of *Lab Manager Magazine*. This new online feature is designed to offer a more in-depth exploration of the ideas behind particular articles and unique information that only the authors and "experts" themselves can provide.

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Lab Manager MAGAZINE Run Your Lab Like a Business

A MULTI-VENDOR SERVICE MODEL

USING DATA TO DRIVE ASSET PROCUREMENT, REDEPLOYMENT AND DISPOSITION by Gary E. Grecsek

Lab managers, aided by the recent economic climate, have seen their roles expand beyond science in order to ensure that the lab is a strategic entity that runs like a business. They are charged with implementing strategic decisions to drive lab productivity and manage costs, particularly as they relate to the lab's major capital assets: laboratory instruments.

The greater interest in capital assets correlates with a greater interest by procurement in how lab managers justify decisions regarding assets. Quantifiable data is key, and that data increasingly needs to be insightful. It's not only how many instruments you have but also how they are being utilized and keeping track of service, the compliance program and overall cost.

> "... many labs do not even have an accurate inventory of instruments."

When weighing redeployment, disposition and procurement questions, the answers are not always obvious given the potential scenarios below:

- The HPLC asset purchased seven years ago may no longer be cost-effective to maintain when compared with one bought two years ago. Would it be better used in a lower-throughput research lab? Or should it be disposed of via an auction or dumpster?
- One lab is utilizing an asset 80 percent of the time while another asset is being utilized only 15 percent of the time. Can the second asset be put to better use elsewhere in the lab? Or at another corporate site?
- A lab needs high-throughput forensic analysis. Its current instrument is meeting demand requirements, but a new instrument has come on the market that offers improved sample handling and temperature stabilization. Would the increase in throughput provide differentiation opportunities or allow additional work to be secured to justify purchase of the newer model?
- A new procurement decision is under consideration for a given technology. How does vendor A compare to vendors B and C across a variety of different criteria, including service cost, uptime and cost of operation?

Answering these questions requires data—as does making decisions about redeployment and disposition of assets—as mergers and acquisitions, budget tightening and shifting agendas alter the landscape. Yet, at the same time, many labs do not even have an accurate inventory of instruments.

Asset data and data mining are new endeavors for many labs and for good reason: Instrument data is typically inconsistent, non-standardized and stored in multiple data sources, making it difficult to mine in order to provide business insight.

Historically, asset management has been an ad hoc process in labs, and the data reflects it. Until recently, many labs deployed an OEM model for service, turning to the manufacturer of each instrument to provide the necessary work. The process, typically fragmented and disconnected, not surprisingly created a data stream with the same characteristics. Data is housed in multiple non-integrated systems and provides limited insight, frequently limited to:

- Financial data, such as purchase price and depreciation
- Service history
- Service costs
- Service contracts
- Consumables costs
- Compliance status

With data non-standardized and siloed asset by asset, vendor by vendor, it is difficult to pull together and analyze.

Without cohesive data, analysis of assets and costs is a rudimentary survey of service contracts, repair activities, instrument value and cost to maintain an instrument in good working order. Most likely the data will be inconsistent from OEM to OEM and from site to site and will be filled with gaps. Furthermore, the information will be accurate only for the point in time when the review takes place. Rather

than ongoing and strategic, the asset management process is episodic and reactive.

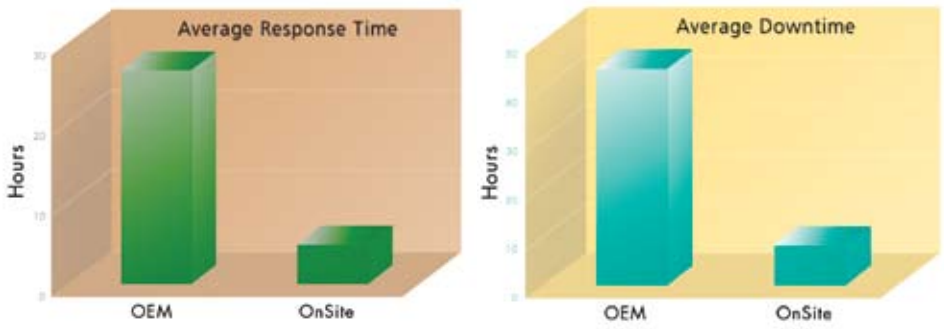
Implementation of a systematic approach requires designing workflows to implement data collection and then monitoring the system. These activities place a burden on scarce resources and siphon manpower away from scientific needs in the lab. It is no surprise, then, that administrative data collection is relegated to a lower priority or not done at all.

Coincidentally, as the economic downturn forced companies to reassess budgets across the board, many turned to comprehensive multi-vendor service models. The concept combines the best practices of insurance-based service models coupled with significant internal investment in training and certifying engineers on a variety of instruments from a variety of manufacturers to provide a next-generation service model.

Rather than chasing a multitude of vendors, the customer needs to make only one call to the multi-vendor service provider to initiate or even facilitate the entire service process. As instrument quantities or service requirements aggregate, dedicated service personnel are assigned to specific customer locations.

This next-generation service model increases instrument uptime, improves service response time and frees scientists to concentrate on their core competencies, all the while curbing and managing costs. A typical on-site service model saves 10 percent to 15 percent on service costs in the first year.

Figure 1. Service Performance: OEM vs. OnSite Service Model



The model produces significant response time improvements over the traditional OEM model, as seen in Figure 1.

Interestingly, the initial draw for customers to this service model was cost savings, although the advanced comprehensive service model improved productivity and reduced administrative costs. Now the multi-vendor service model is producing another key value driver: standardized data that is vendor independent. Instead of siloed information about each brand of an HPLC asset, as an example, a customer can now see data about all HPLCs throughout the laboratory. For companies with multiple sites, the view broadens to encompass all instruments at other sites or even around the globe (see Figure 2).

The multi-vendor service model provides standardized, continuous

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data and, in the most advanced versions, easy access to the metrics. With such a program, the information is available via online dashboards housed in a secure portal 24 hours a day and seven days a week. No longer burdened with chasing multiple vendors and with standardized, vendor-independent data, lab managers employing the multi-vendor model now also have the data to justify new capital asset requests, identify when to decommission assets, and determine where to shift resources as workloads and agendas shift.

Seeing the cohesive, standardized data that is obtainable within a quality multi-vendor service model has

▲ *Figure 2. Global Collection of Asset Data Drive Decisions*

"... a systematic approach requires designing workflows to implement data collection and then monitoring the system."

provided a stimulus in these labs. Taking the data one step further, such a model can provide another crucial tier in the data stream: asset utilization for each instrument, regardless of technology or manufacturer.

Utilization information coupled with operational service and financial metrics improves decision-making capabilities. With this type of information, the lab manager can justify capital requests using quantifiable data about instrument utilization. Through a partnership with a multi-vendor service provider, the lab manager can pinpoint the time when assets become too costly to maintain and need to be decommissioned or auctioned; or the lab manager uses the data to justify redeploying an underused HPLC to another branch or lab to distribute workload.

When the time comes for shifting assets, a comprehensive multi-vendor service provider will have resources at hand to simplify redeployment, either within the site or to other sites, including internationally.

Such a service provider should also be able to help with disposition of assets, including increasing market value by providing checkout certification and warranties to assure potential buyers that the instrument is in good working order and includes all necessary parts, thus maximizing the value of the instrument. These certification programs function much like certified pre-owned programs in the automobile industry. Offering assurances and security regarding the quality of the used instrumentation increases its auction value.

Typical services that increase instrument value include:

- Asset inspection and certification
- Used instrument warranties
- Decommissioning
- Cleaning and sales preparation
- Relocation and storage

Multi-vendor service models continue to be in strong demand in the marketplace. They continue to evolve in order to address changing customer and market needs, such as the increasing need for asset utilization data that is vendor independent. Asset utilization and asset operational data are seen as the next opportunities to unlock savings and productivity throughout a lab, a site or the entire enterprise, and will be key factors in the asset procurement, redeployment or disposition decisions in the future.

***Gary E. Grecsek**, vice president, OneSource Laboratory Services, PerkinElmer, can be reached at Gary.Grecsek@perkinelmer.com or by phone at 203-402-6875.*

TECHNOLOGYNEWS

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Stefan Schuette, Agilent Senior Marketing Director, Liquid Chromatography Business, says SFC has several benefits over traditional HPLC, including significantly reduced consumption of organic solvent and ultrafast separation at moderate operating pressures using conventional particle size columns. "SFC results in high separation efficiency due to improved mass transfer," he said. "It provides higher sensitivity compared to existing systems due to low baseline noise and pulse-free metering."

SFC is similar to normal phase HPLC, but most of the mobile phase is replaced by liquid CO_2. Also, Schuette added, the 1200 Series SFC can achieve a much shorter analysis time compared to standard HPLC, "due to low viscosity and superior diffusion characteristics of supercritical mobile phase."

In addition to significant cost savings, higher flow rates are achieved with proportional increases in numbers of samples that can be run per shift.

For more information, visit www.agilent.com and www.aurorasfc.com. Stefan Schuette, Senior Marketing Director, Liquid Chromatography Business, can be reached at stefan_schuette@agilent.com.

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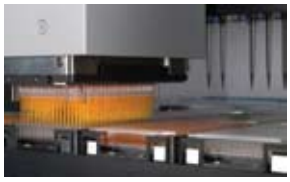

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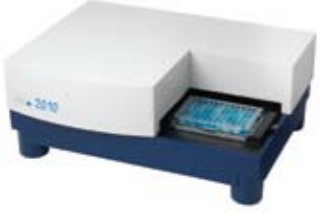

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"You don't want to disturb fragile samples," said Vincent Hsieh, R&D Scientist at Wyatt Technology. "People might be enticed to apply up to 150 volts to a sample… a higher velocity makes it easier to measure, but this can damage the sample."

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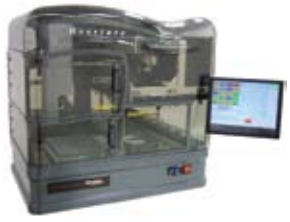

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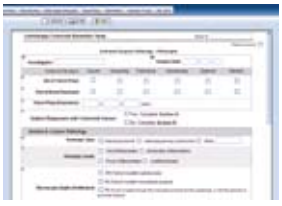

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PRODUCT SPOTLIGHT

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LIMS-on-Demand™ allows organizations of varying types and sizes to leverage all the benefits of an industry-leading LIMS solution without the time and cost typically associated with on-premise software installation.

Offering flexibility and ease-of-use, LIMS-on-Demand helps organizations replace inefficient, error-prone manual processes with an automated data management solution. For the cost of a monthly subscription fee, users can easily and securely create workflows, map sample lifecycles, and generate automatic updates from any standard Internet connection and through any web browser.

The user-friendly interface enables connectivity with a variety of internal instruments and systems, as well as external facilities, partners and regulatory agencies.

Kim Shah, Director of Marketing and Informatics at Thermo Fisher Scientific, says too many labs around the world are still using manual processes to manage the intricacies of workflow and data collection. "There are tens of thousands of small- to medium-sized labs out there that don't have access to databases and don't have IT people," he said. "All the headaches of hosting a server, maintenance, upgrading, data security—all of that stuff is now Thermo Fisher's responsibility."

In addition to seamless connectivity, LIMS-on-Demand touts affordable operating costs. "We have developed an lower laboratory management solution that does not sacrifice functionality," Shah added.

For more information, visit www.limsondemand.com. Kim Shah, Director of Marketing and Informatics, can be reached at kim.shah@thermofisher.com.

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PHD 22/2000

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- Run screen enables the user to quickly create configurations and recall them later

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Plastic Transfer Pipets

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- Available in more than 35 different styles with a choice of capacities, lengths and tip styles
- Sterile pipets are available individually wrapped or in bags of 10 and 20 units

Globe Scientific www.globescientific.com

Conductive 384 Tips

CO-RE Tips for MICROLAB® STAR

- Eliminate electrostatic effects, which can be problematic with non-conductive tips
- Packaged in nested tip racks providing high packing and storing density and reduced space requirements
- Twenty tip racks sit on one tray, providing access to 7,690 tips for longer unattended runs
- Capacitance liquid level detection (cLLD), which improves pipetting accuracy, cannot be performed with other tips on the market

Hamilton Robotics www.hamiltonrobotics.com

Sample Storage Tube Locking Mechanism

Snap Tube®

- By applying downward pressure, sample storage tubes are locked into storage rack
- Ensures samples in non-coded, alphanumeric and 2D coded tubes are kept secure during transport or storage
- Accommodates 96 individual tubes in industry standard configuration
- Available in sterile, RNase/DNase free and with custom specific barcodes for automated tracking

Micronic Europe BV www.micronic.com

Reagent Reservoir

4-row Partitioned Reservoir Plate

- Enables aspiration of up to 4 reagents into a single well space
- Allows pipette tips with strippers to easily reach the bottom of the channeled reservoir
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- Feature pyramid bottoms to reduce reagent waste

Porvair Sciences
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Polymeric Tubing

PEEK and Fluoropolymers

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- All colorants used in manufacture are RoHS compliant

VICI Metronics www.vicimetronics.com

Pipette Disposal Container

Terminal® Pipet Keeper™

- Allows disposal of pipettes, swabs and other items up to 15" in length
- Designed for easy use by both right- and left-handed users
- Made of sturdy paperboard
- Features a plastic lining and webbed corners to avoid soak-through

Whitney Products
www.whitneyproducts.com

Consistent, Stable Incubator and Oven Temperature

Problem: Many experienced lab technicians are aware of the "sweet spot" in their oven or incubator—the back right-hand corner of the middle shelf where their experiment or process always comes out right. It's the spot where the temperature in the oven is the same as that on the unit's temperature display. Of course, what's really indicated is that temperature accuracy throughout the chamber, the most important factor in oven and incubator performance, is uneven.

Solution: Ovens and incubators that provide uniform and stable temperature control are available, and so the resolution to "sweet spots" and other problems with temperature inconsistency is fairly straightforward. But making a decision as to which oven or incubator is best for a specific process requires an understanding of unit construction and quality control practices.

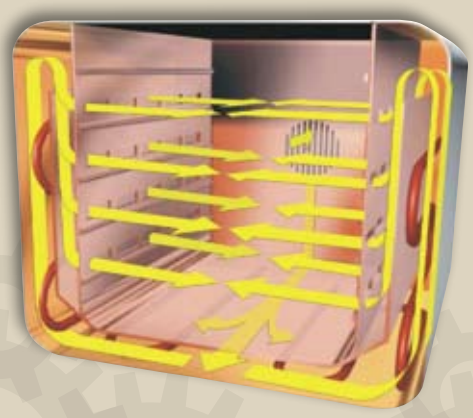
When incubators and ovens are made, units are randomly subjected to quality control testing. Manufacturers typically use either DIN (German Industrial Standard) or ASTM (American Society for Testing and Materials) standards to document the performance of their apparatus.

A brief comparison of the main criteria in each standard will highlight what they indicate about unit performance. The most important of these is the number and location of the measurement points used in testing. The DIN standard requires a two-hour heat-up to steady state, at which point measurements are taken at 27 points in the chamber (nine points on three levels) and monitored six times a minute.

Using the ASTM standard, a manufacturer will measure 9 points in the chamber (four each top and bottom shelf, one in the middle) without preheating and with no defined sampling time.

Unit controller is important as well. A thermostatic device that turns heating elements off and on as a set point is reached is obviously useful in only basic procedures, such as glassware drying. Simple digital controllers provide quick time to set point, while PID (proportional integral derivative) control provides the best accuracy over time at a single point.

Preheating provides uniform airflow within the chamber and consistent temperature for samples. Depicted is the Binder FD Series mechanical convection oven.



How the apparatus is heated is a key consideration. Mechanical convection provides greater consistency than other methods, and also offers faster recovery after the door is opened when compared to gravity convection, the other common heating method. Furthermore, direct heat and gravity convection ovens suffer from direct contact of the heating coils with the inner chamber wall, creating hot spots, and do not offer preheating.

Other factors relevant to performance include the amount and type of insulation, door closing and gasketing options, and ergonomic features such as the location and design of controllers and displays.

It is worth noting that repair/remodeling existing units is almost always ineffective. A technician can test an inconsistent oven or incubator, but charges for test time alone will bring the cost of an inexpensive unit to a level above that of the most expensive product. Repairing or reconfiguring the oven or incubator to offer the desired performance will add even more cost, if it can be done at all.

If the applications for a given incubator or oven will ever go beyond the most basic requirements, the most well-equipped and validated unit available will offer consistent, reliable results and will cost less over time than inexpensive models.

Incubators and ovens from Binder, Inc. are made to DIN standards, utilize mechanical convection, incorporate PID control, and offer a number of other features to meet demanding temperature stability requirements.

For more information, visit at www.binder-world.com/us.

Sample Prep for Phospholipid Removal

Problem: Excessive background from endogenous sample matrix components has always been of great concern in bioanalysis, and has become paramount today with the need for decreasing analytical run times. In bio-analytical mass spectrometry, the issue of excessive background contributes to the problem of ion-suppression.

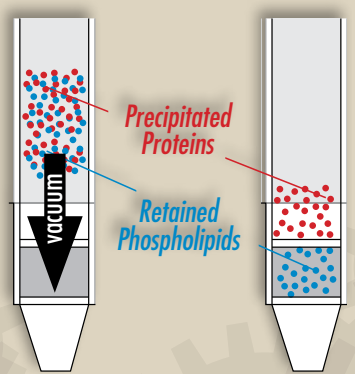
Ion suppression is caused by one or more interfering components or species that co-elute with the analyte(s) of interest during LC-MS analysis, and manifests itself as a loss of analyte response. The co-eluting species can affect droplet formation or ionize concurrently, resulting in an erroneous decrease (suppression) in analyte signal response. The end result is poor assay reproducibility, and losses in accuracy and sensitivity. Such deleterious effects are often most notable at the lower limits of quantitation (LLOQ).

One of the major causes of ion suppression in bioanalysis is the presence of phospholipids during LC-MS analysis in the positive ion electrospray mode (+ESI). Phospholipids are prevalent in extremely high concentrations in blood-based biological fluids (~1 mg/mL), and represent the second largest lipid component in biological matrices after triglycerides.

In addition to ion suppression, phospholipids tend to accumulate on the analytical column, leading to potential changes in retention selectivity. They may elute uncontrollably downstream in an injection run sequence, causing unpredictable ion-suppression effects and poor reproducibility. If gradient conditions are used to elute phospholipids, this leads to longer analysis run times—while the goal is decreasing run times.

Solution: HybridSPE®-PPT technology is a simple and generic sample prep platform designed for the gross level removal of endogenous protein and phospholipid interferences from biological plasma and serum prior to LC-MS or LC-MS-MS analysis.

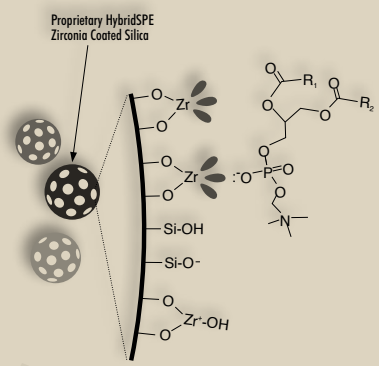
Biological plasma or serum is first subjected to protein precipitation by adding the sample to the HybridSPE 96-well plate followed by acidified acetonitrile (precipitation agent). An upper PTFE frit impedes premature flow of the sample before vacuum application. After a brief mixing/vortexing step to facilitate protein precipitation, vacuum is applied to the 96-well plate. The 96-well version contains a series of low porosity hydrophobic filters/frits. The packed-bed filter/frit assembly acts as a depth filter, facilitating the concurrent removal of both phospholipids and precipitated proteins during the extraction process. After the protein-precipitated sample passes through the HybridSPE-PPT device, the resulting effluent is free of phospholipids and ready for immediate LC-MS or LC-MS-MS analysis.



▲ *Precipitation schematic for HybridSPE-PPT 96-well format*

Mechanism Details:

When a plasma/serum sample is subjected to protein precipitation via the addition of acetonitrile (containing 1% formic acid), it passes through the HybridSPE-PPT packed bed. This packed bed consists of proprietary zirconia-coated silica particles. The zirconia sites exhibit Lewis acid (electron acceptor) properties. Structurally, phospholipids consist of a polar head group (zwitterionic phosphate moiety) and a large hydrophobic tail (two fatty acyl groups that are hydrophobic). The phosphate group—inherent with all phospholipids—acts as a very strong Lewis base that will interact strongly with zirconia atoms functionalized on the particle surface. Formic acid is a critical modifier used in the precipitation agent to improve the recovery of many analytes of interest (e.g., acidic compounds); it plays a critical role in preventing analyte retention without affecting the phospholipid retention/removal process.



▲ *Lewis acid-base interaction between Hybrid-SPE zirconia ions and phospholipids.*

In summary, the HybridSPE-PPT sample prep product is a valuable tool in LC-MS analysis; it helps to eliminate ion-suppression in MS detection, as well as the need for long gradient run times to elute on-column phospholipid build-up.

For more information, visit www.sigmaaldrich.com/hybridspe-ppt.

HybridSPE is a registered trademark of Sigma-Aldrich Biotechnology LP and Sigma-Aldrich Co.

Measuring Sample Volume and Detecting Precipitates

Problem: Significant time and effort is expended in screening chemical and biological sample libraries. However, no matter how advanced the screening system, the end results are only as good as the quality of the sample in the microplate wells.

Compound managers responsible for delivering samples in plate format to screening groups need to have confidence in the quality of their delivered product. Unfortunately, survey data suggests that up to 5 percent of microplate wells may be empty, and 3 to 5 percent of wells may have samples at the wrong concentration.

Empty plate wells—or wells with samples at the wrong concentration—can have a significant impact on the end results. In particular, precipitates in compound solutions not only lead to poor quality screening results, but also result in significant cost wastage. Knowing the sample volume in the source microtube, and whether there is any precipitate, prior to plating, is thus key to improving the quality of screening output.

Scientists need to know:

- If there is any sample in the source microtube
- How much volume of sample is in the tube
- If any of the sample has precipitated out of solution

Existing approaches using gravimetric, ultrasonic and other liquid level sensing methods have their disadvantages and cannot determine if sample has precipitated out of solution. A visual check can help spot precipitates, but this is a tedious task if conducted regularly for all samples, especially in a large library.

Solution: To improve the quality of delivered plates to screening groups and to reduce the cost of wasted screening (time, effort, reagents, missed hits, etc.), vision technology can be used to audit both volume and precipitate in racks of up to 96 tubes (without requiring de-capping).

RTS Tube Auditor™, a high-speed, high-resolution vision system, images multiple sample tubes simultaneously. The images are analyzed and the liquid meniscus detected for each tube audited. Once the position of the meniscus has been determined, the volume of liquid is calculated, taking into account tube and liquid types. Further algorithms are used to detect the presence of a cap and any precipitate in the base of the tube.

Benefits of this approach include:

- Speed: Less than 2 minutes to audit a 96 tube rack
- Accuracy: Volume measurement better than +/-10µl
- Precipitate and cap detection
- No need for tare-weighing
- Non-contact and operates with capped tubes

Suitable applications:

- Multiple applications within the CM/HTS process
- Biobanking
- Sample quality control and empty tube detection
- Sample dissolution and solubility quality checks
- Cap detection (to avoid liquid handling tip damage)

In addition to CM/HTS applications, this technology exhibits good performance when auditing DNA (in buffer) and other biological fluids, requiring significantly less time than conventional methods. Vision technology has made it possible to provide compound managers with a high-speed, high-accuracy instrument for auditing sample volumes and detecting precipitates.

Tedious manual visual checks or slow automated processes can be eliminated by the Tube Auditor™ with regular monitoring of sample tubes, increasing confidence in the quality of the sample being stored, thereby reducing the impact of variable quality on downstream processes such as screening.

For more information, visit www.rtslifescience.com.

▲ *RTS Tube Auditor*

PRODUCTS IN ACTION

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Thermo Scientific Sorvall MTX 150 Benchtop and MX Series Floor Model Micro-Ultracentrifuges

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Website: www.thermoscientific.com/centrifuges

Accurate Shearing of Chromosomal DNA

Problem: All contemporary, as well as NextGen and Third Generation sequencing methodologies are dependent on the generation of DNA fragments from initial MegaBase long chromosomal DNA molecules. General requirements are that such fragments have to be random and of similar size. Many methods of DNA fragmentation have been developed. Most of these methods include limitations and difficulties including high costs, fragmentation, broad fragment size distribution, or irreversible damage in DNA fragments. In addition, the results can become concentration dependant and/or not highly reproducible.

Solution: Digilab, Inc. has developed the HydroShear, an automated, inexpensive, highly reproducible, controllable, and easy-to-use device for the generation of random and tightly-distributed DNA fragments (maximal length being less than twice the size of the smallest ones for 90 percent of the resulting fragment mixture) based solely on hydrodynamic breakage of the double-stranded DNA. This process neither generates heat nor chemically alters DNA molecules, resulting in production of DNA fragments with minimal damage (previously published data suggested that about 60 percent of the resulting DNA fragments can be ligated and cloned even without additional end repair). It has been shown that single-stranded polynucleotides (both DNA and RNA) can also be sheared by the system and were found to be sheared more readily than the double-stranded ones. Successful use of the system has been already reported in more than 400 scientific publications.

The average size of the double-stranded DNA fragments (Figure 1) depends on several parameters that the end-user can easily control (by the type of shearing assembly that the customer chooses; the precise average fragment size can be fine tuned by an adjustable speed code parameter that determines the flow rate at which the DNA molecules are passed through the shearing assembly). The system is very reproducible and, if used with the same parameters, creates DNA fragments with the same size distribution every time regardless of DNA origin, initial size, concentration, or sample volume (within 50-500 µL range). A specifically designed washing procedure, recommended to be performed between two consecutive shearing events, guarantees that all traces of DNA potentially remaining within the system are destroyed and completely flushed out so the next sample is not cross-contaminated (each wash reduces the DNA concentration within the system approximately tenfold).

Digilab's latest model, the HydroShear Plus (Figure 2), completely automates both shearing and washing procedures, and is supplied with a complimentary Wash Solutions Kit designed to optimize HydroShear Plus performance, which is certified to be nuclease- and particle-free. The HydroShear Plus is equipped with a fortified syringe that pumps the DNA sample through the orifice of a shearing assembly unit. The standard shearing assembly unit can be used to generate DNA fragments with an average size from 1.4 to 8 kB. If larger DNA fragments are to be generated, a large shearing assembly unit is recommended. Using a small shearing assembly unit is recommended for the generation of fragments with average size from 0.85 to 3 kB. Shearing of DNA to the current smallest average fragment size (700 bp) can be achieved by using a special shearing assembly unit.

For more information, visit www.digilabglobal.com.

Figure 2. HydroShear Plus DNA/RNA Shearing System

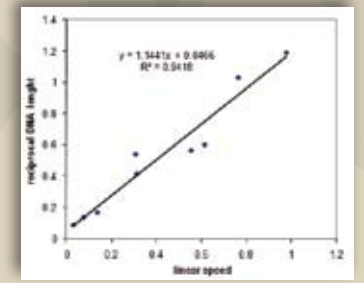

Figure 1. The average size of DNA fragments obtained with the HydroShear Plus system depends on the linear speed as the sample passes through the orifice, which is easily controlled by the speed code parameter.

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  The Economic Realities of Lab Automation, Joe Liscouski, Institute for Laboratory Automation

  Getting Your Staff and Boss to Think Outside the Box, Sam Liggero, Tufts Gordon Institute

  Success Stories on Implementing LEAN to Improve Lab Output, Jan Borge Jakobsen, Algeta

  Networks and Lab Management: It's All About the Beer, Mike Neag, AkzoNobel

  Interdepartmental Laboratory Equipment Teams, Forum for Equipment Standardization, Process Optimization, Time Savings, and Cost Reduction, Mike Mathiesen, Dial Henkel

  Managing Flexible Capacity Resources, Dave Pilosof, The Clorox Company

  Keeping Capabilities Current and Running Within a Limited Capital Budget, Marina Despotopoulou, Arkema Inc. and Phil Edwards, NOVA Chemicals

- **Roundtable Discussions:**
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Dr. Mary Viola, Tufts Gordon Institute and Dr. Jeanette Eberhardy, Wiv, Inc.

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- The study of leaves informs solar cell development
- And modeling the swarming of ants has led to breakthroughs in operational efficiencies in organizations like Southwest Airlines

Today's nature scientists and thought leaders are challenging our current definitions of resources, growth and economy. Can the study of nature's patterns lead us to new ways of thinking and allow us to re-energize our

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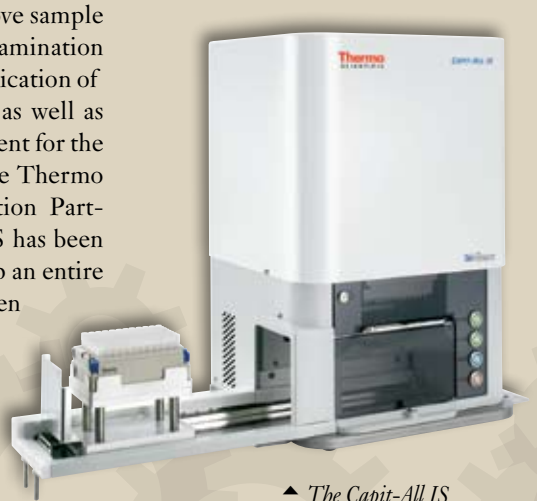
Maintaining Sample Viability

Problem: Screw cap tubes are found in the vast majority of laboratories and are commonly used for the long-term storage and cryopreservation of a plethora of sample types. Effectively maintaining sample integrity in these storage environments is of extreme importance to any researcher, and there are key factors that require consideration.

Although the tightening of these tubes may seem an insignificant process, the level of torque applied can be of paramount importance to successfully maintaining sample integrity. Tightening by hand is a slow process that can lead to repetitive strain injury (RSI) and that does not offer any measure of reproducibility. If the torque of the cap is not optimal, especially during multiple freeze-thaw cycles, samples can become exposed to external—often non-sterile—environments. Such exposure can subsequently result in attrition or contamination of the sample.

In order to circumvent potential cross contamination, slow sample processing and the risk of RSI, all while increasing throughput, laboratories employ the use of automated cappers/decappers. However, these instruments commonly use metal mandrels, which can distort and damage the caps. Also, most automated decappers don't define cycle limits for tube tightness and aren't designed to control the tightness of each tube individually. Consequently, the potential for sample loss and contamination is increased, which can further affect sample viability and concentration, thereby compromising the integrity of any resulting data.

Solution: One way to improve sample integrity and alleviate contamination concerns is to ensure the application of optimal torque to each tube as well as to maintain a clean environment for the tubes when open. As such, the Thermo Scientific and The Automation Partnership (TAP) Capit-All® IS has been designed to de-cap and re-cap an entire rack of samples in less than ten seconds, tightening each tube to its optimal torque at the push of a button. Every tube is individually sealed by its own separate clutch mechanism to a pre-optimized tightness, ensuring secure capping. Furthermore, a novel sealing mechanism prevents the occurrence of cross threading and over tightening, ensuring that all samples are contained within airtight tubes. The decapper is guaranteed to process over one million samples before service maintenance is required.



▲ *The Capit-All IS automated capper/decapper.*

Distortion or damage to the caps after repeated use is prevented via the incorporation of plastic mandrels that fit perfectly into the recesses of the cap. Particulates caused by distortion are eliminated. The lifespan of the tubes and caps is maximized, and sample integrity is effectively maintained. What is more, the Capit-All IS successfully eliminates the risk of RSI, while significantly increasing throughput. With the capability to seal all 96 tubes simultaneously, for fast, quality capping, researchers can effectively integrate the instrument with automated liquid handling platforms to streamline their workflows for an efficient, high-throughput experiment.

In addition to optimally tightening caps to minimize exposure to external conditions, sample integrity is further maintained through a number of contamination control measures. An easy-to-clean drip tray captures and contains sample droplets, significantly reducing the potential for cross-contamination during tube entry and removal from the instrument. Furthermore, no disassembly is required for routine cleaning and maintenance, reducing the possibility of contamination from debris and other external sources. The incorporation of an extraction port also ensures that any aerosols or particulates that are present within the instrument are completely removed.

For further information, please visit www.thermoscientific.com/matrix.

Capit-All IS is a registered trademark of The Automated Partnership.

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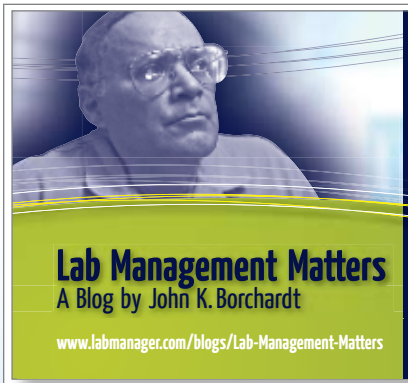
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PARTING POINTS

Takeaways from this month's issue:

Q IS FOR QUALITY

Many laboratories are organized along in-house models or as service entities that provide an array of analytical testing for a variety of customers. Bad quality can rob a lab of good customers. Here are some key areas on which to focus to ensure a high level of quality in the lab.

- Agency regulations (EPA, FDA, etc.) are binding requirements, not merely suggestions
- Training should be ongoing to keep up with changing technology and new regulations
- Well-trained personnel are a vital component of a well-functioning lab
- When people are overworked and worn out, quality suffers

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LEADING CHANGE

Changes aren't easy to achieve. Well-educated, bright and motivated people can be resistant to change. However, the change process can be understood, and change can be implemented more successfully and more reliably by following a few rules.

- Establish a sense of urgency and create a guiding coalition
- Develop a vision and strategy, and communicate that vision
- Empower broad-based action and generate short-term wins
- Consolidate gains and produce more change, then anchor new approaches in the culture

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MANAGING THE COMING DATA FLOOD

Lab managers will face an increasing challenge in the next decade—managing a rising tide of data. To realize the full benefit and value of these data requires effective data management techniques, institutional arrangements and policies. Some of the factors contributing to the flood are:

- Globalization of research and open innovation
- Cloud computing, which is web-accessible data storage and processing
- The use of supercomputers, which enable the creation and processing of large volumes of data

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PERSPECTIVE ON: AN ENVIRONMENTAL LAB

Advanced Environmental Laboratories Inc. (AEL) performs tests for numerous clients including federal agencies such as the Air Force and the EPA. Bob Dempsey, lab manager of the Jacksonville branch, says their success comes from a combination of proper scheduling, communication, and a trained and dedicated staff. Here are some of Dempsey's management tips:

- Communication between employees and clients is one of the most important skills to use
- When time and resources allow, show gratitude to staff with relaxed group functions
- Use a LIMS to log and track samples
- Treat employees fairly. When people enjoy their jobs, it rubs off onto the clients.

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MANAGING OBSOLESCENCE

It is natural to focus on the high cost of replacing an old instrument, but updating obsolete technology can bring many benefits including financial savings, higher efficiency, improved safety and lower maintenance. Here are some of the benefits to upgrading obsolete instruments.

- Faster sample turnaround time—in some cases, analysis time is reduced by as much as an order of magnitude
- Smaller carbon footprint—Newer technologies permit smaller sample sizes, reducing waste disposal quantities and costs
- Ease-of-use—Nearly every instrument is run by software that helps interpret data

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